TAMPERE UNIVERSITY OF TECHNOLOGY

ANU MARTIKAINEN

DESIGN FOR PROCUREMENT

Master`s Thesis

Examiners: Professor Asko Riitahuhta and Associate Professor Antti Pulkkinen
Examiners and topic approved in the Faculty of Automation, Mechanical and Materials engineering council meeting on June 8th, 2011.

ABSTRACT

TAMPERE UNIVERSITY OF TECHNOLOGY
Automation engineering program
MARTIKAINEN, ANU: Design for Procurement
Master of Science Thesis, 56 pages, 2 appendix pages
March 2012
Major: Production Engineering / (Product Development)
Examiners: Professor Asko Riitahuhta (TUT), Associate Professor Antti Pulkkinen (TUT).
Keywords: Procurement, Design for X, Market strategy, Product strategy, Process strategy, Product structure, Strategic Partnerships.

Today, procurement has a major role in companies' businesses. Because of the globalization and harder competition, many companies are trying to focus more on their main knowhow and leave the other issues to subcontractors. That is why the procurement operations have been expanded in many companies and procurement operations form a major share of the total costs of a product. It is important to try to find out how companies could optimize their procurement function so that it would help the whole company's success.

The purpose of this thesis was to find out what Design for Procurement method contains, and how companies could make their procurement more effective and easier to handle. This study is based on a literature research and on interviews of four different companies: Nokia, Osram, Metso Minerals and Konecranes.

Design for X method can help companies to change the way they manage product development process. This method examines, how well the product development succeeds from the selected point of view X, and provides ways to make the particular point of view easier to handle.

The procurement process should be taken into account already at a very early phase. The decisions made in the strategic phase have a major impact on the procurement process. When a company defines the kind of markets the company wants to compete in, and what kind of products the company wants to produce, the company should also think what these decisions mean to the company's procurement process. Product design engineers usually make decisions concerning product complexity and architecture. Also these decisions have a major impact on the company's procurement operations. Better co-operation between these two functions could improve the procurement function and the whole company's performance.

All of the interviewed companies are operating in a complex global business environment with increasing competition with other companies. All of the problems of the interviewed companies at the moment are related to the management of the global environment, such as designing global products to global markets, information management, communication problems and control of the large market areas. Increased quality requirements and cost competitiveness were also common challenges.

TIIVISTELMÄ

TAMPEREEN TEKNILLINEN YLIOPISTO
Automaatiotekniikan koulutusohjelma
MARTIKAINEN, ANU: Hankintalähtöinen suunnittelu
Diplomityö, 56 sivua, 2 liitesivua
Maaliskuu 2012
Pääaine/painotus: Tuotantotekniikka / (Tuotekehitys)
Tarkastaja: Professori Asko Riitahuhta, TkT Antti Pulkkinen
Avainsanat: Hankintatoimi, Design for X, Markkina-alue-, Tuote-, ja Prosessi-Strategia, Tuoterakenne, Strateginen Partnership.

Hankintatoimella on nykyisin hyvin merkittävä rooli koko yrityksen toiminnan kannalta. Globalisaation ja kovenevan kilpailun myötä yritykset keskittyvät enemmän pääosaamiseensa ja jättävät muut osa-alueet alihankkijoille. Tämän vuoksi hankinnan rooli on laajentunut huomattavasti ja hankinnan kustannukset muodostavat merkittävän osan tuotteen kokonaiskustannuksista.

Tämän diplomityön tarkoituksena oli tutkia, mitä Design for Procurement -metodi merkitsee, sekä tutkia, miten yritykset voisivat tehostaa hankitatoimeaan. Diplomityö perustuu kirjallisuustutkimukseen ja neljän eri yrityksen haastatteluun. Haastatteluihin valitut yritykset olivat Nokia, Osram, Metso Minerals ja Konecranes.

Design for X on metodi, jonka avulla yritys voi hallita tuotekehitysprosessia paremmin. Metodin tarkoituksena on tuottaa toimintamalleja ja työkaluja, joiden avulla voidaan parantaa valitun näkökulman X tehokkuutta.

Strategiavaiheen päätöksillä on merkittävä vaikutus yrityksen hankintatoimeen. Yrityksen hankintatoimi tulisikin ottaa huomion jo hyvin aikaisessa vaiheessa, yrityksen suunnitellessa tulevia markkina-alueita seka tuotestrategioita. Tuotekehitysinsinöörit tekevät usein merkittäviä ratkaisuita koskien tuotteen monimutkaisuutta ja arkkitehtuuria. Myös näillä päätöksillä on merkittävä vaikutus yrityksen hankintatoimeen.

Kaikki haastateltavat yritykset toimivat haasteellisessa globaalissa ympäristössä, jolle on tyypillistä kasvava kilpailu. Haastateltavien yrityksien tämän hetkiset ongelmat keskittyvätkin juuri globaalin ympäristön hallintaan, kuten globaalien tuotteiden suunnitteluun, tiedon hallintaan, kommunikaatio-ongelmiin, ja laajojen markkina-alueiden hallitsemiseen. Lisäksi kasvavan kilpailun myötä laatu- ja kustannuspaineet ovat kasvaneet.

Tuotekehityksen ja hankinnan yhteistoiminnalla voidaan saada merkittäviä parannuksia hankintatoimeen ja koko yrityksen toimintaan. Lisäksi, koska yritykset ulkoistavat yhä enemmän toimintojaan, on tärkeää, että myös yrityksen tuotekehitysosasto tekee yhteistyötä alihankkijoiden kanssa.

