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Organization design approach to the management of uncertainties in contract manufacturing relationships

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ABSTRACT

In this paper we study management of contract manufacturing as an organization design problem. We build on the information processing perspective and analyze uncertainties created by the contract manufacturing relationship as well as integration mechanisms that managers can use to manage the relationship.

The paper includes two in-depth case studies in electronics and food industries. The first company has to deal with the management of new outsourcing projects, whereas the second company has a more mature relationship with contract manufacturers.

It was discovered that despite the different environments and case features, there are also similarities in the use of integration mechanisms. The companies seem to be managing different types of uncertainties in a similar manner. This forms a contribution to the literature, especially in terms of how the different types of uncertainties can be operationalized in the context of contract manufacturing.

Keywords: contract manufacturing, integration, coordination, integration mechanisms, case study

1 INTRODUCTION

Designing an operations network involves choices on three fundamental issues related to structure, infrastructure, as well as ownership and governance (Hayes et al., 2005). During the past decade especially the issue of ownership has received significant attention; in their continuous search for improvements in efficiency, cost structure, or product variety, contracting out some company activities has become a normal procedure for companies (Heikkilä & Cordon, 2002; Hayes et al., 2005). The concept of core competence developed by Prahalad and Hamel (1990) has been extremely influential especially in contract manufacturing practice. Prahalad and Hamel (1990) made a distinction between core and non-core activities, suggesting that companies should focus on their core competencies and outsource the rest to specialized suppliers.

In practice, outsourcing is a significant challenge. As an example, one of our case companies is a traditional manufacturer of luxury grocery products. When introducing a seasonal product, the company wanted to source out the production of this new type of product, considering the production of it somewhat outside of its core competences. The outsourcing process turned out to be a challenging one to manage; the product introduction was delayed and the product did not make it to markets according to the original schedule but only in the next season. This obviously caused significant costs to the company.

Outsourcing has also received significant attention in academic research. In operations management research on outsourcing (defined as the process of having suppliers provide goods and services that were previously provided internally (Fan, 2000)), the focus has been especially on the make-or-buy decision; whether the company makes the products in-house or buys them from an external provider. To make-or-buy is a strategic decision (Welch & Nayak, 1992; McIvor et al., 1997) but is also inherently a decision of supply chain structure (Fine, 2000;

McIvor, 2008; Kim, 2003). Despite being strategic, the make-or-buy decision can also be of operational nature in supply chain context (Fine, 2000). This is especially the case if the purpose of outsourcing is to search for flexibility and eased capacity load, for example, by managing external suppliers as a part of the supply chain. A number of factors have been suggested to affect the decision, such as the frequency of need, uncertainty, asset specificity, capabilities and resources, coordination requirements, and strategic control and risks (Hayes et al., 2005; Heikkilä and Gordon, 2002; McIvor et al., 1997).

In this paper, we address the issue of contract manufacturing; we focus on management of outsourced activities after the actual outsourcing decision has been made. Our aim is to increase the understanding of how a firm can successfully manage contract manufacturing. In particular we approach the issue of management of contract manufacturing as an organization design problem. In this paper we address the questions of (1) what uncertainties (risks) companies face when contracting some part of their production out, and (2) which managerial tools (integration mechanisms) companies are using to manage these uncertainties. We conducted two in-depth multiple embedded unit case studies to empirically address the posed research questions, one from electronics industry and one from food industry.

This research complements prior research on outsourcing and contract manufacturing in several ways. First, majority of the prior research has taken a strategic perspective to contract manufacturing by studying the actual make-or-buy question. Second, this research provides a complementary view on outsourcing by building on a different theoretical perspective (information processing perspective (Galbraith, 1973)); prior research on outsourcing has built on various strategic and organizational theoretical perspectives, such as resource-based view (i.e. McNally and Griffin, 2004; Boyer and Pagell, 2000) and transaction cost economics (Grover and Malhotra, 2003; Stratman, 2008; Ellram et al., 2008) but a call for additional theoretical

perspectives has been made as McIvor (2009) argues that neither of the most-used theoretical provides a full understanding of the phenomenon. Third, the empirical context of this paper also complements prior research as outsourcing in the foods industry is rarely studied. It also allows for interesting comparison between two very different industries; electronics as the industry most often experiencing outsourcing and foods industry as a less typical context for outsourcing.

2 LITERATURE REVIEW

2.1 Benefits and risks of contract manufacturing

Outsourcing refers to purchasing a complete or a partial function, connected to either services or products that the buying company has had in-house, from an external supplier (Van Weele 2005). Outsourcing refers to the decision-making process and changing the responsibility of production or part of production to a contract manufacturer. Contract manufacturing, on the other hand, is connected to actual operations and is defined in the context of this paper as management of operations after the transfer of the responsibility of a part of the operations process to a supplier has been made (Van Weele, 2005). This approach is used for example by Fan (2000), who separates two key areas: pre-outsourcing decision process and post-outsourcing supplier management, which we refer here as contract manufacturing. Contract manufacturing can be done for two different purposes; sourcing out an existing product from own production line or finding a manufacturer for a completely new product beyond own product variety. Notable is that contract manufacturing can concern only a part of the traditional operations, excluding the actual production, for example packaging. In contract manufacturing, the buying company holds brand rights and is responsible for the sales interface.

