

## **Analysing System Sourcing Organising Interplay**

**A Case Study of System Design, Sourcing Strategy and Organisational Arrangements**

### **ABSTRACT**

System sourcing has been identified as one sourcing setup that is increasingly applied by companies as part of the increasing attention given to purchasing by companies. It refers to the purchasing of a larger system comprising several components, rather than buying these components in isolation from one or several suppliers. This paper explores the complexity and variety observed in system sourcing setups, outside the automotive industry context where the majority of current system sourcing research has been conducted. A literature review reveals three important dimensions in the organising of system sourcing – system design, sourcing strategy and organizational arrangements. Furthermore, indications of interdependencies across these three dimensions calls for further research on the potential interplay between these three dimensions. A single case study serves to analyse and illustrate the interplay as well as emphasizing the network context in which these three organising dimensions take place. The paper concludes with managerial implications and suggestions for future research.

### **KEYWORDS**

System sourcing, network perspective, system design, sourcing strategy, organizational arrangements

## INTRODUCTION

There is hardly any dispute regarding the increasing attention given to purchasing among managers and researchers over the last decades (e.g. Dubois and Pedersen, 2002; Gadde et al., 2010; van Weele and Rozemeijer, 1996). Literature addresses a number of trends and strategies in order to increase the efficiency and value of purchasing operations. System sourcing is one sourcing strategy that is increasingly applied by companies (Lamming, 1993; Trent and Monczka, 1998). It refers to the purchasing of a larger system comprising several components, rather than buying these components in isolation from one or several suppliers (Gadde and Jellbo, 2002).

When reviewing current research on system sourcing, two main strands of research dominate the literature. First, physical system design and the coordination across system interfaces is a widely researched area (e.g. Baldwin and Clark, 1997; Howard and Squire, 2007; Momme et al., 2000; Jellbo, 1998). This literature stream mainly stem from the systems approach (e.g. Churchman, 1968) that defines the underlying principles of systems. Ulrich (1995) is one of the main contributors to the field of physical design. He defines the concept of the product architecture as 1) the functional elements necessary for the system to operate successfully, 2) the mapping of these functional elements into physical components as well as 3) the interface between the components and the larger product. Furthermore, the product architecture can possess widely distinguished characteristics in how its various components or systems are related. The systems are claimed to be either decoupled, so that changes within one system do not spread across system boundaries, or integrated so that they are closely interdependent. These two characteristics refer to modularized or integral system designs respectively (Frigant and Talbot, 2005; Ulrich and Tung, 1991). The majority of current system sourcing literature focuses on modularization, an important trend that serves to allow for designing and managing systems independently that still function together as a whole (e.g Baldwin and Clark, 1997; Howard and Squire, 2007). The second stream of literature focuses on the division of responsibilities between buyer and supplier (e.g. Brandes, 1993; Carbone, 1999; Jellbo, 2002; Lilliecreutz, 1996). System sourcing typically implies that assembly activities are outsourced to suppliers. However, increasingly suppliers are also committing to design and specification work. Moreover, there are even situations where the supplier focuses only on system design, while actual assembly activities, typically due to physical constraints, are carried out by the buyer. Hence, a wide range of sourcing setups is referred to as full or partial system sourcing. In order to illustrate these rather different natures of system sourcing, Doran (2004) distinguishes between the integrator role and the modulariser role in terms of the buyer's responsibility. The integrator role implies that the buyer remains control over the design and/or function of the purchased system and assures that it fits with adjacent systems. The modulariser role, on the other hand, entails that the systems are decoupled from each other so that design responsibility can be transferred to the supplier. While these two areas of system design and division of labour are clearly crucial for the organising of system sourcing setups, there is little research on other factors impacting system sourcing. To exemplify, Gadde and Jellbo (2002) claim that system sourcing affects, and is affected, outside its product structure and by actors beyond the focal buyer-supplier relationship. According to their research, there are important network implications inherent in the organising of system sourcing.

Furthermore, the vast majority of current system sourcing research stems from the automotive industry. According to Brandes (1993), this industry provides unique opportunities for system sourcing because of mass-production, high levels of modularity and dominating end producers. Consequently, most research has focused on highly modularised

versions of system sourcing with standardised interfaces among components and systems (Fujimoto, 2001). With this skewed dominance towards a particular industry context there is a substantial risk of neglecting the potential variety inherited in system sourcing setups. Furthermore, purchasing has been criticised for being managed one-sidedly in literature, focusing only on the buyer's perspective to the detriment of supply side needs and constraints (e.g. Gadde et al., 2010). A two-sided perspective on purchasing is especially useful for system sourcing as it causes the responsibility for each system, as well as the resulting end product, to be spread across a number of different actors. The current focus on the automotive industry limits the opportunities for such a view on purchasing in general, and system sourcing in particular, because automotive companies often are in a position to dominate and control their supply sides.

This paper aims to explore the organising of system sourcing with a network perspective, in order to develop a theoretical framework that can be used for analysing system sourcing setups. The paper is based on an exploratory single case study design that allows for the identification of dimensions crucial in system sourcing. The focal case company is located within a small-scale industry, characterised by project like characteristics and where buyers are not dominating.

The paper is outlined as follows. First, an exploratory single case study serves to generate deep understanding for a system sourcing setup outside the automotive industry. This case analysis derives three dimensions that are crucial when analyzing the organising of system sourcing. Second, these three dimensions are compared to previous literature on system sourcing, stemming mainly from the automotive industry. Third, a discussion is carried out, aimed at highlighting the interplay between the three dimensions, as indicated by the case analysis as well as supporting literature. Finally, the paper ends with conclusions and suggestions for future research.

## METHODOLOGY

The study is based on a single case study design as it allows for mapping of interdependencies in several dimensions and across organizational boundaries. Moreover, it allows for context-specific findings. This seems to be of high relevance as system sourcing has been described as a complex sourcing setup that is influenced by many circumstances. The case study approach has been recommended by e.g. Halinen and Törnroos (2005). The single case study design consists of three embedded cases. The overall case study focuses on the purchasing activities of a manufacturing company specializing in microwave and antenna technology. Each embedded case corresponds to one system sourcing setup, with a relationship focus but studied from a network perspective. This paper is based on one of these three embedded cases. It should be emphasised that the overall case company, as well as the three identified systems corresponds to the call for research on system sourcing contexts outside the automotive industry. The focal case company is characterised by low production volumes, little standardization within and across systems and products as well as a rather weak position in the supply network.

The results are based on interviews carried out both with buyer and supplier representatives. The interviewees have been selected to represent various functions and hierarchical levels in order to provide holistic information and complementary perspectives. In total, about 30 interviews have been carried out at the buyer company, five of which have been specifically targeted at the focal system. The other interviews have provided general knowledge regarding the company and its context. This information was crucial in order to identify important

issues for the focal system and direct these focused interviews. On the supplier side, three interviews have been conducted. The interviews have been complemented with observation of buyer and supplier manufacturing operations as well as participatory observations of a buyer-supplier meeting. These observations have greatly enriched the data.

#### CASE STUDY - A SYSTEM SOURCING RELATIONSHIP OF A MICROWAVE AND ANTENNA PRODUCER

The focal buyer in this case is a manufacturer specialising in microwave and antenna technology. They produce various antenna products for customers worldwide. Each sale represents a large investment for customers and is characterised by extensive customisation and lengthy development projects. The operations are therefore directed by heavy technology focus and individual customer requirements. As a result, virtually every product sold is unique and this is also why the production volumes are truly low.

