

INFORMATION SHARING AS A NETWORKING ACTIVITY. CASE OF R&D COLLABORATION IN THE ICT SECTOR

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Abstract

This study examines the nature of information sharing activity in the context of buyer-seller relationship, more specifically R&D (research and development) collaboration. Information sharing is assessed by its content, media and style in different phases of the R&D programs. Especially, challenges and success factors relating to information sharing are identified. The theoretical background focuses on particular features of information sharing needed in R&D collaboration. The study has been conducted as a single case study with three Sub-Cases in the Finnish ICT (Information and Communication Technology) sector. The results indicate that especially the success of the specification phase is a critical factor in the information sharing, although emphasis should be given to the early phases of the program in general. This study verifies the fact that the nature of R&D collaboration as such emphasizes the role of face-to-face contacts as an information sharing medium.

Keywords: information sharing, R&D collaboration, ICT sector

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Introduction

The purpose of this study is to analyze the information sharing process between the focal company and its R&D suppliers. Indeed, information sharing has been identified as an important success factor in buyer-supplier relationships (see e.g. Ellram, 1991; Mohr and Spekman, 1994) and in new product development (e.g. Brown and Eisenhardt, 1995) When combining the complex buyer-supplier interaction with the turbulent telecommunication business and specific challenges relating to R&D collaboration, information sharing becomes a challenging field to manage.

The trends of networking and outsourcing have increased the need for inter-organizational communication and interaction. However, the networking of companies makes information sharing difficult and challenging to manage. First, sharing of proprietary information with business partners is often a necessity when doing business. The trend towards partnerships between suppliers and buyers means that buyers are sharing not only product technology, but also process technology to aid suppliers in delivering quality goods on a just-in-time basis. This necessity of open information sharing increases the risk of losing proprietary information. There is also a trade-off between widely disseminated information and protection of information: effective information processing mandates that information is widely available and shared, whereas such wide dissemination can jeopardize the firm's ability to retain proprietary ownership over important information which forms the basis of their competitive advantage (Mohr 1996). Leverick and Cooper (1998, 78) have made a similar finding when saying that "the sharing of sensitive information with a partner has already been identified as a danger area in collaboration management." Moreover, when considering the risks of collaboration, the following issues were put forward: the leakage of firm's skills, experience, and knowledge (Parker 2000), and the risk of divergent aims and objectives resulting in conflict (Tidd, Bessant and Pavitt, 2001).

The nature of the R&D context clearly makes information sharing more challenging, because the content of information is not always locked at the beginning of the development project, and even the customers cannot specify exactly what they want. This means that the development process must be kept open for customer feedback and other change requests coming from other functions or development projects within the focal company. This may result in changes in the requirements and subsequent modifications in the product. (Segelod and Jordan, 2004) Another feature of the new product development is the complexity of information to be shared: future products consist of many elements, which must match each other, and they include a lot of detailed product information (codes, specifications, product features, etc). There is also a fear of losing direct control over the R&D process in the organization, as reported by Parker (2000). Moreover, the changing competitive

environment forces much more planning, coordination, and review to take place during the design and development process than previously. (Hart and Baker, 1994) Finally, information sharing is found challenging because it is so strongly related to “people issues” and culture, as stated by Ruggles (1998, cited from Jarvenpaa and Staples, 2000).

Furthermore, the nature of telecommunication sector emphasizes the need for managing information sharing. Firstly, companies are increasingly working against the clock, and the business logic has changed. Secondly, the increased use of outsourcing of manufacturing and R&D to suppliers, shorter product life cycles, and compressed time-to-market have induced changes in coordination mechanisms. (Agrell, Lindroth, and Norrman, 2004) As a consequence, circumstances affecting information sharing become significant in complex networks which include different types of companies, resources, and capabilities. This task is even more challenging because of the fact that companies often lack the necessary supplier management capabilities required in the coordination task (Wagner and Boutellier, 2002). These challenges become emphasized, since there are some typical problems relating to the management of information sharing especially when considering the perspective of supply management. Such problems include poor guidelines for supplier involvement, integrating suppliers with company systems not implemented correctly, standardization efforts hindered by outdated information, buyer’s engineers are not well trained in the supplier’s components, and the supplier’s output is not incorporated into the design because the buyer engineer does not appreciate the value of the supplier’s contribution. (McIvor and Humphreys, 2004)

As a consequence, the objective of this study is to increase our understanding of information sharing as a networking activity. To be more precise, the aim is to find out how to share information in the context of R&D collaboration? Being such a wide phenomenon, the focus is on analyzing the major challenges and their success factors appearing in information content, media and style from the viewpoint of supplier management.

This study is structured as follows. In the following section the information sharing concept is clarified. After that the facets of information sharing are reviewed. Then the research design and methodology are introduced and the empirical results will be revealed. After that the study findings are summarized and discussed. Finally, the main contribution and the limitations are considered, and future research issues are suggested.

Conceptualization

The main concepts of the study are networking and information sharing. Johnsen et al. (2000) define networking “as a transformation process of ‘independent’ actors and resources into a more closely knit configuration of a supply network.” It highlights the interaction (i.e. information sharing process) of actors (the focal company and the suppliers) who exchange resources (R&D and related information).