An influential background for outsourcing has been the concept of core competence (Prahalad and Hamel, 1990). Concentrating on core competencies and developing superior

performance in these is a key for both parties in outsourcing activity. The competencies that the company defines as core are the most critical in achieving competitive advantage over competitors (McIvor, 2008). Buying companies today have more possibilities to outsource due to rapid development of specialized manufacturing and service companies. Companies strive to leverage the specialized capabilities of suppliers, and in more critical business areas such as product design or customer relationship management. Some companies have drifted away from all manufacturing activities and become sole brand houses.

The benefits and risks of outsourcing have been discussed extensively in prior research. A summary of reasons to outsource is presented in Table 1 and of risks in Table 2 below.

Table 1. Reasons to outsource and potential benefits

Reasons to outsource	Explanation	References
Scarcity of capital	Companies have insufficient capital to develop all activities. Outsourcing some activities reduces the capital required.	Heikkilä and Gordon, 2002; Kim, 2003; McIvor et al., 1997
Cost savings	Often the top reason. The perspective can be a very short term cost reduction. The scale advantage or technological advantage that the supplier can get from large volumes the main source of savings.	McIvor, 2000; Momme and Hvolby, 2002; Zhu et al., 2001
Lack of know-how	To develop competencies in-house requires resources and time. The emergence of specialized suppliers with superior skills makes outsourcing a viable option.	Womack, 1990; Dobler and Burt, 1996; Heikkilä and Gordon, 2002
Flexibility and the need for quick response or small production	Suppliers with specialized skills and machinery can offer speed or quick response to market changes.	Heikkilä and Gordon, 2002; Vollmann et al., 2004; Jennings, 2002; Kim, 2003
Technological advantages	Access to technology the buying company does not have. Can also be seen as access to superior quality.	Jennings, 2002; McIvor et al., 1997; Momme and Hvolby, 2002
Speed or time to market	Outsourcing new product development (NPD) activities allows a company to bring products to market fast.	Blanchette, 2004; McIvor, 2000

Table 2. Potential drawbacks and risks connected to outsourcing

Risk or drawback	Explanation	References
Transfer of know-how that encourages new competitors	Many companies have experienced that suppliers have become their toughest competitors.	Hall, 2000; McIvor 2008; Momme and Hvolby, 2002; Arrunada and Vazguez, 2006
Changes in the balance of power and opportunistic behavior	Dependency, confidentiality and security issues affect the relationship. As companies become increasingly interdependent, transaction costs tend to rise.	Arrunada and Vazguez, 2006; Heikkilä and Gordon, 2000; McIvor, 2000, 2008; Momme and Hvolby, 2002
Implementation and project management	Implementation needs skillful planning, executing and management. When companies are sourcing some part of their existing operations out, links in the value chain increase. Therefore, the requirements for efficient data flow and communication increase	Fan, 2000; McIvor and McHugh, 2000; Momme and Hvolby, 2002; Van Weele, 2004
Failure to deliver against expectations and quality issues	This normally means prolonged schedule, additional cost and re-work, which diminish easily a lot of the potential benefits.	Fan, 2000; McIvor, 2008; Vining and Globerman, 1999; Zhu et al., 2001

The main benefits that companies strive for by utilizing outsourcing are related to cost savings, the reduced need of capital resources, technological advantages, taking advantage of market competition and achieving flexibility (e.g. Kim, 2003; Blanchette, 2004; Fan, 2000; Zhu et al., 2001). By outsourcing the organization gets access to technology that it does not have and cannot acquire without extensive investments (McIvor et al., 1997). Thus, it is reasonable to outsource, especially if the volumes are so small that the investment would not pay back in a reasonable time. The ever-increasing complexity of products and technologies is also one factor that favors dedicated suppliers that have the required specialized machinery (Momme & Hvolby, 2002).

In avoiding the risks connected to outsourcing, a well-managed implementation process becomes essential. Solving implementation challenges is difficult without a formal procedure for the whole outsourcing process (McIvor & McHugh, 2000). Longer-term perspective is required

on higher level to support the decision making and implementation at operative level. This brings us to the very core of this paper, challenges in managing a contract manufacturing relationship.

2.2 Organization design and integration mechanisms

In this paper we take an organization design approach to outsourcing. We thus approach the managerial challenge *after* the decision to outsource has been made. The immediate subsequent problem is to ensure that the focal firm is internally effectively organized after its internal task has been changed due to part of its activities taken out of its immediate control and that the focal firm and the contract manufacturer are able to work together as a common whole yet being separate firms. These are inherently issues of organization design (Galbraith, 1973; Lawrence & Lorsch, 1967; March & Simon, 1958).

In general the designing on an organization can be considered to involve two managerial decisions (Child, 1977; Mintzberg, 1983): (1) the division of tasks, and (2) coordination and integration of activities. The division of tasks means dividing the organization into sub-units and assigning specific sub-tasks to each sub-unit. Coordination and integration, on the other hand, refer to designing processes and systems that ensure the accomplishment of broader, overall organizational tasks to which the sub-units contribute. Different ways of dividing the tasks give rise to different needs for integration. Even though the focus of Lawrence and Lorsch (1967) was in cross-functional context, differentiation can also refer to for example the varying organizational structures of organizational units located in different countries as well as the varying nature of inter-unit relationships (Ghoshal & Bartlett, 1990; Grandori & Soda, 1995; Nohria & Ghoshal, 1997).