The sourced system that is in focus in this case constitutes the structural frame that surrounds one of the products sold by the buyer. It is made up of a number of composite components that are assembled, together with some cables and metallic components that are moulded into the structure. The composite components include various laminate sheet materials that are combined with a honeycomb core to create the wanted shapes. The supplier of this system is a manufacturer specialising in composite production, with an emphasis on supplying components to the aircraft industry.

The buyer and system in focus was one of the first businesses acquired by the supplier and represents the most long-term commitment at present. Moreover, while corresponding to minor volumes in relation to the aircraft components the buyer in focus is still considered to be an important customer, partly because of the long-term history, partly because of the low number of total customers. It should also be noted that the focal system is not the only structure supplied by this supplier to the focal buyer. There are a handful of additional structures included in the buyer-supplier relationship.

Interestingly, while initially stating that they are committed to and satisfied with the relationship, both buyer and supplier representatives express interest in ending it. From the supplier's point of view the argument is based on the anticipation to acquire a more stable customer that better contributes to filling production capacity. Hence while the buyer is currently contributing to overall cost sharing in the facilities, the contract might not be extended if there is an opportunity to replace the business with a long-term serial production. Currently, there are no such business opportunities. From the perspective of the buyer, the main reason for considering other suppliers can be found in escalating costs and the unwillingness to share the cost structure behind these increases, coupled with the identified risk of being dropped by the supplier. A formal investigation has even been carried out to identify alternative suppliers. However, when reviewing the results it was judged as too expensive to follow through with the initiative because of high switching costs coupled with the low volumes. Hence, while both parties have long term plans to replace each other, they are currently dependent on each other.

This section has served to introduce the case and the main issues identified in the system sourcing setup. These issues will now be analysed further while simultaneously deriving dimensions important when analyzing system sourcing setups.

#### PROBLEMS AND OPPORTUNITIES RELATED TO PRODUCTION AND ASSEMBLY

The structural frame is designed with dual functionality in mind. First, the main function of the structural composite frames is to encapsulate and protect the radar product inside. However, the structural frame also needs to allow the radar signals to pass through the surface, as this is the main purpose of the end product to which the structural frame belongs. Because of this dual function, the focal system cannot be designed in isolation but needs to be coordinated with the remainder of the product design. As already mentioned, the product designs of the buying company are highly customized and adjustments are typically made individually within each customer project. Hence, although small functional modifications rarely affect the focal system design, substantial coordination and integration efforts are still necessary in order to assure the overall functionality after every modification. In order to respond to customer requirements and allow for as much design freedom as possible, all systems making up the radar products are designed independently from each other and subsequently coordinated with each other. It could have been possible to standardize some interface parameters in order to allow for changes inside systems that would not have affected adjacent systems. However, such a standardized design would have implied substantial initial investments that cannot be offset by the comparably low production volumes. Furthermore, considering the lengthy development projects and expensive products, the costs involved in coordination can easily be justified. It should also be mentioned that, although every product sold is unique, the overarching design parameters are rather stable and the coordination and integration needed for every customer project is considered to be manageable. Hence, the physical design characteristics of the structural frame are highly adapted to the project context in which it is developed.

Moving on to the production of the system, it is carried out in the supplier's production facilities. These operations are resource intensive as there are a number of specialised equipments involved in producing composite structures. The main production steps include cutting and preparing laminate materials, baking the laminates into hardened composite structures followed by testing, painting and assembly of metallic components on the finished structures. It should be noted that there is no assembly line. While the production facility has been designed to optimize the production flow, each piece of machinery is individual and it is possible to manufacture very different structures. Supplier representatives state that the focal system fits well in their production context. The equipment used and production process followed is identical for all components and systems produced by the supplier, across all customers. Because of these similarities, all customers contribute to increased resource utilization in the production facilities. However, there are two major problems related to the production of this particular structural frame. These problems, that will now be outlined, imply that the cost drivers for the structural frame do not stem from actual material cost and assembly time but from surplus charges related to the supply management, inventory management and resource management. Because of these circumstances, the supplier is forced to offer longer lead times and higher prices to the focal buyer than for other customers.

First, the supplier's production system is adapted to mass production, a setup that is not very well aligned with the low and uneven demand for the focal system. During the origin of the business relationship between the buyer and supplier, there were few other customers. Managing lower volumes and infrequent operations represented everyday business for the supplier. However, over time their demand side has developed towards large volume operations and the operations of the supplier have been adjusted accordingly. This development is contradictory to the characteristics of the demand side of the buying company and causes the supplier to perceive the focal buyer's demand pattern as problematic. The

inherent stop's and go's of this particular customer incur substantial extra costs for the supplier. Apart from charging the buyer for material costs and other direct costs, it also has to compensate for inconveniences associated with the uncertain demand, such as monthly rental fees for unutilised production capacity. This shows that although the composite structures that are produced by the supplier are completely unrelated to each other, they become interdependent due to the fact that they share production facilities. If the buyer cannot increase the similarities in relation to the other customers of the supplier, it either has to accept the extra costs incurred or search for an alternative supplier with different operations.

Second, the throughput time for one system in the supplier production process is enormous because of the unique material included in the focal system. This material was industry standard at the time of original design. While other composite customers with higher production volumes have upgraded their design as material technology has developed, the buyer has found it too expensive to implement new materials in the designs. Because of extensive regulations, there are substantial costs incurred when altering design specifications. These costs arise because of tests and documentation that are needed in order to verify that design changes do not jeopardize the quality of the end product. A specific circumstance relates to the fact that other composite users rarely need to verify that radar signals can pass through the material, meaning that specialised tests are needed that are not available from the material suppliers. Not updating the design works for the buyer's isolated context. However, over time the buyer has become the only user globally of this particular material, making it necessary for the supplier to coordinate material supply separately from other customers. The focal supplier is having difficulties managing a large variety of different materials for the separate systems. The problems are mainly related to supply in that planning and ordering several smaller batches of various material is costly. Furthermore, because of the minimal order quantities associated with the material due to high switching costs, material suppliers are becoming increasingly unwilling to supply the material and frequently prioritise other customers. This problem does not only apply to the focal system but to several product designs within the buyer's product portfolio. Many of these products include composite structures from the focal supplier. However, in order to maintain full design freedom for the various products, the buyer is not coordinating the design of similar systems. This has resulted in different composite material choices for all the structural frames that are purchased by the supplier. On individual product levels this decision is well motivated. However, when relating the physical designs to each other and their production context, problems appear. If the buyer restrained its own design freedom and harmonised material choices either internally or in relation to other customers of the focal supplier, the prices and lead times would become significantly reduced as there would always be material in stock.

In summary, when analysing the design of the structural frame together with the production and assembly operations, some interesting characteristics appear. At first glance, the system design can be considered to be well motivated in relation to the overall product architecture and the buying company's perspective. However, when relating this design to similar system designs and the characteristics of the supplier operations, it cannot be perceived as equally efficient. Secondly, the dynamics inherited in system design and production was illustrated. The original system design was aligned to both material characteristics and operations of other customers. However, over time the focal design has remained stable while seemingly unrelated product designs and operations have changed. Since these systems share the same production facilities they affect each other. In the case of the structural frame, the result has been escalating costs and lead times. These observations lead to the conclusion that the system design, and how it is related to other systems that share production facilities as well as

the characteristics of these manufacturing operations, is an important dimension when analysing system sourcing setups.