Information sharing, communication, knowledge transfer, and data exchange – they all have a similar meaning as the concepts refer to the informational interaction between two or more participants. However, they have not always been defined distinctly and are used in a disorganized manner depending on the research stream and author (see e.g. Gooijer, 2000; Lueg, 2001; Warkentin, Bapna, and Sugumaran, 2000). In terms of the definition of information Sveiby (1996, 382) points out the Oxford English Dictionary definition of information, and how it is connected both to knowledge and communication: “Information is knowledge communicated concerning some particular fact, subject or event; that of which one is apprised to tell; intelligence, news.” Often information is regarded as explicit knowledge (Nonaka and Takeuchi, 1995), and is differentiated from another familiar concept, “tacit knowledge”. In fact, knowledge refers to the application and productive use of information (Davis and Botkin, 1994), or as stated by Nonaka and Takeuchi (1995, 58), “knowledge is about beliefs, commitment and action. Thus, information is context-specific and relational, and a flow of messages.” In this study the following definition of information is used: “Information refers

to anything in verbal, written, or symbolic form that can be read, viewed, heard and comprehended by another human being” (Allee, 2003, 82).

Halinen (1997) makes a distinction between information sharing and social exchange, which together constitute the concept communication. Another classification is provided by Mohr and Spekman (1994), who define information sharing referring “to the extent to which critical, often proprietary, information is communicated to one’s partner.” The phrase sharing of information could be used as a synonym for exchange or communication with only slight distinction: exchange takes place between two or more partners, whereas sharing is one-way (in this research, information sharing originates from the focal company, and sharing is a well-reasoned concept to be used). According to Jarvenpaa and Staples (2000, 130), information sharing embeds the notion of willingness to share. Accordingly, involuntary information sharing is actually called information reporting, whereas information sharing is understood as a voluntary act of making information available to others.

To summarize, the phrase information sharing, used in this study, refers to the voluntary, one-way act controlled by the focal company. The definition provided earlier by Mohr and Spekman (1994) is useful in the context of this study. It not only expresses the content of action, but also relates the communication aspect to the concept. Although communication – referring to the social exchange between individuals – is intentionally limited out of the focus of this study, it cannot be totally ignored. Especially when dealing with information sharing media, the role of communication and its social dimension is emphasized. In other words, sharing of information, for example, during face-to-face meetings involves a high amount of social exchange, and therefore the communication aspects must be included in the analysis.

Facets of information sharing

This section clarifies information sharing as a networking activity and the characteristics of it will be categorized. Information quality and quantity are the main determinants. Leung, Wong, and Chow (2003) classify information quality into content, form, and time characteristics. The authors introduce information quantity that refers to the information flow frequency. On the other hand, Mohr and Nevin (1990) perceive frequency, direction (directionality is not discussed here, because the starting point in the analysis is one-way information sharing, and therefore directionality is not relevant), modality, and content as a combination of communication facets. Mohr and Spekman (1994) speak about communication quality, and contend that quality includes such aspects as the accuracy, timeliness, adequacy, and credibility of information exchanged. Furthermore, Albino, Garavelli, and Schiuma (1999) contend that media is characterized by code and channel, which means that they regard code (i.e. content of information being exchanged) as part of the media. According to the authors, the channel is the means by which information is shared. Maltz (2000) suggests three dimensions to be used in the typology of interfunctional communication modes: richness, spontaneity, and speed.

As it can be seen, the features or facets of information sharing vary a lot among the researchers. The following sections describe the nature of information sharing divided into three parts: the content of information, media to share information, and style of information sharing which include both qualitative and quantitative attributes. This categorization will be used later in the study when analyzing the nature of information sharing in R&D collaboration. Furthermore, in order to specify the information sharing activity, the process of networking is divided into three parts according to the phases of R&D: beginning, middle, and end of the R&D program.

Content

According to Mohr and Nevin (1990), content refers to the message that is transmitted or what is said. Evans and Wurster (1997) divide information attributes into richness and reach, which include both the information content and sharing. Richness indicates the amount of information (bandwidth), the degree of customization of information, and interactivity. Reach will be dealt with in the

following section in the style characteristics. According to Maltz (2000, 112), “richness refers to the degree to which the mode of communication is able to provide instantaneous feedback for the receiver, and to the number of cues that can be used by the receiver to interpret the information being communicated.” This definition of richness is linked to the communication mode (see the following section).

The most general information shared between suppliers and buyers is demand information (Harland et al., 2004). In R&D collaboration the type or content of information is typically related to the design of a product. The most important levels are the operational level and the strategic level. Harland et al. (2004) highlight the importance of exchanging strategic information in the supply network in order to ensure the long-term prosperity of the network. This would include strategy, market, technology, and new product information. Larson and Kulchitsky (2000, 32), on the other hand, suggest that “strategic communication supports or shapes competitive advantage and may include information such as new market/product plans, long-term forecasts, and financial information.” Another type of communication used by Larson and Kulchitsky is tactical communication, which refers to day-to-day operations. According to these authors, face-to-face contact and phone were strongly preferred in strategic communication while other media were used in tactical communication. Instead of making a difference between the strategic or operational content, Zahay, Griffin, and Frederick (2004) use the source of information as the classification criterion. Information types range from those internally developed to those obtained from sources external to the firm. As an example, strategic and project management information is typically developed internally whereas technical information is developed both internally and externally.