In this paper we approach organization design from the information processing perspective. According to the information-processing scholars (Egelhoff, 1982, 1988; Galbraith, 1973, 1977; Joyce, McGee & Slocum, 1997; Tushman & Nadler, 1978), organizations are

information processing systems, which differ in their need for information processing as well as in their capacity to facilitate information processing. Information processing in organizations includes the gathering of data, the transformation of data into information, and the communication and storage of information (Egelhoff, 1991). Information processing needs are suggested to be created by uncertainty, which is (in a rather loose way) defined as the absence of information or having information that is inadequate for performing the organizational task (Galbraith, 1977, 35-57). Integration, then, is a way to increase the capacity for information processing. In operations management research information processing model has been used in, for example, studying purchasing category management (Flynn & Flynn, 1999; Trautmann et al., 2009), inter-organizational relationships (Premkumar et al., 2005), and organizational performance (Wang, 2005).

In order to integrate activities, managers have a variety of tools and practices (for a thorough overview, see Martinez & Jarillo, 1989). At the most general level, the integration practices can be divided into vertical and horizontal integration mechanisms. Vertical mechanisms build on organizational authority, and include mechanisms such as centralization and standardization. Lateral mechanisms, on the other hand, are based on communication rather than authority and they may be formal or informal and include structures such as task forces, liaison and integrator roles, boundary roles, and various team and meeting arrangements and integrative units. Information systems are a separate set of integration mechanisms. However, their role is more as a complement to vertical and lateral mechanisms as information systems as such rarely integrate anything (some cases force to act in a standardized way), but they can mostly be used to transfer information both vertically and laterally across sub-units. Finally, various social mechanisms, such as incentives, can also be used as integrative mechanisms. However, they are used mostly for other than information processing purposes, for example

social consistency of behavior, but in some forms can also support information processing (Table 3).

Table 3. Classification of integration mechanisms

	Integration mechanisms	References
1	Vertical mechanisms of centralization, standardization and formalization	Burns & Stalker, 1961; Child, 1972, 1973, 1975; Pierce & Delbecq, 1977; Pugh et al., 1968; Pugh, Hickson, Hinings & Turner, 1969
2	Information systems	Galbraith, 1973, 1977, 1994
3	Informal lateral mechanisms, such as cross-functional job rotation, informal lateral communication	Edström & Galbraith, 1977
4	Formal lateral mechanisms, such as cross-functional teams, committees, integrative departments, and integrator roles	Adler, 1995; Galbraith, 1973, 1977, 1994; Hage et al., 1971; Lawrence & Lorsch, 1967; Tushman, 1977
5	Organization-level incentives and other social mechanisms	Barnard, 1938; Grandori & Soda, 1995

The main idea of information processing perspective is that in effective organizations, there is a fit between the information processing requirements and the information processing capacity created by the integration mechanisms (Galbraith, 1973). When the requirements for information processing are high, numerous complex lateral mechanisms are needed, but when the information processing requirements are low, the organization can do well with vertical mechanisms like centralization. Furthermore, due to the costs of integration mechanisms, increasing the information processing capacity excessively would not be rational. Instead, the goal is to achieve the mentioned fit of information processing capacity to the extent required.

In this paper we take the information processing perspective to the context of outsourcing and contract manufacturing. Our purpose is to analyze what creates uncertainty for the focal firm who decides to outsource part of its operations to a contract manufacturer. Furthermore, we then assess how these uncertainties are managed by analyzing the integration mechanisms used both

within the focal firm as well as on the interface between the focal firm and the contract manufacturer.

3 METHODOLOGY

In this research we address the issue of contract manufacturing. In order to understand how companies can manage uncertainties created by contract manufacturing, we adopt an exploratory case study approach (Yin, 2009). This method is suitable for investigating a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. Yin (2009, p. 18) states also that the case study inquiry relies on multiple sources of evidence, with data needing to converge in a triangulating fashion; and as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis.

Prior empirical research on outsourcing has spanned across several industries, such as automotive industry (Corswant & Fredriksson, 2002; McIvor et al., 1997), construction (Dubois & Gadde, 2000, Lai, 2000), consumer products (Choy & Lee, 2003, Leavy, 2004), electricity (Langfield-Smith & Smith, 2003), heavy machinery (Momme & Hvolby, 2002, Venkatesan, 1992), information technology (Aubert et al., 1996, Bahli & Rivard, 2005, Han et al., 2008, Lonsdale C., 1999), medical industry (Blanchette, 2004), public services (Grimshaw et al., 2002), and telecommunications (Berggren & Bengtsson, 2004, Leavy, 2004, Marshall et al., 2007, McIvor, 2003). For the purposes of this research we selected two case companies for in-depth analysis representing different industries: Electronics industry and food industry, which together offer an interesting comparison in the context of contract manufacturing. Within both firms, several contract manufacturing cases were analyzed, so the study can be described as multiple embedded unit case study (Yin, 2009). These two case firms were selected because they offered