#### PROBLEMS AND OPPORTUNITIES IN THE RELATIONSHIP

The structural frame is supplied build-to-print, implying that the buyer is responsible for design and functionality while the supplier manufactures according to these specifications. The main reason for this setup can be found in the buyer's need to maintain in house control in order to adapt the product design to customer requirements. Furthermore, the variety across customer projects is the main reason for not coordinating the supply of different systems but to keep it as separate businesses. Moreover, in line with its own demand situation, the buyer is ordering systems on a project by project basis, in order to assure that no systems are ordered that cannot be sold. The prognoses are limited and order patterns are extremely uncertain and fluctuating, stemming from a very uncertain demand side. These conditions are stipulated by the buyer that is seemingly dictating the sourcing setup. From their perspective, the system sourcing setup is well adapted to their context. However, while convenient for the buyer, it is causing major problems for the system supplier. The volumes are considered to be extremely low per se, but the the lack of market information and planning visibility makes it impossible for the supplier to plan production and supply and compensate for the uneven demand.

Being the more dominating actor in the business relationship due to the negligible volumes transacted between the two parties, the supplier is simply transferring all extra costs incurred, compared to its other customers, to the focal buyer. There are no fixed prices for the system but the price and lead time differ depending on current material costs and lead times as well as the status of supplier operations. Furthermore, the supplier does not offer to share any risks with the buyer in order to motivate more regular buying behaviour. To exemplify, if the buyer agreed to head start the purchasing of material without an order when this is beneficial for the supplier operations or the second tier suppliers, costs and lead times could be reduced. However, at the time there are no incentives behind such initiatives as the buyer is left with all costs if they later do not succeed in achieving customer orders. Although the buyer is slightly frustrated that they carry all risks and overhead costs alone they do understand that their demand pattern is the cause behind these costs. The situation could have been acceptable, had it not been for the buyer's unawareness of the cost drivers. Lately, however, concerns have been raised that the supplier is becoming too commercially focused. Buyer representatives that have been engaged in the relationship for a long time describe the transition. From being treated as an important customer in the beginning of the relationship, the supplier has recently become more bureaucratic and prices are escalating. One frustrated purchasing manager declares "how much can a sheet of carbon fiber cost?", unaware of its negligible impact on the total cost. The buyer has requested the supplier to share its internal cost structure. It is believed that such insights would allow for informed decisions on how to cut costs and lead times while also assuring that the supplier is not overcharging them. The supplier has firmly turned down the request as the risks of sharing them outweigh the potential benefits, especially considering the minor business associated with the buyer.

The problems described illustrate the dynamic nature of business relationships. As already concluded, changes in the surrounding business environment, outside the focal buyer-supplier relationship have impacted on it. This is the reason why the current system sourcing setup, although it has never changed, is becoming increasingly problematic. In the beginning, the focal buyer represented the main business of the focal supplier and the supplier was then willing to center its operations on this business and adapt accordingly. At this point in time

there were no problems associated with the buyer dictating business terms and conditions. Over time, however, other customers have become increasingly important and the focal buyer of this analysis is not prioritized when the supplier is planning and executing their operations. With this changed behavior, the costs related to the structural frame have escalated. These dynamics are also visible in the fluctuations of the general business climate. During economic booms, the focal supplier has several business opportunities and is much more critical of the buyer as a customer. It is during these times that there have been realistic opportunities to end the relationship and take on more stable business to fill up production capacity. The same reasoning applies to the material supply. During boom years other material customers are prioritized and lead times and cost escalates. During recessions, however, the supplier is more dependent on the buyer. The material suppliers on the other hand, typically scale down their operations during recessions and are even less willing to produce odd materials.

Having understood the underlying problems in the empirical case, it can be argued that changes in the business relationship are necessary in order to improve the system sourcing setup. To exemplify, if the division of labor was changed so that the supplier assumed design responsibility, they could adapt the system to fit the supply side better. However, maintaining design responsibility is costly, especially considering the low volumes. Moreover, the supplier might be specializing in structural design but the buyer possesses crucial antenna competence and system integration skills. In addition, the situation is also complicated by the fact that the buyer needs to continuously adapt the system to their customers' needs. Hence, it seems like shifting responsibility between the buyer and supplier is not sufficient to solve the problematic relationship.

Rather, it seems like the buyer and supplier needs to collaborate more closely in order to balance the opportunities and limitations inherent in their respective operations. The supplier is in desperate need to provide more planning visibility in order to plan their operations. Furthermore, there is a need to redesign the systems to allow for more supply similarities in relation to other customers. The buyer on the other hand finds it difficult to forecast their demand and has the urge to maintain design freedom in order to respond to their customer requirements. In addition, redesigning the structural frame to allow for more similarity is very costly and not motivated considering the small production volumes. Because of these circumstances, it is obvious that neither buyer nor supplier benefits from dictating the system sourcing setup. Through closer interaction and by jointly sharing risks, the parties could solve the problems with a two-sided perspective. To exemplify, costs would radically decrease if the buyer planned their orders to be placed regularly rather than exactly when their customer contracts were signed. This could be accomplished by pre-manufacturing the standardized parts of the system when it suits the supplier's production planning. Similarly, the material supply could be arranged during periods of lower demand to avoid long lead times and premium prices. However, the buyer is not willing to take on the accompanying risk of such a purchasing strategy, with more tied up capital and the risk of not selling the system. The supplier is equally unwilling to share this risk with the buyer even though their planning would be substantially improved. If the relationship developed so that more information was shared the consequences of the current sourcing setup would become clearer. Such a shared knowledge base could function as decision support to achieve necessary changes. However, at the time of data collection, neither buyer nor supplier was willing to share more information with each other. The low volumes were raised as the main motif behind these standpoints, making it too risky to share proprietary information. As a result, both parties are continuously losing money.

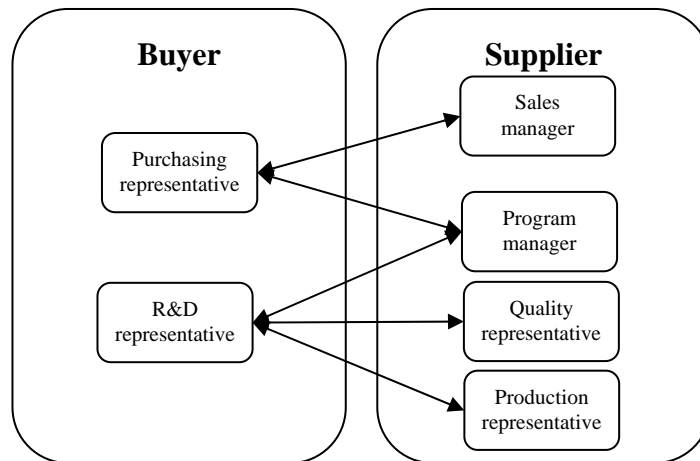


In summary, when analysing the business relationship between the buyer and supplier it becomes clear that the current system sourcing setup is affected not only by the division of responsibility but also by business terms and conditions as well as the nature of the relationship in itself. Furthermore, it becomes clear that there are dynamic characteristics involved in that what constitutes a successful business relationship today does not necessarily imply a successful relationship tomorrow. It should also be emphasised that circumstances outside the focal buyer-supplier relationship clearly impact on the sourcing setup between the buyer and the supplier. These observations lead to the conclusion that the sourcing strategy and its fit into the business environment where it exists, is an important dimension when analysing system sourcing setups. Moreover, sourcing strategy refers not only to the division of labour but also the level of relationship involvement, information sharing and legal terms.