Media

Advances in technology and IT have also brought forward the technological aspect in information sharing. Leek, Turnbull, and Naude (2003) have discussed the change that the development of information technologies causes in the use of communication tools. According to the study, the newer methods of communication (including mobile phone, email, audio- and videoconferencing) are enhancing interaction between businesses, but they do not replace the more traditional methods (landline phone, fax). Mohr and Nevin (1990) present several ways in which communication media can be classified. For example, media can be either face-to-face, written, telephone, or other modes. Another categorization principle is to consider the medium’s ability to transmit rich information where face-to-face is the richest medium followed by video-phone, video-conference, telephone, electronic mail, personally addressed documents to formally, unaddressed documents. (Mohr and Nevin, 1990) Larson and Kulchitsky (2000) distinguish between personal (face-to-face contact and telephone), mechanical (mail and fax), and electric communication tools (EDI and e-mail/Internet). Maltz (2000) presents four general modes of communication, namely written communication, electronic communication, telephone, and face-to-face. Another classification is made between a synchronous and asynchronous medium (Patrashkova and McComb, 2004). Sakthivel (2005) also adopts this type of categorization, as she takes time and place aspects into account. Synchronous media, such as face-to-face meetings and telephone conversations occur when two or more team members engage in the communication act at the same time. Asynchronous media refer to the communication that takes place at the different time (e.g., emails). These two communication media also differ in their capabilities to share information: synchronous media are called rich media since they are able to transfer more information per message than asynchronous media.

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

Style

The style of information sharing is understood as features that describe the process of information sharing. The style of information sharing includes, among other things, the consistency (the formats or processes used to communicate data as explained by Schurr and Pazer, 2002), spontaneity (whether the receiver has received advance notice of the communication encounter), and speed (the degree to which the sender can transmit information instantaneously) (Maltz, 2000). According to Evans and Wurster (1997), reach means the number of people who exchange information. Huang, Lau, and Mak (2003) use the term neighborhood within this context. It indicates those with whom the information is shared. Determining the companies (and parties) involved in the information sharing process is essential, since information sharing is always associated with some costs (e.g., acquisition of information, installation of information system) and barriers (e.g., privacy of information). Mohr and Nevin (1990) suggest the term adequacy to be used in defining the quantified feature. When speaking of the adequacy of information sharing, it has also been noticed that the lack of information creates problems. Ring and Van de Ven (1992, 488) state that “the lack of information may be a result of scientific or engineering uncertainty, or a consequence of information asymmetries.”

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

Summary

The multidimensional nature of information sharing was illustrated above. When considering the nature of information sharing in the R&D collaboration context, some of the features are clearly emphasized. Additionally, for the analytical purposes needed in the empirical part, a couple of features will be selected from each category. First, the content plays a critical role because of the sensitive nature and complexity of R&D information. The sensitivity of R&D information refers to the very essence of company's competitive advantage: what is the core content of their products and what product areas are given emphasis in R&D in the future? This requires decisions about the openness (transparency) and adequacy of information sharing in particular. Additionally, the adequacy is an important measure, since the lack of information affects the degree of risk faced by the parties to a transaction. These decisions should be evaluated both on the operational level (relating to technical and project information) and on the strategic level (relating to business information, such as financial information, future-oriented supplier and technology strategies). Secondly, the complexity of R&D information forces a company to rethink their resources, capabilities and processes with their key partners in order to guarantee a smooth process to share and exchange information. Consequently, the features of information sharing frequency and other style attributes combined with the right information sharing media are emphasized. In terms of frequency it is not essential to count every phone call or email sent, but to evaluate on a general level the work load of information sharing. The frequency of meetings is easier to calculate, since they are often organized according to a certain schedule. Finally, it will be pointed out that the choice of the medium also involves a notion of information richness, which is closely related to the openness and transparency of information sharing.

Research design and methodology

This study is a qualitative, mainly descriptive case study in its nature (see e.g. Yin, 2003), where the empirical evidence has been collected in a Finnish ICT company. The main argument for the case study research method here is that the research problem is very complex in its nature: it includes many variables and concepts which are not easy to grasp with a quantitative study, for example.

Three R&D programs, known also as Sub-Cases, represent the units of analysis. Since the perspective of analysis is the focal company and how it perceives information sharing in R&D collaboration, the case study is defined as a single case instead of multiple case studies, in spite of the three separate Sub-Cases. This decision is based on the argument that since the focal company is the same in each R&D network, there are similarities in strategic decisions, organization, and company culture. In each R&D program one buyer-(R&D)supplier relationship is analyzed from the viewpoint of nature of information sharing. The collaboration between the focal company and its R&D suppliers can be described very close and intense, which is also the selection criterion of the R&D supplier. All the R&D programs selected for the study and the products being developed within these are complex and highly innovative technologically. The reason for this kind of scope was to show that R&D collaboration includes extensive information sharing (see e.g. Bensaou, 1999; Lamming et al., 2000). To summarize, the following figure illustrates the Case Company, the three Sub-Cases, and different parties involved in the study.