access to multiple supplier relationships within the studied phenomenon, and thus suit well for the purposes of this study. Limiting the number of firms and choosing several projects and products within both of them, however also allows for controlling for some environmental factors that might affect the findings. Contract manufacturing in electronics industry is a common practice and much research has focused on this industry sector. Food industry, on the other hand, has been studied to significantly lesser extent (as an exception, see Gottfredson et al., 2005). This, however, reflects the reality in a sense that in food supply chains contract manufacturing has been applied to a lesser extent than in other industries (Van Hoek, 1999). Despite of many similarities, some distinguishing factors make food industry different from other manufacturing industries. First, the requirement for quality in every step of the value chain needs to be met. As the end product is consumed for nutrition, it must meet not only the nutritional requirements but be safe to consume. Also, an issue not that urgent in other industries is the best before problem, as the lifetime for some products can only be some days before they become obsolete. The cycle is much faster than, say with electronics, as the product may not even be used after the set date and must be discarded. Brand and label are important for food manufacturer to create loyalty among customers and consumers.

Main data collection method was structured interviews, supported by analysis of process descriptions, strategy documents, and company operating guidelines. Altogether almost 100 interviews were carried out in several different stages. For case 1 we carried out 34 interviews in four countries. Interviewees were from different organizational units, including buying, supply chain planning, supplier development, quality and supplier integration, planning process development, and top management of the procurement function to provide multiple perspectives. Three different interview guidelines were used according to the expertise areas of the interviewees. The first part targeted on daily operative tasks, and it was used with buyers and

supply chain planners. The second part on supplier development and selection of collaborative modes was used with persons working with supply and supplier development and category management. The third part focused on broader perspective of overall strategy, and long-term directions in each supplier relationship. In most interviews there were two interviewers and one respondent. Seven interviews were made by phone.

The data for case 2 were collected in three rounds. In the first round of interviews the main purpose was to familiarize the authors with the company and its business logic, and to gain deeper knowledge of the problem. In the first phase four key persons, representing different functional managers, were interviewed. In the second round, the objective was to gain deeper knowledge of the situation from key stakeholders in the process. Altogether 20 interviews were carried out with functional managers and team leaders from quality assurance, product development, supply chain management, production, sourcing, and logistics. The topics discussed in this round included motives for outsourcing, organizational capabilities, faced challenges in the projects, and the level of collaboration. In the third phase, altogether 27 interviews were carried out with 24 different people. The focus was twofold. The aim was to gain top management view to contract manufacturing, and managing director as well as the vice president of communications were interviewed. The aim was also to gain an understanding of potential differences in perspectives between the buyer and supplier. Hence, interviews with the four contract manufacturing partners were carried out.

All interviews were documented as memos and sent to the interviewees for validity check after the interview. In both cases a comprehensive case description was written after the interviews. To further increase the validity of the results, the results were discussed in several workshop sessions with the case companies.

4 ANALYSIS

4.1 ElectronicsCo

The case company ElectronicsCo is a large, globally operating electronics manufacturer with manufacturing plants in Europe, Asia, and the Americas. Its product/service offering consists of manufactured, complex electronics products as well as large system projects delivering full infrastructure solutions to customers. Altogether the case company has 1400 customers with direct contact at 150 countries. The industry the case company is in has been highly competitive, resulting revenue of 12-14BEUR annually for the case company with operating margin around zero.

The relationship between the case company and the contact manufacturer can be characterized as a relationship with high volume and broad range of items. The contract manufacturer has operations at 18 countries, where 70% of headcount is located in low-cost countries. The case company is served by the contract manufacturer from multiple factories around the globe.

The business between the case company and the contract manufacturer covers several types of services. Primary business is electronics manufacturing services to multiple business lines, but service portfolio includes also mechanics manufacturing, custom components, repair services, new product introduction services, and engineering services. The case company is strategically and from a revenue perspective a top 5 customer for the contract manufacturer, and the contract manufacturer is a strategic supplier for the case company.

Organizationally the case company is a global matrix organization structured around two dimensions: Key business processes like product creation process and delivery process in one dimension and main business areas as another dimension. Contract manufacturers, like any other

suppliers, are managed by the global procurement function of the company. The processes and respective cross-functional process teams conducting the daily work determine how business is done with the contract manufacturers. The key processes involved in management of contact manufacturers are supplier base management process, supplier selection process, and supplier management process. The sources of uncertainty, as well as the mechanisms which the case company is using to manage the uncertainty, are illustrated below in the Table 4.

In the ElectronicsCo, the most notable characteristic is the broad use of cross-functional teams, often including also representatives of the contract manufacturer. The teams have a central role in management of the relationship with the contract manufacturer. During normal operations the cross-functional team – the category management team - is primarily concerned of managing demand and supply uncertainty. The team includes members from both global and local organizations, and from different functions: Procurement, manufacturing, quality, supplier development. They are operating the relationship with a high level of empowerment.