#### PROBLEMS AND OPPORTUNITIES IN THE ORGANISATIONAL DIMENSION

The buyer and supplier meet face to face approximately five times every year when there are orders in production. The communication is also complemented with daily contacts via telephone and email. Topics covered range from technical to commercial issues and involve detailed issues on system design, production techniques and warehousing strategies. However, when comparing the content of interaction with the actual contact pattern, there are very few people involved in the contacts between the companies.

In total, four supplier employees and two buyer employees are regularly involved in the relationship (see figure 1). The supplier representatives stem from program management and production which are both organised under operations. The buyer representatives belong to purchasing and product development. Furthermore, it should be mentioned that the seniority level of the buyer representatives are substantially lower than those of the supplier. The few people involved imply advantages as well as potential problems. On the one hand, the daily coordination streams are clear and response lead times are short. On the other hand, while day to day communication is well-functioning, the few people, departments and hierarchical levels involved cause immediate problems when changes are needed and desired. To exemplify, considering the buyer's context with heavy focus on customer projects and customisation it could be questioned why sales and marketing or project management is not involved in the relationship. Similarly, due to the experienced problems with material supply, it could be argued that the supplier's purchasing department could be more heavily involved. If key people are absent from the relationship it becomes difficult to acquire proper information, create necessary interest within the internal organizations and possess appropriate decision power. The difficulty in arriving at a decision to change materials is an example of a situation that would have improved if more people had been involved in the relationship. Interestingly, the supplier's choice of contact people facilitates such situations to a much larger extent than the customers as they possess the coordinating role across various functions as well as possessing sufficient decision-making authority. Interestingly, there are fewer direct contacts between the buyer and supplier today than in the early stage of the relationship. This can naturally be partly explained by the fact that the supply is considered to be more stable today after initial specifications and production schedules have been implemented. However, as this analysis has shown, there are other issues today that would benefit from further exploration, issues such as the material problem and the lack of planning horizon experienced by the supplier. Hence, when analyzing the organisational arrangement between the buyer and supplier, it does not seem to have developed in a manner that enables the adaptations necessary to improve the current system sourcing setup.



**Figure 1:** The people involved in the buyer-supplier relationship.

Furthermore, as illustrated in figure 1, the contacts are clearly divided between technical and commercial interaction. The key account manager of the supplier is the only party that is involved in more than one setting. From the supplier's perspective this makes sense as there is a need to coordinate commercial aspects with production. However, it could be questioned why there is not a similar approach on behalf of the buyer. Since the buyer is design responsible there should be a similar need for them to coordinate commercial and technical aspects with the supplier. This is not the case however, at least not inside the relationship. Rather, the purchasing representative is the key account manager and the only party that is involved in commercial discussions. The technical representative from the buying side possesses more of an operational role and claims to stay out of all decision making. Considering the technical emphasis of the buyer's operations, it is questionable whether purchasing should maintain such a significant role in the relationship. The main source of dissatisfaction on behalf of the buyer stem from a lack of understanding regarding how the system design and lack of planning opportunity affects the bottom line for the supplier. Had there been better coordination from the buyer's perspective in the relationship, the commercial impact of the technical problems would have been much more visible.

There are also other reasons for questioning the current interaction between buyer and supplier. At present, the relationship interaction in this case is not aligned with the relationship characteristics. In the studied buyer-supplier relationship the supplier is clearly dominant. This is manifested by the fact that although the buyer is dictating design specifications, the supplier is free to dictate contractual terms. The buyer has no choice but to accept as there are currently no other potential suppliers of the specific system. In such a situation, where the buying company needs to accept the conditions provided by the supply market, it is fair to argue that the purchasing function must be able to pass on these conditions to its internal organisation. This requires purchasing to be rather dominant so that they can dictate certain conditions that are commercially viable. However, in the buyer's internal organisation, purchasing operations play a less important role, demonstrated by the fact that it constitutes a supporting function to production. Sales, product development and project management collaborate tightly in the customer projects while purchasing is involved only in the final stage. The actual ordering activities are carried out by purchasing people, but in reality decisions about what to purchase are taken long before and by representatives of other departments. Consequently, purchasing has little insight or influence over the design of purchased components and systems. This is the reason why the system design cannot be changed even though its current characteristics make the system supply unnecessary expensive. Obviously, a technology intensive company providing customised products to its

customers cannot be dominated by the purchasing function. However, when supply market conditions are highly dictating commercial conditions and thereby severely affecting the profitability of products sold, there needs to be more awareness and attention diverted to the impact on purchasing of various product design decisions.

When analyzing the case of the structural frame, it is difficult to judge the appropriateness of the contact patterns between buyer and supplier without relating them to the internal coordination of the respective parties. Naturally, there is always a link between inter-organisational contacts and intra-organisational contact in that people physically active in any buyer-supplier relationship forward the necessary information to their internal organizations. While it can be assumed that such an alignment is always important, the case illustrates that it is even more crucial when the inter-organisational contact patterns are limited. To exemplify, people that could be perceived as lacking in the inter-organisational arrangement can be compensated by well-functioning internal communication and reporting lines. Conversely, if all key people are involved in the buyer-supplier relationship, there is less need for internal coordination. As already concluded, in the studied case there is no coordination between commercial and technical aspects on the buying side inside the relationship. The case analysis shows that the supplier compensates for the lack of involved people through a well-functioning internal organization. To exemplify, all internal operations center around business processes that integrate technical and commercial aspects. This means that there is a natural dialogue internally regarding the interplay between technical and commercial aspects. This internal organising was recently established and it is responsible for the increasing frustration of the buyer regarding the tougher relationship climate. Reorganising their operations internally has revealed several inefficiencies in the business relationship that was previously hidden. This is the reason for the escalating costs that the buyer has been experiencing. When turning to the buying side, the situation is rather different. First of all, there is no natural coordination internally between commercial and technical aspects. Rather, organisation is highly separated both into separate customer projects and between ‘before contract’ and ‘after contract’ elements within each customer project. There are few people present in both contexts or in several customer projects, hindering all long-term initiatives spanning across several products or projects. With such a fragmented internal organisation, tremendous status and decision power is needed in order to accomplish change. Having a purchasing representative with such little status internally, as key contact person in the buyer-supplier relationship, does not fulfill these criteria. Furthermore, the internal fragmentation into ‘before contract’ and ‘after contract’ is also impacting negatively on the relationship interaction. Recently, promising contractual discussions in the relationship interface recently broke down because of lack of internal communication. The discussions aimed to implement exclusivity which would have provided the supplier with increased demand certainty, something that would largely have facilitated the current supply and production planning problems. However, it turned out that circumstances on the buyer’s demand side made it impossible to award exclusivity to the supplier. Had there been representatives of sales present in the relationship, such a disappointment could have been avoided.