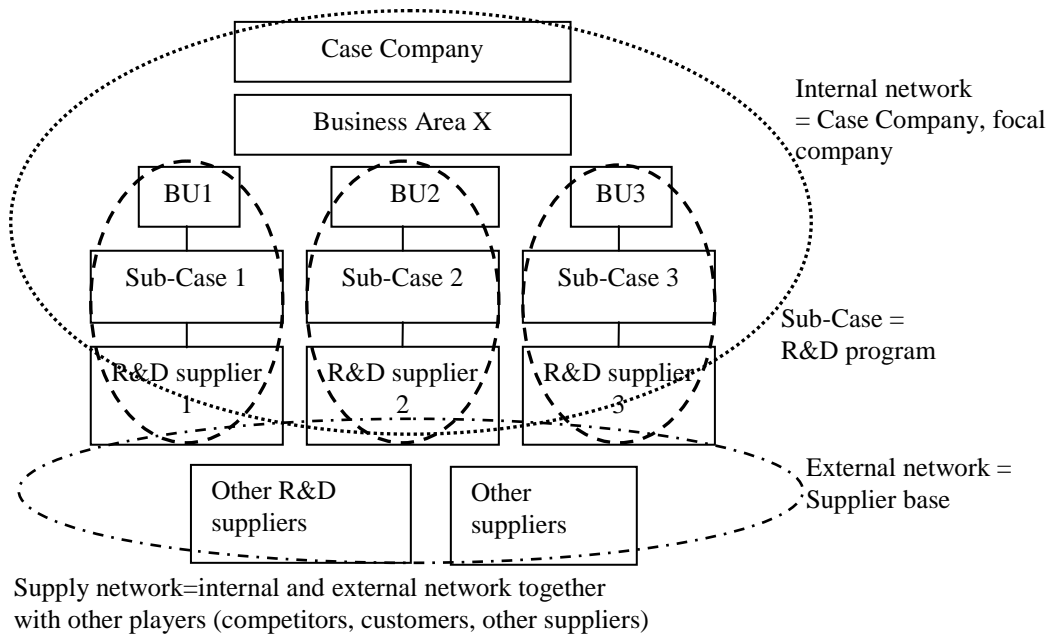


Figure 1. Empirical research context

The empirical evidence is based on interviews conducted in the focal company. Altogether 19 interviews were held. In each Sub-Case there were several interviewees from the collaboration management level to the program level. Additionally two introductory “interview-type” sessions were held with the key informants of the Case Company. The interviews were semi-structured theme interviews in their nature, which helped to gain a holistic view of information sharing in R&D collaboration. All interviews were taped and transcribed, and contained altogether 350 pages, making approximately 18 pages per each interview. After this the interview data was classified, categorized, coded, and analyzed (see Yin, 2003, and Miles and Huberman, 1994) for the process of dealing with the interview data).

Introduction to the empirical research setting

The Case Company can be defined as a supplier of mobile, broadband, IP (Internet Protocol) network infrastructure and related services. The Case Company owns the brand of the products being bought from the supply market, which emphasizes their role in the network. The Case Company consists of several Business Areas, but this study focuses only on one of them (called Business Area X). This choice is based on the fact that the Business Area in question is large, and there is a great variety of products within it. The Business Area which is in the focus of this study is characterized by project-based production instead of mass production. There are three business units in this Business Area,

and one R&D program was selected from each business unit. Next, these three Sub-Cases will be shortly introduced.

Sub-Cases

All the R&D programs selected for this study developed a complex product and the R&D tasks given to the suppliers could be considered complex as well. The relationships between the focal company and each of three R&D suppliers had last at least five years. Sub-Case 1 developed a hardware/software product, and the program was the biggest among the three Sub-Cases. The R&D supplier in this program was Finnish. The program was carried out in several sites in Finland and additionally in one European country. Sub-Case 2 was a software program. The program was middle size when comparing to other two programs. The R&D supplier in this program was Asian, and the program was carried out in several sites in Finland and additionally in two sites in one Asian country. Sub-Case 3 was a hardware program. The program size was small in comparison to the other two programs. The R&D supplier in this program was Finnish. The program was carried out in several sites in Finland, and in contrast to the other Sub-Cases, the R&D supplier was located in the same city as the rest of the program team. These differences between the Sub-Cases are essential to report, since they may have an influence on the information sharing process, as will be shown later.

Research and development process

In the Case Company, R&D activities are performed in R&D programs. One program consists of several sub-projects, which can be either R&D projects or others, such as quality assurance or customer documentation. In this study the R&D program is divided into three main episodes or phases, which differ slightly from the five phases defined by the Case Company (the episodes are based on information gained from the Case Company Material, 2005). This was justified because, firstly, there is no need to go through the phases in too much detail, and secondly, the intention is to avoid revealing the Case Company's R&D process. In fact, it is assumed that making a difference between the beginning, the middle and the end provides enough distinction between the phases for analytical purposes. Additionally, there is a so-called pre-planning phase, where many important decisions are being made in terms of the R&D program. Episode -1 comprises the following two phases presented in the literature: 1) idea generation, and 2) business/technical assessment. This episode has been left out of the study due to the following reasons: i) the R&D program was not yet thoroughly defined, ii) issues on information sharing were restricted only to a small number of company's own staff, meaning that information sharing was already well-controlled, and iii) suppliers were not included to great extent in this episode. Episode 1 includes the planning of the program, and the program will begin with full resources. In Episode 2 the main development or production tasks are being done. In Episode 3 the product is prepared for larger production. Before conducting the empirical research it was assumed in the discussions with the Case Company advisors that information sharing during Episodes 1–3 was easier than in the pre-planning phase. This could be assumed, because there already existed the idea of a product being developed. However, the R&D process was regarded challenging, because the specifications and standards adjust and develop during the program. This creates challenges, for example, in the field of change management and decision-making. These challenges are further increased in the collaboration, when also the questions of proprietary information sharing come to place. In addition, the challenges are emphasized when the program begins, because a large number of people become involved. Therefore, the limitation of the study to the above-mentioned three episodes is well justified.