From the perspective of the contract manufacturer, early supplier involvement and supplier participation to the operative team reduces the uncertainty related to the supplier and buyer commitment, and reduces possible opportunistic behavior. Global processes on all key activities, strictly followed by the case company, are used to manage the uncertainty related to roles and responsibilities both from the perspective of the buyer as well as of the contract manufacturer.

When seen from the change management perspective, formalized procedures and project management practices reduce significantly the implementation-related uncertainty in change situations. Strict project management reduces the uncertainty related to implementation projects and their success. Clear supplier requirements, audit procedures and involvement of quality

experts in teams are used to manage the quality-related uncertainty both at the change situations as well as in normal daily operations.

4.2 FoodCo

The case company FoodCo represents food industry. It is headquartered in the Nordic countries and has a strong market position in the Nordics and Baltic countries. The company has three factories, a number of product lines and strong brands in various categories, especially in luxury category. Annual sales of the company are 1.159 million Euros, and the number of products is around 400.

Currently about 7 % of the production volume of the company is outsourced and contract manufacturing is starting to play a more and more important role in the firm. There are numerous reasons for this. First, contract manufacturing is used to accommodate varying demands of the market; consumers and retailers require frequent introductions of new products and modified packages of existing ones. Second, contract manufacturing is used for additional capacity; the nature of the demand is very volatile and at some peak periods, even though own capacity is used at a very high rate, additional capacity is needed. And third, contract manufacturing is also used for more strategic reasons; the company aims at increasing variety and diversification of product range through contract manufacturing.

The company does not have a specific organization unit responsible for managing contract manufacturing, nor dedicated resources for specific suppliers. The normal procedure is to start a project and build a cross-functional team around it. Currently projects to contract products or packages out are done on ‘as needed’ basis. Therefore, the project team is built each time suitable for the project by pooling together professionals from different functional areas. In this study four contract manufacturing relationships were studied. Two of them concerned packing, and two manufacturing.

The study was done by investigating the managerial practices of a contract manufacturing relationship. The characteristics of the projects are presented in Figure 1 as a matrix, where the novelty of the products and product type serve as axes. In project 1, the focus was in increasing production capacity for an existing product. In this project major challenges were related to the impacts of processing phase to product taste: items produced in-house and externally should equal in taste. Our analysis points out that contracting out a new product in project 2 included many risks and uncertainties related to selection of the contract manufacturer, component selection and demand, which the company was not able to manage successfully. Project 3 included outsourcing of packaging of a seasonal product. And finally, Project 4 was outsourcing of a work-intensive packaging phase of production of a relatively low volume product by a previously known supplier. To conclude, the uncertainties related to the four different projects vary, and they can be linked to the manufacturing process, novelty of the product or to the supplier.

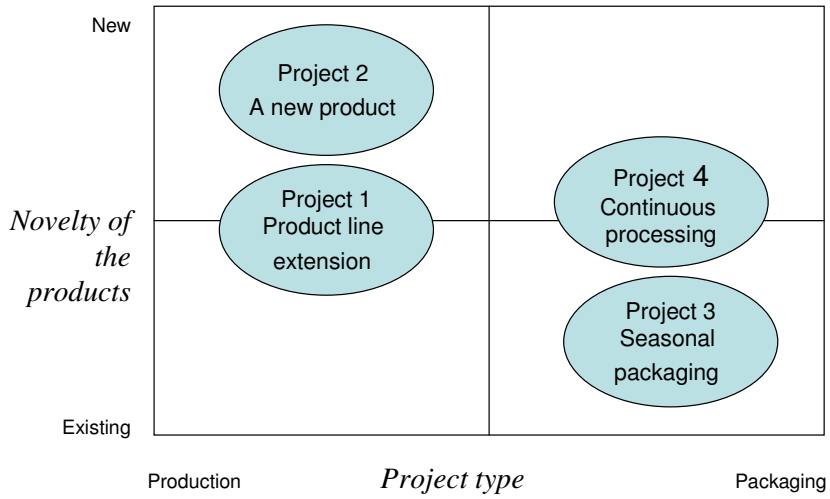

Figure 1. The projects studied in FoodCo.

The implementation of contract manufacturing projects has not always succeeded well. For example, several interviewees pointed out that the current organization is very factory-centric,

meaning that own production is preferred, and processes and operation models are created for in-house production. How the company is responding to different uncertainties in the studied four contract manufacturing relationships, is collected into the following table (Table 4).

It can be concluded that the organization in FoodCo is clearly functionally and internally oriented in managing contract manufacturing. The cross-functional team members pointed out to be representatives of their respective functions than really members of a team that works together on issues related to contract manufacturing. The tasks of the team are not planned and budgeted for the workers, but come on top of everything else and thus limit the time and attention devoted to the team. However, the company is highly internally oriented. There is a strong trust in own capabilities and own production capacity, and this reflects also to the role of contract manufacturing; it is considered as a strategy to manage exceptional cases, not as a part of everyday operations model. This attitude can be also considered as a hedging mechanism towards the risks connected to outsourcing, especially towards quality failures. The company is strongly minimizing all risks connected to the product quality and brand image: negative news would immediately destroy their image.