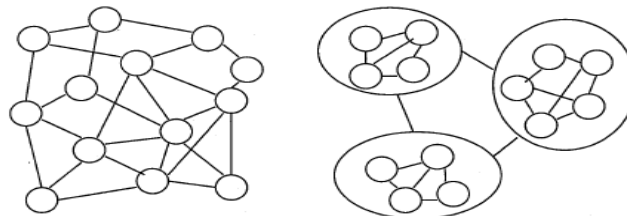
These observations demonstrate that when analyzing system sourcing setups, the organizational arrangements are crucial as they provide the conditions for interaction and information exchange, both internally and in the relationship. Moreover, it has been clearly demonstrated how the contacts within the relationship needs to be designed in relation to the internal organisation of the buyer and supplier in order to assure proper coordination. Hence, organizational arrangements are judged to be an important dimension for the organising of system sourcing setups.

## TOWARDS A SYSTEM SOURCING FRAMEWORK - THREE DIMENSIONS OF SYSTEM SOURCING SETUPS

The case study has derived three dimensions crucial for system sourcing setups, namely system design, sourcing strategy and organizational arrangements. This section aims to compare these findings with literature.

### SYSTEM DESIGN

The first dimension identified is system design. As mentioned in the beginning of the paper, system design is an area that has already been widely researched with regards to system sourcing. It was also claimed that most literature on system design focuses on the product perspective and whether the system design is modular or integral, as illustrated in figure 2. It needs to be emphasized, however that it is only theoretically possible to distinguish between integral and modular product architectures as there will always be some degree of overlap between different parts and functions (Ulrich and Tung, 1991). Therefore, depending on what dimensions of independence or interdependencies that are prioritized, there are multiple ways to design a system and its interfaces. This is further supported by Carbone (1999) and Gadde and Jellbo (2002), claiming that system sourcing setups vary substantially even within largely modularized contexts, such as the automotive industry. Existing literature very accurately describes system design issues within an individual product context. This research also applies to some extent to the studied case where the lack of modularization causes adjustments to spread across system boundaries throughout the end product. Moreover, from the buyer's perspective this design was advantageous as the low volumes made it too expensive to invest in modular designs. Furthermore, maintaining full design freedom for every system and product was perceived as important to satisfy the high requirements for customization on the demand side.



**Figure 2:** Integrated and modularised system designs (Dubois, 1998).

However, the case also revealed important network consequences. When analyzing the case of the structural frame it became apparent that the system design did not match very well with the production systems of either first tier or second tier suppliers. When analyzing the system design from this perspective, it did not appear to be very successful at all. This network perspective is currently lacking in the system sourcing research. In spite of this lack of research, there are some general theoretical ideas that can be transferred to the system sourcing context. To exemplify, Piore (1992) emphasizes the need for analyzing the alignment of resources on an industrial system level rather than focusing on individual actors or products. Furthermore, the Industrial Network Approach (e.g. Håkansson et al., 2009) discusses how to manage the physical interdependencies that arise when the resource bases of buyers and supplier are connected. More specifically, Håkansson and Waluszewski (2002) categorize physical resources into products and facilities. Furthermore, the characteristics of products and production facilities are assumed to depend on each other and companies often try to 'economise' on existing resources in order to improve the relationship between cost and value (Jahre et al., 2006). Economising of facilities refers to the principles governing economies and diseconomies of scale and issues typically revolve around production volumes and setup times. In relation to products, economising concerns the elimination of unprofitable

products as well as the introduction of new solutions. Naturally, the facilities determine the conditions for economizing on products because of the large impact of manufacturing costs. Similarly, product characteristics substantially impact on the economizing of facilities as the degree of standardization determines opportunities for manufacturing. Often, the products and the facilities can be found within company boundaries. Sometimes, however, economizing occurs through business relationships. Sometimes, however, economizing occurs through business relationships. This typically occurs in a buyer-supplier relationship, meaning that “the product exchanged between a buying and a selling firm may be adapted in order to better suit the buyer’s usage context or changed in order to suit the producer’s manufacturing context” (Jahre et al., 2006, p. 57). When economizing across ownership boundaries, there may be problems in balancing benefits and costs among the involved parties. It is very unlikely that the buyer and supplier are equally affected by the changes or share the same perspective regarding them. Furthermore, the situation is further complicated by the fact that third parties are affected when product design production facilities are adapted. This is the reason why a network perspective is advocated.

Although not specifically addressing system sourcing, these theoretical ideas fit well with the studied case. When analyzing the design of the structural frame, it was clear that the system would benefit from being redesigned with both the internal context of the buyer as well as the production systems of the suppliers. Such redesign would have economized both on products and facilities. The Industrial Network Approach also explains the dynamics found in the case. The analysis showed that the current system design initially matched its network context but that changes in other parts of the business environment eventually had caused it to become outdated in relation to the production facilities of the suppliers. Transferred to the Industrial Network Approach, these situations appear when changes in one part of the resource structure spread and impact on other parts due to the interdependencies and adaptations inherited among physical resources (Jahre et al., 2009).

#### SOURCING STRATEGY

The second dimension identified in the case study was sourcing strategy, referring to division of labor, relationship involvement, information sharing and legal terms. In the introduction, the division of labor was identified as one of the two main streams of research concerning system sourcing. This literature has mainly focusing on categorizing system sourcing according to the various divisions of responsibilities that are possible. These alternatives are presented in table 1. When comparing this table with the studied system sourcing setup, it seems to be a type 4 case. This refers to partial system sourcing as the development is conducted by the buyer while the production and assembly is outsourced to the supplier. Recalling the situation in the studied case, the buyer provided detailed system specifications while the supplier purchased material and assembled the system according to this design.

<b>TYPE</b>	<b>DEVELOPMENT</b>	<b>COMPONENT PRODUCTION</b>	<b>ASSEMBLY</b>	<b>SYSTEM SOURCING</b>
1	In-house	In-house	In-house	-
2	In-house	In-house	Supplier	Partial
3	In-house	Supplier	In-house	-
4	In-house	Supplier	Supplier	Partial
5	Supplier	In-house	In-house	-
6	Supplier	In-house	Supplier	Partial
7	Supplier	Supplier	In-house	Partial
8	Supplier	Supplier	Supplier	Full

**Table 1:** Division of labour alternatives that implies some level of system sourcing (Jellbo, 1998).

Moving on to the relationship involvement, this is also a widely researched area in purchasing literature. According to Ford et al. (2003), buyer-supplier relationships range from arm's length conditions to deep collaboration. However, specifically concerning system sourcing there is no consensus in literature regarding the extent of interaction necessary with each system supplier (Howard and Squire, 2007). Although it is generally agreed upon that system sourcing reduces the number of direct contact points with suppliers. However, there have been few attempts to characterize the nature of these remaining contacts. On the one hand, it is argued that greater collaboration with suppliers is necessary in order to minimize and handle interdependencies between system interfaces (e.g. Hsuan, 1999; Hsuan-Mikkola, 2003). On the other hand, it is claimed that by delegating system responsibility to the supplier it can operate independently from the buyer (e.g. Muffato, 1999). When analysing these contradicting findings closer, it is natural to assume that the degree of relationship involvement is closely connected to individual characteristics of each unique system sourcing setup. Naturally, more integrative design interfaces accompanied with more responsibility assumed by the supplier call for more interactive relationships. This idea seems to be applicable to the case as well. It was suggested that the system design should be redesigned in order to better fit with both buyer and supplier circumstances. However, it was also concluded that in order to accomplish such a redesign, the supplier had to take active part which called for closer communication and more information sharing between buyer and supplier. At present, there does not seem to be any literature specific to system sourcing aimed at verifying these findings.