Empirical research results

In this section the results of the interviews are presented. First, the content, media and main features of information sharing between the collaborating parties are reported. An attention will be paid to the challenges and problematic issues as well as their management practices found out in the Sub-Cases. These issues will be then placed in the different phases (i.e. episodes) of the R&D program.

Content of information sharing

The type of information shared in the R&D phase fall into two main categories: The strategic information (business information), and 2) the operational information (technical R&D information and program/project information). In the R&D collaboration context, operational information sharing takes place on the R&D program level, whereas the strategic information is shared in the supplier management steering groups and in other similar forums. Information is shared based on the actual need, avoiding everything-to-everyone. The strategic information consists of future trends and business strategies, the forthcoming programs where the supplier might have a role, product roadmaps, and financial information. In the upper management meetings information that is not shared is clear: third party information cannot be told, and for the most part the companies are careful when telling about the strategies and financial information, such as prices. It was indicated in the interviews that the way in which the focal company reveals their business strategy, future focus areas and technologies is very important to the supplier. The supplier can concentrate on these specific areas and increase their capability already before the forthcoming R&D programs and collaboration. When moving to the operational level, namely, onto the R&D program and project levels, the content of information is very clear: practically all technical information is shared with the supplier. This includes information about specifications, codes, and test plans, among other things. During the interviews it became clear that information sharing culminates with the sharing and understanding of specifications.

One challenge in writing specifications is that it is difficult to forecast what the customer wants. Therefore, it should be checked earlier together with the customer, whether the requirements match the customer requirements. This requires close cooperation with the marketing unit and the R&D program management. Another challenge is that specifications require a deep understanding of the product being developed, and this type of capability is increased only when collaborating with the specific focal company. Therefore, it is highly important that the supplier understands what they should do in the program, and the way in which the specifications are done and explained to the supplier becomes the key issue. In the studied programs the specifications were guided and done mainly in meetings or email exchange. The supplier's participation in the specifications phase depended on the project in question: the specifications were often done in the focal company, but in some projects the responsibility was given to the supplier, or specifications were done together. This organizational issue turned out to be critical in the success of the specification phase, and this calls for cooperation between the collaboration unit and the R&D program management. A further direction for the R&D program management is to cooperate with the production unit. One important task is to make sure that the product being developed is easy to produce: for example, the number of components must be kept reasonable. Naturally this task is highlighted in the production of hardware. In order to communicate production-specific product targets to the R&D program, the representative of the production team often attends the R&D program meetings throughout the R&D process.

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

Several challenges relating to the content of information sharing were reported. One challenge in the interaction was that a lot of issues are taken for granted: it just does not come to mind to share every piece of information. Additionally, the following types of questions were asked: Which issues must be documented and which should not? Who needs this piece of information? How detailed a piece of information on product roadmaps can be shared with the suppliers? How do they get that information? These questions were asked especially in the beginning of the program, and they came

up mainly in Sub-Cases 1 and 2. Asking these types of questions obviously tells us that the guidelines for information sharing are not detailed enough.

Media

The media of information shared in the R&D phase can roughly be divided into the following types as was suggested in the theoretical part: i) official face-to-face meetings (e.g., steering groups and project meetings with agenda), ii) unofficial face-to-face meetings (e.g., coffee and cigarette breaks, and other ad-hoc meetings), iii) telephone, iv) email, v) (common) databases, vi) net meetings and telephone conferencing, and vii) other (onsite coordinator). These media can be divided into synchronous and asynchronous media. Interaction by synchronous media consists of information sharing and social exchange, and could be called communication. Communication takes place in face-to-face contacts (including onsite coordinators), telephone conversations, net meetings, and over cups of coffee. Asynchronous media – where the term information sharing is more appropriate – expresses a documented and therefore a formal way to share information, where team members engage in communication at different times. These both ways are important in R&D collaboration.

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

An alternative to face-to-face meetings are net meetings which decrease the amount of traveling. Net meetings proved to be an important way to share information especially in the multisite organization. However, these meetings often suffered from poor quality in voice and picture, which was emphasized when speaking in another language and especially when having a strong accent (this last point came up especially in the Sub-Case 2). Additionally, delivering the meeting material was sometimes difficult because of technical restrictions (firewalls). Telephone is a good medium when there is a need to get things clear right away, but the problem is that there is no later evidence of the conversation held on the phone. The interviewees also told that telephone could have been used more often instead of emails. The problem with the telephone is the barrier when speaking in another language: it is often easier to send email. Moreover, in Sub-Case 2 one reason for not calling was that the program’s employees with the supplier did not have a telephone.

Onsite coordinators were an essential part in interaction in Sub-Case 2. They were located in the focal company’s site partly in order to get information what is being done in the program. In fact, persons who were called onsite coordinators represented the supplier’s team and acted in the interface between the two companies. In a way the onsite coordinator was the substitute of the supplier for the program manager. There were also other supplier personnel in the focal company’s site, but they were normal project workers. In addition, to ensure information sharing with the supplier’s team in their home country, it was possible that only the onsite coordinator had access to the tools required in the development work: it was not always possible to arrange these tools and access to them in the supplier’s site. Furthermore, it was important that the supplier’s representative also had an email account in the focal company’s domain: it decreased the threshold to send email. Additionally it was easier to have interaction with onsite coordinators than persons who were working far away.