An interesting observation was that it is very attractive for the FoodCo to outsource work-intensive parts outside the actual production process. This helps to level the work load connected to seasonal products, and as the actual production is kept in-house, to avoid direct risks connected to product quality. It seems more attractive for the case company to outsource the packaging phase of its production process rather than the production process itself because it is then able to avoid product quality concern, which is a major issue in the industry.

Table 4. Identified uncertainties in the case companies and mechanisms used to manage them

Source of uncertainty	ElectronicsCo		FoodCo	
	Used mechanism(s)	**Outcomes**	**Used mechanism(s)**	**Outcomes**
Demand uncertainty	Intensive communication between buyer and the contract manufacturer of demand changes Agreed flexibility up/down at supplier (slack, but defined) Dedicated personnel and teams both at buyer and at contract manufacturer to manage demand, response, and communication	Provides exceptional flexibility, but costly. Sometimes flexibility not sufficient	Slack capacity at the supplier	Ok, but a costly mechanism. More frequent and regular information sharing on demand changes needed.
Supply uncertainty, capacity limitations or limited availability	Intensive daily/weekly communication of product/component availability between the contract manufacturer and the buyer Global materials execution organization: Managing component allocations including both own manufacturing and contract manufacturing. Contract manufacturers purchasing in some cases on buyer's contracts	Due to high fluctuation of the business, supply uncertainty of long lead time components is a real problem. The case company has a good ability to adjust the manufacturing and delivery operations to supply limitations when needed	Capacity availability ensured in audits and contracts. Buffering in the form of time (waiting time) or stocking components or goods	Buffering is a costly mechanism, and cause delays.
Uncertainty about supplier capability to meet expectations	Supplier audits and supplier development plans Clear, formalized requirements for both existing and new suppliers Building long term relationship with the supplier	Ability to manage high amount of product changes and new product introductions successfully	Supplier audits. Clear requirements Building long term relationship with suppliers. Selecting known suppliers for new products.	Ok, but lack of systematic collection of supplier capability data to be used in future projects
Ensuring continuous development and relationship management, uncertainty about realized costs	Contracts and additional documents on key topics (like logistics service level agreement). Clear roles: Supplier owner, category manager, executive sponsor. Dedicated supplier development and supplier integration resources. Shared development plan, targets and budget. Frequent management and executive meetings, reviews of business performance and development activities	Clear plans for development of both the relationship, and shared business activities Uncertainty about business implications of the development projects	Contracts. Regular supplier meetings. Key persons, but no dedicated resources to specific suppliers.	Ok, but contract contents was not always communicated to all stakeholders
New product type	Early supplier involvement to product development and NPI Dedicated purchasing & delivery capability resources at each of the R&D projects (a mandatory role)	Clear component requirements already in planning phase, frequent checks of all issues.	Project team with representatives from all key functions	A case project heavily delayed. Mistake in selecting a component noticed only after purchase -> remarkable costs. Supplier is not involved in the process.
Implementation success, meeting the requirements	Formal, standardized project management methodology with strict management follow-up. Supplier base implementation as a normal subproject A cross-functional implementation team, led by an experienced project manager	Very good, taken the business volume and uncertainty High amount of simultaneous implementation projects causing resource projects -> split resourcing between projects	A cross-functional project team lead by a project manager. Standardized process model.	Team effectiveness not at the best level. Unclear responsibilities cause problems; in some cases all key functions were not included in the team. Process model not always obeyed. Uncertainty about when to move forward in the model.
Uncertainty about meeting product quality requirements	Technology assessments and supplier audits. Test production series, formal NPI procedures. Sourcing engineering and quality representatives as mandatory members of both category management and R&D project teams. Supplier involved early, cross-functional involvement expected.	Sometimes high uncertainty involved in technology selections due to nature of the business. Through sourcing engineering and early supplier involvement quality requirements and preferred solutions known well and early.	Supplier audits. Test production. Product quality function informed in good time and responsible.	Ok, but takes a long time. Quality needs to be ensured also in the end of best-before period.
Uncertainty about schedule	Detailed, formal project management methodology, supplier assessment criteria. Early supplier involvement	Projects always under intense time pressure due to competitive situation. Good success	Detailed process model to be followed	In some projects long delays, too informal procedures. Too short planning phase cause uncertainty in following phases.
Skills, learning and increased know-how	Project team members are dedicated for projects. Project work is a full-time assignment, but an expert can have several similar projects. Formalized project management methodology and training for all project team members	Management of contract manufacturers is done based on well-developed processes Issues in knowledge management and information sharing between the projects	Project team members are experts from various functions. Project work is a part-time job even for project manager.	Managing projects as one-time projects does not support learning on previous implementations. Project work considered as of secondary importance.

5 DISCUSSION

The second step of our analysis focuses on cross-case analysis in order to increase the understanding of when different integration mechanisms are used to manage uncertainties created by contract manufacturing. First, we discuss the various sources of uncertainties manufacturing companies face when engaging in contract manufacturing, and second, we discuss ways in which the firms manage these uncertainties. We provide two sets of propositions for further research. The first propositions (1A-1E) concern the sources of uncertainties in contract manufacturing relationships, and the second set of propositions (2A-2E) relate to the management of these uncertainties.