It was also mentioned that sourcing strategy traditionally has been one-sidedly applied in literature. According to Gadde and Jellbo (2002) relationship involvement is resource demanding for suppliers as well. Therefore, it cannot be assumed that suppliers are unconditionally willing to comply with the buyers' selection of sourcing strategy. Rather, they impose their own requirements on the system sourcing relationship depending on their own business strategy and profile. This fact was also clearly visible in the studied case. The buyer obviously dictated the basic conditions of the system sourcing setup, including the division of labor as well as the current order patterns. However, because of the substantial costs incurred on the supplier due to these conditions and due to the fact that the buyer is clearly dependant on the supplier, all the incurred costs were transferred to the buyer through legal terms. If both buyer and supplier adapted to each other, e.g. through joint redesign and adapting to more regular order patterns with shared risk, there would probably be substantial cost and lead time savings. This is a perfect example of a sourcing setup that cannot be dictated one-sidedly by the buyer even though it is trying to. Rather, system sourcing strategy develops in interaction with suppliers rather than being developed and applied by buyers.

In summary, the case study showed that what constitutes a suitable sourcing strategy depends on the specific circumstances of each system sourcing setup and depends on both buyer and supplier capabilities and constraints. While many of these conclusions are intuitively logical, there have been few attempts to investigate these context specific characteristics further. The literature so far has focused either on the division of labor or relationship involvement as isolated phenomena. Gadde and Jellbo (2002) represent one of few studies that have focused on several sourcing strategy dimensions simultaneously. Because of the complex interdependencies between these sourcing strategy dimensions, the authors claim that there is no general answer as to what constitutes the most appropriate system sourcing strategy. Rather, firms may come up with entirely different strategies in terms of system sourcing" (Gadde and Jellbo, 2002: p. 44).

## ORGANISATIONAL ARRANGEMENTS

The third and final dimension identified was organizational arrangements. This area was not mentioned at the beginning of the paper as there has been very little research conducted concerning the organisational aspect of system sourcing. However, as the case study clearly indicated, the organisational dimension plays a crucial role in system sourcing setups. The case analysis concluded that the organizational arrangement provides the conditions for interaction, both internally and in the relationship. Modig (2007) support these findings in claiming that organizational arrangements are important for system sourcing.

There has been some research related to the intra-organisational arrangement and system sourcing. It is for example argued that in order to effectively design systems to outsource, the organizational structure and business processes need to be as loosely coupled as the intended systems (von Hippel, 1990; Sanchez and Mahoney, 1996). According to Brandes (1993) system sourcing requires increased coordination between functions in order to jointly develop system friendly products. Such coordination can typically be accomplished through project or matrix organizations and cross-functional teams (Hillebrand and Biemans, 2004). These theoretical ideas match well with the case findings where it was found that the fragmented internal organisation of the buying company did not support system sourcing.

Moving on to the inter-organisational arrangement, research do claim that system sourcing imposes requirements to organize supplier relationships in order to minimize and handle interdependencies across system interfaces (Gadde and Jellbo, 2002; Hsuan-Mikkola, 2003). However, there is no literature characterizing the inter-organisational contacts. In fact, research on inter-organisational aspects in buyer-supplier relationships is scarce all together. Literature focuses more on what sourcing strategy to apply than how to organizationally design for that interaction (Gadde et al., 2010; Persson and Håkansson, 2009). Cunningham and Homse (1986) provide the most significant contribution. They claim that the interaction between buyer and supplier is embedded in a complex network of contacts on both sides of the dyad and develop a taxonomy that characterizes these contact patterns. Three main dimensions identified in this taxonomy include the frequency of contact, the breadth across different functions and the seniority level of interacting parties. Although developed for buyer-supplier relationships in general, these three dimensions seem to be applicable to system sourcing as well. To exemplify, the case analysis raised questions as to whether the appropriate functions and seniority levels were present in the relationship.

More importantly, the case study showed the need for linking intra- and inter-organisational arrangements. It was concluded that such alignment is especially important in cases where the inter-organisational arrangement is limited. This particular finding is supported by Cunningham and Homse (1986), claiming that alignment between internal organising and relationship organising is even more crucial when the relationship organising is lacking. Apart from this statement, there have been few attempts to connect the two organizational aspects, applying to purchasing in general and system sourcing in particular (Dubois and Wynstra, 2005; Gadde et al., 2010). The most specific guidelines, regarding how to align intra- and inter-organisational dimensions, are provided by Dubois and Wynstra (2005). They outline nine different roles of purchasing, depending on internal and external conditions. However, the model does not focus on system sourcing and it only describes the alignment generally without specific guidelines on how to organize either internally or inter-organizationally.

In summary, the literature does support the finding that organizational arrangements are crucial for system sourcing. However, there are few direct recommendations concerning what constitutes suitable organising. This conclusion especially concerns the inter-organisational arrangement as well as the linking between intra- and inter-organisational aspects.

#### DISCUSSION - IDENTIFYING INTERPLAY BETWEEN THE THREE DIMENSIONS

So far, the paper has focused on identifying and analyzing three dimensions of system sourcing organising. During this analysis, it has been concluded that although the emphasis on system design, sourcing strategy and organizational arrangements as crucial dimensions in system sourcing organising are supported by scattered literature streams, there has previously been no attempt to bring these dimensions together into a holistic framework. In addition, system sourcing has previously been studied from the perspective of the buying company or the focal buyer-supplier relationship. While the theoretical foundation of the Industrial Network Approach supports the findings of this case study, there have been few attempts to apply these theoretical ideas to the system sourcing phenomenon in general or these specific dimensions in particular. So far, the three dimensions have been analyzed separately. However, there is reason to also investigate them in relation to each other, both empirically and theoretically. Both the case study and literature findings indicate that there is important interplay between system design, sourcing strategy and organizational arrangements.

Beginning with the system design versus organizational arrangements, the case clearly demonstrates this interplay. The intra-organisational arrangement of the buyer clearly mirrors the current product designs. Since the products are developed independently from each other, the organisation is also divided according to product groups. Furthermore, there is little communication and coordination across individual customer projects because of the customized characteristics of the product designs. A similar interplay can be found concerning the inter-organisational arrangement. These contacts are rather limited which can be explained by the fact that the current system design is perceived as stable. As mentioned previously, there used to be more people involved at the beginning of the relationship when the system design and production facilities were introduced. As already concluded, this organizational arrangement seems to function well under routine circumstances. However, several examples have been provided where changes have been difficult to accomplish. One such example is the material change where the current intra-organisational and inter-organisational arrangement is hindering development of the system design. This is a clear example of a situation where the system design is not only influencing the organisation but where the organisation is also impacting the system design. The identified interplay between system design and organizational arrangement has also been indicated in literature. Araujo (2006) claim that the organisation is developed to match the technology but also that the technology is influenced by the established organizational arrangements. Furthermore, Frigant and Talbot (2005) discuss the importance of matching product design and organizational arrangements in achieving modularity in a comparison between the automotive and aircraft industry. The interdependency between technical and organizational features is the most discussed interplay in literature. Most literature limits the discussion to one organizational actor. Moreover, specific references to system sourcing are scarce. Jahre et al. (2006), however, extends the perspective to a larger network context and also addresses system sourcing specifically. They refer to mixed interfaces where organizational and physical resources are confronted with each other. According to the authors, physical resource interfaces do not evolve automatically but depend on organising actions that in turn rely on organizational resources. By adapting a physical resource, such as the system design or a production facility, economizing can be achieved. The organizational resources and how