Coffee break visibility is also important. An example is given in Sub-Case 1: The physical relocation of the supplier employees led to a decrease in conversations and informal discussions over cups of coffee. As a result, it was noticed that the specifications and other documents were no longer on a sufficient level for the supplier, because the coffee break visibility was lost and these informal discussions had included a lot of information that was not documented.

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

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

Style

The nature of the interaction style could be regarded by the following attributes: openness, frequency, and adequacy of information sharing. Information sharing was described open and smooth in all three R&D programs, although there were some extra challenges related to the cultural differences in Sub-Case 2. An example of open information sharing is a situation where the project manager comes from the supplier organization. They may be present in the program management meetings just like the project managers from the focal company and get the same information as others though being a supplier's representative. In some cases information sharing was more open than in others. The supplier's position and persons participating in the steering groups had an influence on the content and sensitivity of information shared in the steering group. One proof of open information sharing in the steering group concerned information which was not even shared with the companies' own personnel. One explanation for such a bold way to share information might have been the experience of the top managers and the ability to tell information so that it did not reveal too much to the partner. Moreover, having more face-to-face meetings may have had an influence on the openness of information sharing: the same information probably would have not been shared, for instance, in emails.

Information sharing took place rather frequently. This was an obvious finding in each program excluding two sub-projects (in Sub-Cases 2 and 3) where information sharing was rather limited and mostly took place in weekly meetings. The high frequency of information sharing was mostly a consequence of a complex R&D task, and in this sense, the high frequency can not be always considered as a positive issue. In fact, complex R&D tasks (described as having a lot of technical and human interfaces, and being not an “independent entity”) often lead to increased amount of specifications, which increases the need for overall communication. Secondly, since the technology in the current telecommunication business is immature, specification changes take place frequently anyway. These features make information sharing even more challenging in the current business.

Basically information sharing was regarded adequate due to the open and smooth process. However, the adequacy of information was difficult to evaluate, because the suppliers were not interviewed. In Sub-Case 2 it was admitted that more information could have been shared with the supplier. This was difficult partly because it was not known what the current situation with the supplier was; what kinds of problems and challenges they faced, among other things. Some interviewees said that busy

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

Episodes

The content, media and style of information sharing get specific characteristics according to the phase in the R&D program. It is useful to describe these characteristics in different episodes, because it will help to specify certain management means within the phases of the R&D program. It was proposed earlier that in the R&D context these episodes could be the beginning, the middle and the end of the program representing planning, production/development, and delivery. Although excluding the pre-planning phase from this study, it must be reminded that important decisions concerning the program are made in this phase (e.g., the make-or-buy decision). After the R&D program has started, product features are clarified and the program and project plans are finished. By the end of the first episode the supplier has been selected and all parties involved should be aware of the development tasks, namely, the responsibilities and the working methods. However, even in the end of the first episode there were no clear plans what the supplier was expected to do. Therefore, when the program began, information was not as structured as it was expected before the interviews.

During the first episode the need for information is the biggest, and information sharing may not be adequate enough. This might be due to several reasons. First of all, the supplier's contact in the focal company (normally the project manager) may not have enough time to provide all the information at once to everybody. Secondly, there may be suspicions in the beginning of the collaboration, especially if the different parties have not met each other. Particularly the beginning of the R&D program is characterized by the challenges in information systems. It takes a lot of time to get access rights defined, and this is not always taken into account when the R&D program begins. In Sub-Case 1 it was experienced that it was difficult to restrict the access rights of suppliers to relevant information: either the supplier saw nothing or they might have seen everything. This was improved later as a new common database was launched. Another challenging issue in the programs was having two programs going on at the same time: this may lead to a lack of support for the supplier when an old program is ending and a new one has already started.

Physical proximity and face-to-face meetings mean more in the beginning of the program, when team members get to know each other. Afterwards it is easier to communicate by other media. Cultural differences are an exception: for instance, in Sub-Case 2 face-to-face contacts were important throughout the program. The main development work was done in the middle phase of the R&D program. Information was shared on a frequent basis, although it could vary from daily meetings to monthly meetings. At this phase information sharing received special attention when problems arose. For example, detecting errors in the test phase could increase the frequency of meetings from one meeting in two weeks to two meetings in one week or even every day. The focal company had strongly pointed out that suppliers should inform them right away about any problematic issues.

The end of the R&D program focused on moving the developed product into production. Information shared in this phase consisted of final program and project reports. In the end of the R&D program it became crucial to transfer the supplier's know-how back to the focal company (or the third party, who was responsible for production). However, this part of the interaction (information flows from the supplier to the buyer) is not examined in this study and in fact, this type of interaction refers mainly to the knowledge transfer instead of information sharing.

Summary and discussion

In the description above, information sharing has been regarded as a one-way action from the focal organization to the suppliers. Several challenges have been reported in this interaction between the participating companies. Consequently, it becomes important to analyze the problematic areas in the interaction process and other factors relating to the relationship and generic business environment.