5.1 Sources of uncertainties

Both of the companies we studied consider product quality as the primary concern in their contract manufacturing relationships. In ElectronicsCo, the product quality and uncertainty related to it can be traced to the significant impact that quality problems have on various costs, in particular delivery costs and warranty costs. Quality problems may cause remarkable delays and additional costs in assembly, or during the long operating time. Also for the FoodCo product quality is of significant concern but for different reasons. The brand of FoodCo is a well-known consumer brand, associated especially with high quality and luxury. Quality issues, whether significant problems or even a small variation in the product creating difference in critical features like composition or taste, are seen as a major risk in contract manufacturing arrangements.

> Proposition 1A: *Product quality creates uncertainty in the contract manufacturing relationship.*

Second main area of uncertainty relates to the quantity of production. Achieving quantity flexibility is a motivation to encage in a contract manufacturing relationship (Heikkilä and Gordon, 2002; Kim, 2003), but ensuring the supplier capability to deliver required quantities, i.e. ensuring availability, is also a major concern in the relationship. The drivers for this uncertainty come from two sources: Unpredictability and fluctuation of demand, and risks and uncertainty related to availability of supply. In case of FoodCo, the main source for the demand uncertainty is consumer. FoodCo uses contract manufacturing to supply seasonal products, like products for Christmas and Easter, which makes the forecasting of consumer demand challenging. For ElectronicsCo, uncertainty in demand is driven through competitive situation at the market. At the same time, availability of critical electronics components like semiconductors from 2nd tier suppliers causes an additional source of uncertainty in supply.

> Proposition 1B: *Quantity uncertainty is related to the capability of the contract manufacturer to ensure availability of products or components in response to customer demand.*

The third area of uncertainty is related to the continuous management of the relationship with the contract manufacturer. Both FoodCo as well as the ElectronicsCo have allocated significant portions of business to be realized using contract manufacturing. Both firms have also committed significant resources to manage the relationship. Investments in the relationship create uncertainties for the focal firm: On the one hand, activities in the contract manufacturing interface need management resources and generate costs. On the other hand processes connecting the focal company and the contract manufacturer are not to be treated as permanent but need resources for continuous development. Also prior research points out that long-term development of the relationship is critical for the buyer (Momme and Hvolby, 2002, Arranada and Vazguez, 2006, Zhu et al., 2001) to avoid the risks of expected outcomes not realizing (Fan, 2000).

Proposition 1C: *Process uncertainties are connected to the operational efficiency of the processes linking the buyer and the contract manufacturer, and to the continuous development of the relationship.*

The actual implementation phase includes major uncertainties for firms (McIvor & McHugh, 2000), which is evident in both of our firms as well. FoodCo missed the key season for a seasonal product due to unsuccessful implementation of contract manufacturing, which led to postponement of the product. ElectronicsCo, on the other hand, is running multiple implementation projects simultaneously with the same contract manufacturing firm. Implications of the uncertainty are visible especially in terms of time; in a fast-paced industry like the electronics (Fine, 2000), delays in production can have significant impact for the success of the firms.

Proposition 1D: *Implementation of the contract manufacturing creates uncertainties in the contract manufacturing relationship.*

For ElectronicsCo, choices in technology and its consequences pose a major source of uncertainty. The company develops and produces R&D intensive high technology products, and success of the product development and new product introduction determines to large extent the competitive position of the company. This involves a risk of transferring know-how to the contract manufacturer (Hall, 2000; McIvor, 2009). For FoodCo, in turn, right anticipation of consumer preferences and trends, and correct product development as a response to those, was observed to be a business critical factor. With both of the companies the uncertainty related to success of new product development was including both the question whether the new product will be a success, and also whether the R&D can be accomplished as expected.

Proposition 1E: *In case of new product development, product type, schedules, and supplier risks create uncertainties in the contract manufacturing.*

5.2 Management of uncertainties

After identification of different types of uncertainties in the cases, our analysis of the cases proceeds to the use of integration mechanisms to manage uncertainties created by contract manufacturing.

The first observation from the cases is that all procedures for ensuring product quality were very carefully managed in both studied companies, and even more thoroughly in the FoodCo. Both of the companies use specific requirement lists and audit procedures to ensure that the supplier fulfills the various requirements related to product quality. The quality assurance mechanisms include also standardization of production process and involvement of experts throughout the life cycle. Quality was clearly in focus: Responsibilities were clear, procedures for supplier auditing were well defined and requirements for suppliers were clear and thorough. Standardization is a suitable integration mechanism especially in the case when the interdependence of the relationship is of sequential nature (Thompson, 1967; Van de Ven et al., 1976) as is here in terms of product quality.

> Proposition 2A: *Uncertainty related to product quality is managed by standardization of requirements, standardization of production process and putting high emphasis on the implementation phases involving functional experts.*

To manage quantity uncertainty, the FoodCo was utilizing contract manufacturer as a slack capacity to level own work load and to be able to respond to seasonal demand peaks. In addition to this, it is able to use own inventories as much as the perishable product allows. This is however a costly mechanisms, although needed to be able to respond in a batch production system to seasonal demand. Based on the observations from the ElectronicsCo, we believe that the need of slack resources can be reduced by intensive communication.