they are used are crucial in achieving this economizing. To exemplify, if the purchasing function reduces the number of component variants to purchase, there will be positive effects in the physical resource interfaces. However, to achieve these effects it might be necessary to change the organizational arrangement of the purchasing function (Dubois, 2003). One such change could be to move from a product based organisation that makes it difficult to achieve synergies across various product portfolios. In this way it is stated that physical and organizational resources are combined. According to Jahre et al. (2006), system sourcing can be viewed as an economizing act that is dependent on mixed interfaces. By purchasing complete systems rather than individual components cost advantages can be reaped. However, as already concluded such a strategy requires an organizational arrangement that supports dividing a product into subsystems.

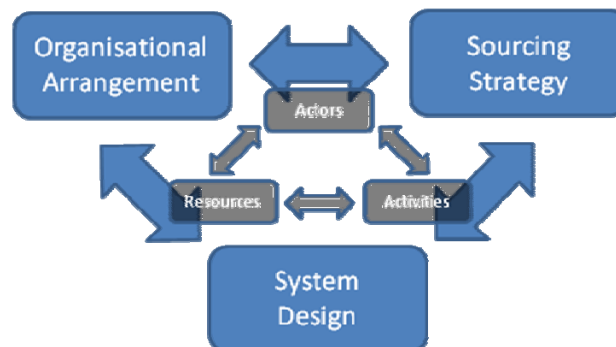
Moving on to the system design dimension versus sourcing strategy, this interplay was also clearly visible in the case of the structural frame. As already concluded, the main reason for maintaining system design control internally on behalf of the buyer was a perceived need to continuously coordinate system design with other parts of the product structures. Such coordination is always necessary to some extent when dealing with customized products. However, the amount of coordination is determined by the nature of the system design. With a more modular design more adjustments within system interfaces would have been possible without impacting across system interfaces. Thereby, the system design in the studied case is limiting the sourcing strategy opportunities. Also here, the interplay is two-sided. The current interaction setup, with little information-sharing and joint planning impedes the learning process regarding cost drivers and future opportunities. This in turn reduces the chances to redesign the system to fit better with buyer and supplier contexts. When choosing a system sourcing setup so that system design is carried out in one company and system production in another one, substantial coordination that allows for mutual adjustments would have provided the actors with more flexibility to adapt to each other. This interplay has also been mentioned in literature. To exemplify, Henderson and Clark (1990) state that the more modularized a system design is, the more responsibility and control can be transferred to suppliers. This is supported by Gadde and Jellbo (2002), describing that there is an important interaction between design features and manufacturing processes, also referred to as the design-build interaction. Furthermore, although not specifically addressing system sourcing, Araujo et al. (1999) have developed a framework connecting physical interdependencies with relationship involvement by categorizing four types of interactions in buyer-seller relationships depending on the level of technical interdependencies between their resource bases. Applying this framework to the studied case, it seems to be a case of specified interfaces, implying that there is a customized product and the supplier functions as a subcontractor acting upon detailed customer specifications. This interface is appropriate when the supplier can pool orders and reap economies of scale beyond the reach of any of its customers. It has already been concluded in the previous case analysis that the current sourcing setup is not beneficial for either buyer nor supplier but that more collaboration and mutual adjustments would be needed in order to reduce costs and lead times for both parties. This is line with the recommendations of Araujo et al. (1999), advocating what they refer to as interactive interfaces for cases where both use and produce contexts need to be taken into account in order to balance costs and benefits in design and production. Furthermore, the authors claim that interactive interfaces are expensive, which was one of the arguments for not collaborating closer in the studied case. The other argument, being that the buyer is unwilling to lose control over the system design in relation to the end product, is also mentioned in the paper. Hence, it seems like the framework developed by Araujo et al. (1999) fits well with the complexity inherited in system sourcing contexts.

Finally, the interplay between sourcing strategy and organizational arrangements was also present in the studied system sourcing setup. For example, the division of labour between the two parties impacted on the inter-organisational arrangement. Because of the clear division of responsibilities between buyer and seller, few people are necessary in daily communications. Furthermore, the reason why purchasing takes the leading role in interaction on the buying side is that technical details are perceived as an internal matter. This is due to the current division of labour where design is carried out by the buyer alone rather than in interaction with the supplier. Furthermore, the clear division of responsibilities is also the reason why the inter-organisational arrangement is divided so that little coordination occurs between commercial and technical people. The current inter-organizational arrangement function well for daily communication, which mirrors the stability entailed in the sourcing strategy, where nothing has changed in the sourcing setup since the establishment of the relationship. However, as for the other dimensions, the interplay is two-sided. While the established sourcing strategy has impacted on the organizational arrangement, the current organising is also impacting on the sourcing strategy. To exemplify, there has been discussions regarding placing more regular orders in order for the supplier to improve its production planning and material supply. However, due to the current organizational arrangements there are no buyer representatives with proper decision making authority present in the relationship. Moreover, the fragmented internal organization of the buyer makes it impossible to invest in such an initiative. The project-centered resource management system implies that there is no funding available to tie up capital for non-existing projects. Thereby, the organizational arrangement is currently hindering changes in the sourcing strategy. There has been limited focus on this interplay in literature. Furthermore, the claims that have been made represent minor details in connection to other contributions, such as side effects of the researched interplay between technology and organization. Along these lines, Araujo et al. (1999) claim that some sourcing strategies require more people involved across organizational boundaries. Furthermore, Novak and Eppinger (2001), while specifically addressing organizational arrangements and system design, provide examples of how failures in sourcing strategy decisions sometimes can be derived to organizational arrangements that separate purchasing from other important functions. The interplay between sourcing strategy and organizational arrangements, particularly in connection to system sourcing, is clearly an inadequately researched area.

Having concluded that there is interplay between system design, sourcing strategy and organizational arrangements, it is obvious that developing all three dimensions simultaneously is important when organising system sourcing setups. As concluded in the case study, it is not possible to achieve changes in the system design without accomplishing change in the current organizational arrangement. Internally, the buyer needs to improve coordination across products and projects and from 'before contract' to 'after-contract' contexts. In the relationship, more people from various functions of both buyer and seller need to be involved in order for the mismatches between their contexts to become visible. Furthermore, a precondition for changing the system design is a changed sourcing strategy towards long-term thinking and planning. The buyer and seller would need to adopt a closer and more open relationship where they jointly try to adapt their context to each other. This example clearly demonstrates the need to develop all three dimensions simultaneously. However, achieving change in all three dimensions of the system sourcing setup may be very difficult. To exemplify, Araujo (2006) claim that organisation and technology develop on different levels and follow different trajectories, meaning that while interdependent, the two dimensions are not always aligned. Following these ideas, it would not always be possible to accomplish change in system design, sourcing strategy and organizational arrangements

simultaneously. These difficulties are also indicated in the case analysis. For example, it has already been illustrated that while the recommended modifications in system design would improve the situation on an industrial system level, it would cause substantial problems from the perspective of the focal buyer. Furthermore, the suggested changes in the buying organisation would improve the development and purchasing of the focal system. However, there are other reasons for the current organizational design, such as the importance to customize and coordinate tightly within specific customer projects. Moreover, the current organisation is the result of historic conditions. For example, during the last five year period the business unit was first acquired by another company and thereafter merged with another business unit. During such affairs there are purely social and administrative circumstances that impact on what is perceived as a suitable organizational arrangement, regardless of the impact of this organising on product designs and purchasing. These examples illustrate that although the three identified dimensions are clearly interrelated, they also operate along different circumstances. Moreover, while there are benefits involved in developing the dimensions together, depending on the perspective and level of analysis that is taken, some issues have to be prioritized against other ones.