The nature of information sharing varied depending on the episode of R&D collaboration, and the early phase of the program is critical in the success of collaboration. In the first episode the sharing of specifications and project plans was important, and there was a lot of interaction taking place between the companies. Still, the adequacy of information might have been poor. Therefore, the focal company should make sure that the supplier had enough technical support in the interface. The openness of information was lower, because the collaboration parties did not know each other very well, but it must be pointed out that in general all the interaction can be described very open (it was just least open in the beginning).

Face-to-face contacts were highlighted as an information sharing medium in R&D collaboration. Email is a medium that was used a lot, but it was also claimed for being a slow way to discuss and solve problems. Too many emails were sent, which increased the possibility to lose important information. Net meetings turned out to be an important medium in the multisite organization, but the medium suffered from poor quality. Some interviewees claimed that technical issues (access right management, functionality of the extranet solution) made information sharing challenging, and the supplier did not have the latest information available right away. Typically, the supplier did not have access rights, the employees could not use the common database, and access right management was not controlled. One problem with the media was that they were not ready when the program began. The changes in information systems created big challenges as well: for instance, audit revealed problems in the common database when some of the earlier program's information was not available. Due to these reasons it is important to pay attention to the careful pre-planning of the program. However, it must be stressed that many of the media-related issues presented here were identified challenging already in-house. Therefore, they are not particularly collaboration-related, although the challenges may be emphasized, for example, due to using a foreign language and strong accent.

When comparing these findings with the existing research, a couple of notions can be made. It was contended in the theoretical part (Zahay et al. 2004) that information shared in the NPD process may constitute of eight types of information. However, in this study the focus was given only on two rough categories, namely, strategic and operative information. Additionally, the operative information was limited to the technical and project information, and other types of information were excluded (e.g. customer information). All in all it can be stated that the ways in which the Case Company shares strategic information is in line with the findings of the previous studies. The empirical research verified the fact that strategic communication should be shared in face-to-face contact, while sharing of operational information could be shared in an asynchronous way (see the study by Larson and Kulchitsky, 2000). However, this study revealed one significant area in the operational information, which also requires a face-to-face contact: sharing of technical R&D information, such as specifications. Furthermore, it was also found out that sharing of strategic information is very important already before the beginning of the R&D program, since sharing information about the future business and strategies is a good way to improve the supplier's capability. The similar finding is reported in the study by van Echelt et al. (2008).

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

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

to share specification information in a face-to-face contact, or the supplier could take the responsibility of doing specifications.

Another challenge in R&D collaboration derives from the turbulent and immature ICT business. Indeed, the role of technological maturity in information sharing requires more explanation. The studied R&D programs represented different technology areas: one of the programs was in an immature technology area when compared to the other two. In the current technology area of Sub-Case 3 the standardization was not very clear, but there were "*sidetracks*", as one interviewee put it. This means that when comparing current technology area to the former one, there are nowadays more forums which want to standardize their own issues. Developing an immature product technology means that more specification changes may take place, and this increases the need for information sharing. Consequently, the R&D work becomes more unstable and changes occur more often. The unclear future prospects increase the collaboration challenge as well: "*since it is difficult to forecast the key technologies and products of the future, it is challenging to make decisions about on which areas to focus, which capabilities to develop, and which suppliers have the most capabilities to collaborate*", as one interviewee pointed out. It was established earlier in terms of the content of information (especially in the specification phase) how important it is for the collaboration unit to participate with the R&D management in the issue of developing capabilities. Moreover, it is also difficult for the customers to specify their needs early enough, and customer uncertainty increases the possibility of changes (and information sharing) later in the program. This is related to the challenges in the specification phase as well, and it was suggested that close cooperation is required between the marketing unit and the R&D management (a lot of research has been done in this field, see e.g. Griffin and Hauser, 1996).

In addition to the immature business and specification phase challenges, the complexity of the R&D tasks was another factor that had a great influence on the amount of information sharing and interaction. It was already known that the maturity (newness) of the product and the architecture of the product (leading to product complexity) are as such features that could be regarded as influential factors in information sharing as stated e.g. by Bensaou (1999) and Lamming et al. (2000). However, the role of product turned out to be an interesting one, since it was hard to compare the products in the first place. Therefore, it was suggested that instead of paying attention to the product characteristics, task characteristics should be regarded more important. This is verified by Dubois and Pedersen (2002) who argue against the use of product type as a starting point in network research. This is due to the fact that product is part of a complex system where it is subject to interdependence in several dimensions: 1) any product is a result of numerous activities carried out by different firms, 2) the activities engage resources that are also activated in the production of other products, and 3) products are interconnected since they are parts of different technical contexts.

Consequently, in terms of analyzing the R&D task characteristics, following issues describe appropriate tasks for collaboration (i.e. they decrease the need for information sharing). The list is a synthesis of the views of the interviewees and the interpretation of the author: 1) If the collaborated task is an independent entity collaboration is a success: if the task requires development in different projects or in both companies, the pressure for the speed and accuracy of information sharing is increased, and the success of subcontracting decreases, 2) The collaborated task should have few technical interfaces and a thin human interface, 3) If there exist internal problems, collaboration is not advisable, and 4) If the supplier has a clear responsibility area, but is dependent on the focal company, there is a strong, technical connection: information sharing is increased and collaboration becomes more challenging. In this study, the decision concerning *make-or-buy* was often made on the upper management level, but in some cases the program could make this decision. It led to the fragmentation of collaborated tasks, and as a result, the decisions concerning the collaborated tasks were not always very well justified. Therefore, the decisions concerning the collaborated tasks should be done very carefully.