Proposition 2B: *Uncertainty related to product quantity can be managed with formal and frequent information sharing practices, regular and frequent meeting procedures with the supplier to share information added with ad-hoc communication.*

In both firms, complex team structures have been developed as the integration mechanism to manage uncertainty in demand and supply management as well as in implementation projects. These are two different kinds of teams; teams involving people from different functional areas within the focal firm (both ElectronicsCo and FoodCo) teams involving multiple functional areas within the focal firm but also from the contract manufacturer (ElectronicsCo), hence being both cross-functional and cross-organizational in nature. In FoodCo, internal cross-functional teams are used in the implementation of each contract manufacturing case; the main purpose of the team is to integrate the various functions to facilitate the implementation of the contract manufacturing relationship. An interesting observation is that ElectronicsCo has implemented dedicated teams for managing the contract manufacturing relationship implementation, in which both the focal firm and the contract manufacturing firm are represented. Hence, being both cross-functional in nature involving different internal functions, the teams are also inter-organizational in nature. This would suggest that the implementation is more uncertain in ElectronicsCo, as the implementation is managed with more complex team structures (Galbraith, 1973). Furthermore, the interdependence in the implementation is more reciprocal and team in nature (Van de Ven et al., 1976), which suggests that mechanisms such as standardization are not sufficient to manage the uncertainty, requiring more elaborated ways to manage information processing between the parties. These empirical findings are supported also by some prior purchasing and supply management research (Trent 2004, Van Weele 2005), which suggests that the use of teams has become more common.

Proposition 2C: *Uncertainty related to implementation of the contract manufacturing relationship can be managed by a well-resourced, skilled and dedicated cross-functional and inter-company project team.*

When studying the cases we notice a difference in the use of the teams. FoodCo faced many challenges in managing its contract manufacturing cases, particularly in the implementation of the relationship. For each case, a project team was formed, but the team responsibilities were not clear, project manager lacked skills and the team work was not planned and included in worker's responsibilities. In ElectronicsCo, most of the work in the company is done in teams, team management is strictly guided and supported, and projects obey formal process models which define project structure and deliverables step-by-step. Therefore there is a clear cultural difference in working practices. However, the results suggest that in addition to having the teams to manage the relationship, there needs to be certain standard procedures and agreed ways of working. This is also supported by early organization design literature, which suggests that integration mechanisms are not used in a substitutive manner but rather together to support the effect of each other (Martinez & Jarillo, 1989).

Proposition 2D: *Uncertainty related to process management can be managed, in addition to adopting team structures, by formal and regular collaborative inter-company meeting procedures.*

A clear difference in the management of uncertainty related to new product development can be observed between the firms. In ElectronicsCo, the company works together with the contract manufacturer in new product development and the supplier company performs a remarkable share of the development work. On the other hand, FoodCo develops the product itself, and then seeks for a suitable supplier to manufacture the product. This suggests that the uncertainty related

to new products is higher in ElectronicsCo and engaging in development activities with the supplier provides potential knowhow in the supplying company.

Proposition 2E: *Uncertainty related to new product introductions can be managed by involving the contract manufacturer early in the process to involve best skills and knowledge to the process.*

6 CONCLUSIONS

In this paper we have focused on contract manufacturing as an organizational design phenomenon. We especially focused on studying the use of integration mechanisms in managing uncertainties that are created by engaging in contract manufacturing. Although some of the mechanisms are used to manage the relationship between the focal firm and the contract manufacturer, we addressed the uncertainties from the perspective of the firm who outsources part of its activities. Our empirical results point out that firms face various sources of uncertainty when engaging in contract manufacturing; some are related to the focal supplier and some to the firm itself and its products. Furthermore, the analysis also point out various ways that firms use to manage uncertainties created by engaging in contract manufacturing.

Our paper has been one of the first attempts to address the issue of contract manufacturing as an organization design issue. Most OM research has focused on outsourcing decision and factors affecting it (Kakouris et al., 2006, Welch & Nayak, 1992). Hence, this research complements prior research on outsourcing by focusing on how firms can manage dependencies with the contract manufacturer after the decision to outsource has been made. This way the research also has significant managerial implications especially as empirical evidence suggests that management of contract manufacturing poses significant challenges even in firms that have outsourced activities for years (Van Weele, 2005). This paper also complements prior research on

supplier integration. While there is abundance of research on supply chain integration in OM (oftentimes including both supplier and customer integration), the majority of the literature focuses on assessing the effects of various integration mechanisms on performance treating all suppliers equal (e.g., Das et al., 2006; Frohlich & Westbrook, 2001; Koufteros et al., 2007; Narasimhan & Kim, 2002; Swink et al., 2007; Vachon & Klassen, 2008), we have given further insight into a particular type of supplier relationship – the case of contract manufacturing. Furthermore, instead of focusing on the effects of the use of various mechanisms, our analysis given insight into when the different ways of managing the dependencies are used.

The research also provides avenues for further research. Our empirical context is clearly limited and further empirical analysis is needed by broadening the number and type of organizations to be studied. Future research could be carried out by conducting a survey to address the types of uncertainties and integration mechanisms identified in this research and developing the propositions into testable hypothesis and testing them. Future research could also engage in in-depth case analysis of the effectiveness of the various integration mechanisms in different contexts.

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