Figure 3 outlines the three dimensions system sourcing organizing, as derived from the single case study of a particular system sourcing setup. They are illustrated together with the three dimensions of the Industrial Network Approach, symbolising that every individual system sourcing organising initiative takes place within a network context where actors, resources and activities interplay across organizational boundaries, providing unique opportunities and limitations for every system sourcing setup between any particular buyer and supplier.



**Figure 3:** A framework for analysing the organising of system sourcing within a network context

## CONCLUSIONS

This paper has provided a holistic perspective of the organising of system sourcing setups. By analyzing a single case of system sourcing, three dimensions crucial for system sourcing have been identified. Furthermore, these dimensions have been studied and analyzed from a network perspective, broadening the hitherto narrow view of system sourcing. Although previous research does support the identification of system design, sourcing strategy and organizational arrangements as dimensions important for the organising of system sourcing, this literature is scattered. Previous research on system sourcing has focused on isolated dimensions, such as system design and division of labor and has focused on either the buyer or the buyer-supplier relationship in isolation. In addition, the empirical foundation of this paper stems from a context that has largely been neglected in previous research. Although rather complementing than contradicting previous research, it is fair to assume that many of the complexities derived from the studied case can explained by this different empirical basis. Consequently, the theoretical framework derived and presented in this paper represents one of the first attempts to provide a comprehensive analytical tool for system sourcing setups.

When summarizing the paper, three main conclusions can be made, apart from the identification of the three dimensions in themselves.

First of all, the case analysis emphasizes the importance of analyzing each system sourcing case within a wider network context. Previous literature has focused on individual systems and how they relate to the larger product structure as well as the impact of system sourcing on individual supplier relationships. This case reveals that there is a need to take the analysis further to account for surrounding technologies and relationship patterns. When analyzing the system design, the sourcing strategy and the organizational arrangement independently it is concluded that there are network consequences present within each dimension. To exemplify, the studied system design is judged to be relatively modular and disconnected from related systems in the end product. Still, several challenges were identified in the system sourcing setup, due to technical interdependencies across buyer products as well as related to supplier production and second tier suppliers. Moreover, inefficiencies and challenges were identified as the sourcing strategy applied by the buying company was not sufficiently taking the supplier's perspective into account. This supplier was largely influenced by other actors in the network. Finally, it was found that the organizational arrangement of a system sourcing setup needs to take internal as well as external aspects into consideration as well as how they are linked to each other.

Secondly, the paper demonstrates the importance of linking system design, sourcing strategy and organizational arrangements when organising the system sourcing setup. Regardless of the product architecture of the purchased system, there are alternative ways to organize the division of labour and extent of interaction with suppliers. Similarly, for any one system design or given sourcing strategy, there are several alternative organizational arrangements, internally as well as externally. The case analysis clearly illustrates how these alternative setups need to be aligned to each other as changes in one dimension require changes in the other ones. To exemplify, changes in system design was needed in order for the supplier to take on more responsibility. However, these changes were not possible because of the current organizational setup, both internally at the buyer and externally in the buyer-supplier relationship.

Third, the case study illustrates that these three dimensions are not always aligned to each other. Although several challenges were identified in the case, the discussion regarding alternative solutions indicates that improving conditions in one dimension or on one level would result in complications along other dimensions or levels. To exemplify, changing the system design would better align it in relation to the larger resource structure of first tier and second tier suppliers. However, from the perspective of the individual buyer, such a redesign would hinder design freedom in individual products and customer projects. Moreover, reorganising internally to allow for more coordination across products and customer projects would substantially improve the interaction regarding purchasing and individual systems. However, this improved coordination would be to the detriment of communication and coordination of individual projects, a key objective for the overall organisation. Finally, changing the sourcing strategy to award the supplier with more responsibility and influence would indeed result in more balancing between the buyer and supplier context with regards to any individual system sourcing setup. However, such an initiative would imply losing control of e.g. system design, a task that is perceived as crucial for the buying company. Because of these findings, it is concluded that the organising of system sourcing is a continuous balancing act along several organising dimensions.

### MANAGERIAL IMPLICATIONS

The findings of this paper have some direct managerial consequences. The paper has illustrated how the interplay between system design, sourcing strategy and organizational arrangement impact on the opportunities and limitations of system sourcing setups. This implies that managers have to analyze and assess all these dimensions together when organising system sourcing setups, rather than designing each dimension separately. Since these three organising dimensions typically belong to rather different functional areas in organizations (such as product development or engineering, purchasing and top management), this paper advocates that system sourcing is discussed, analysed and organized by many functional areas together.

Furthermore, in order to balance the three organising dimensions, both in relation to each other and outside organizational boundaries, companies need to adopt more knowledge about the network context. This is crucial in order to understand the environment in which they operate so that the cascade of organizational and technical interdependencies can be better understood. One problem is that companies often do not possess proper insight regarding how their resource base connects with the larger network context of which it forms part (Araujo et al., 1999). This was clearly the situation in the studied case where neither buyer nor supplier possessed sufficient information about each other and the resource structure to which they belong. The situation is also complicated by the fact that the situation is highly dynamic and develops over time. This was also illustrated in the case where the system sourcing setup has remained unchanged while the surrounding business environment has developed. Continuously assessing and adjusting the interplay between organizational and technical interfaces is therefore crucial, as is developing the business relationships that are necessary in order to change the established resource structures (Jahre et al., 2006).

### LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Furthermore, this paper is based on an exploratory single case study. However, it should be mentioned that the research on which this paper is based consists of two additional system sourcing setups with the same focal buyer but other suppliers and technologies. These two cases show similar results. Regardless, more research is naturally needed in order to further examine the usefulness of the theoretical framework that is suggested in this paper. Therefore, research is requested in various contexts in order to investigate the relative importance of and network consequences of each dimension in isolation, as well as their interplay with each other.

Four avenues of future research are suggested. The first research issue concerns the exploration of system design within a network context, as most research so far has been limited to individual systems and product contexts. The second research issue pertains to the exploration of system sourcing strategy, beyond the scope of division of labor and including the perspective of suppliers and their network context. The third research issue deals with the organizational aspect of system sourcing, both in general but particular concerning the connection between intra- and inter-organisational arrangements. Finally, the fourth research issue is designated to the analysis of the relationships between system design, sourcing strategy and organizational arrangements in order to increase the understanding of system sourcing interdependencies.

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