This study clearly emphasized the fact that the influence of sociological factors cannot be underestimated (see e.g. Parker, 2000). Especially the Sub-Case 2 revealed challenges that were partly a consequence of cultural differences. However, as pointed out by one interviewee, *“it is often an excuse to claim the different culture or long distance of the supplier.”* Experience has shown that if becoming aware of the possible cultural challenges, they are easier to confront and prepare for. For example, taking part in a cultural course was regarded important. Face-to-face interaction might be highly appreciated in another culture, and therefore frequent face-to-face meetings should be arranged. Especially important this is in the early phase of the program to let employees know each other. Net meetings and onsite coordinators were also keys to overcome challenges in interacting with people coming from another culture. Sometimes there are situations, where the focal company is unarmed. Learning to listen and understand a strong accent merely requires time, and in general the collaboration becomes smoother only gradually when the employees learn to know each other.

Conclusions

This study has focused on analyzing the nature of information sharing in R&D collaboration between the buying organization and its three suppliers. The contribution of the study relates first to the increased theory-driven classification of the nature of information sharing. The review of the supply management literature revealed how large and fragmented an issue information sharing is. Previous studies on information sharing have mostly focused on the use of information systems (EDI, Internet) and the management of the logistics data (inventories, demand information, etc.). When regarding the communication between buyers and suppliers, there is a strong relation between the success of the alliance and the amount of communication. However, as was pointed out by Moberg et al. (2002, 767), *“the literature provides little empirical support for the importance of information exchange or the characteristics and practices that will lead to increased exchange.”* As a result of the theoretical part, the features and elements of the information sharing activity were identified. Therefore, this study contributed in clarifying the nature of information sharing especially during the R&D collaboration.

Information sharing was determined to be dependent on the stage of the interaction process (i.e. the episode in the R&D program). Another important finding was the critical role of managing properly the specifications phase during the process: it had a great impact on how smooth information sharing was. Moreover, this study verified the current understanding of the significant role of “traditional” information sharing media used in communication: especially the role of face-to-face meetings is crucial in R&D collaboration, and it cannot be replaced by any other medium. Moreover, in the case of strategic information sharing the focal company wants to motivate the supplier in collaboration, and develop and guide the supplier’s capabilities and resources in the right direction. In other words, the driver is to keep the suppliers informed about the customer requirements and the current business: the focal company may reveal the trend in the forthcoming technologies and in which areas the suppliers could develop their capability for their main partners. Finally, the study revealed some context-driven challenges, such as the immature technology, features of complex R&D task, and cultural differences. Some means to overcome these challenges were identified as well.

When evaluating the generalization of this study, a couple of issues have come up. First of all, the single case study does not aim at statistical generalization. Instead, as verified for instance by Stake (1995, 7–8), the objective of the case study is to create a detailed view of the studied phenomenon through the cases, and the term particularization should be used instead of generalization. Yin (2003, 31–32) speaks about “analytic generalization,” where the developed theory is the level on which the generalization of the case study results will occur. To a certain extent the created concepts and models can explain other, similar phenomena occurring in similar contexts. Consequently, in terms of this study it is not purposeful to evaluate facets, challenges or success factors of information sharing according to their appearance or significance. Instead, the study aims to find out such factors that have been found influential in the studied Sub-Cases. In other words, this study and the research methodology is not useful for statistical generalization, but it could be used as a starting point for further, rather quantitative, analysis. That is, this study is designed to identify possible features

arising from R&D collaboration context and interaction between the companies, and explain more profoundly their nature.

Nevertheless, this study has some managerial implications, when keeping in mind the limitations concerning the generalization. Identification of the facets of information sharing during the R&D process help to create management practices around information sharing. For example, the study findings suggest to emphasizing the early phase of the R&D program (especially the specification phase), and the use of face-to-face meeting throughout the process (especially when collaborating with suppliers coming from different cultures). As it can be seen, there exist a wide range of success factors that have an influence on smooth information sharing in the buyer-supplier relationships. This is of importance especially to the companies that plan offshore activities or collaboration in general. It can be typical that concerns about arranging smooth information sharing and communication between the collaborating companies are not paid enough attention in the decision-making of other collaboration arrangements.

The study has limitations as well. This study follows mainly the supply management approach. However, since the empirical research has been conducted in the field of R&D, the better understanding of this research stream would have made this study more comprehensive. One obvious limitation of this study deals with the chosen research perspective: while conducting the interviews only in the focal company, some relevant and significant information concerning the suppliers' perceptions remains unclear. Moreover, the confidentiality towards the Case Company has made it challenging to report all the relevant information that would have been required in order to understand the case context properly.

When evaluating future research areas, some relevant pathways came up. First, this study looked only at the focal company's side and opinion in R&D collaboration. Therefore, it would be interesting to include the perceptions of the R&D suppliers in the R&D program. Also, extending the focus to the other suppliers and customers of the total R&D network as well would increase the understanding of information sharing in a wider context. Finally, since this study is descriptive in its nature, it would be fruitful to take a step forward and analyze more carefully the consequences of the study findings. For example, more detailed evaluation of the management practices required in the information sharing would provide valuable information for researchers and practitioners in the field of R&D collaboration.

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