PREFACE

This thesis was part of a larger research project, "Design for Procurement", which is conducted in the Department of Production Engineering at the Tampere University of Technology, Tampere, Finland.
I would like to thank Professor Asko Riitahuhta from the Department of Production Engineering for giving me the chance to work on this interesting project and for his guidance and improvement ideas for this thesis. I am also very grateful to Associate Professor Antti Pulkkinen for his guidance and valuable advices regarding this thesis. I would like to express my gratitude to my former co-workers in the Department of Production Engineering for giving me good advices and a helping hand whenever it was needed.
I also give my thanks to all the interviewed people from the collaborating companies for their co-operation in this study.
I would also like to thank my parents Sinikka and Teuvo for their support. Finally, I would like to thank my husband Ilkka for all the encouragement and support throughout my studies.

Ann Arbor, Michigan, December 12th, 2011

Anu Martikainen

TABLE OF CONTENTS

ABBREVIATIONS

DFA	Design for Assembly
DFC	Design for Cost
DFL	Design for Logistics
DFM	Design for Manufacturing
DFP	Design for Procurement
DFQ	Design for Quality
DFX	Design for X
ERP	Enterprise resource planning
ESI	Early Supplier Involvement
FMEA	Failure Mode and Effect Analyze
R&D	Research and Development
V&V	Verification and Validation
VUP	Verification Upstream Project

1 INTRODUCTION

1.1 Motivation

The product development process is nowadays more complicated than ever before, mainly because of the increased complexity of the products is often combined with a relatively fast time-to-market cycle. Additionally, the quality requirements of the products have tightened and the pressure for cost-effectiveness has increased due to competition with production from low-cost countries. Conversely, as trade opportunities now exist all over the world, the companies' operations have also become more global. The new global environment is a big challenge for all companies; it makes the competition harder in many fields and the old business methods may need to be revised. On the other hand, the globalization also brings many new possibilities. New networks can increase the competitiveness of a company and co-operations can lead to new business ideas and innovations. At present, the global economic turmoil has increased the demand for effective product development even further.

The procurement strategy of a company is in a critically important role when the future trade opportunities and possibilities to improve competitiveness are being considered. Procurement includes all activities that are required to get the product from the supplier to its final destination. It also includes supplier relationship management, quality control and assurance aspect. (Weele 2005, p. 14) An effective and efficient purchasing and supply function can make an important contribution to the company's profits. This is an important aspect especially at present, as the procurement operations of companies have expanded and the procurement operations form a major amount of the total costs of the product. If a company wishes to improve its procurement operations, it has to be determined a) what is the company`s main knowhow as well as b) which operations could be outsourced. At the same time, it has to be evaluated, which kind of new strategic networks these decisions mean to the company. Understanding new trade opportunities and the company's own strategic role in the new business environment is often very challenging. Because the strategic role of the procurement operations is more important than before, it is important to find out how companies could optimize their procurement operations so that it would help the whole company's success.

Design for X (DFX) method is both a philosophy and a methodology that can help companies to change the way they manage product development process from the selected point of view (Huang, 1996. p.3). There are many different opinions and view-

points about what the Design for Procurement (DFP) exactly is. Depending on the context, DFP can also be related to many subjects. The main goal of DFP is to exchange procurement knowledge among the product design engineers. Product design engineers usually make the decisions that have an effect on the complexity and architecture of the products. These decisions affect also the complexity of the procurement operations. The purchasing department usually makes all decisions about which sources are used to purchase the goods that are needed. Greater coordination with these two functions could improve the product development process, the procurement process, and the performance of the entire company.

In a network orientated business environment different organizations are responsible about different tasks related to the implementation of the product, logistics or defining of the product or part of the product. More often the suppliers are also responsible about the product design. The main challenge is how different organizations can get information about the other processes. Comprehensive procurement strategy focuses mainly on reliability of delivering and long-time cooperation with the suppliers. Moving away from traditional purchasing roles companies can focus on getting better performance from suppliers and do more active management of supplier relationships. Partnership is often defined as a relationship between two or more parties that share the risk and rewards of a business venture. Partnership also includes engaging in activities to a common goal. (Wincel 2004, p. 39) When a partnership succeeds, it can bring many new possibilities to both parties. In order to be able to confront new business environment challenges, companies need to work together with suppliers in the areas of manufacturing, logistics, services and product development.

1.2 Research problem and aims of the study

This thesis is part of a larger research project with under the same title, “Design for Procurement”, which is conducted in the Department of Production Engineering at the Tampere University of Technology, Tampere, Finland. In this project, the main goal is to develop various tools and guidelines in order to control complicated procurement operations. The project “Design for Procurement” is a collaborative effort between the researchers in the Department of Production Engineering at the Tampere University of Technology and research groups in two international partner universities, University of Bath, Bath, UK and Technical University of Munich, Munich, Germany. The industrial perspective to this academic effort is contributed by three Finnish companies: Nokia, Metso Minerals and Konecranes. These companies were selected as they all are relatively large, international companies that represent different fields in the Finnish industry.

From the academic perspective, the main goal of this master's thesis is to find out what Design for Procurement method comprises. From the industrial perspective, the main goal is to search how companies could make their procurement operations more effective and easier to handle. Because the subject described above is quite broad, the main focus of this thesis is on the effects of the strategic decisions of a company on the procurement process, the effects of the decisions on the product structure and on procurement, and the benefits of strategic partnerships and alliances.

The primary research questions of this thesis are:

1. What DFP is?
2. How does the corporate strategy affect procurement functions?
3. How does the product structure affect procurement operations?
4. How could companies benefit more on their co-operations with suppliers?

I will use Nokia`s on-going project called Verification Upstream Project (VUP) as a practical example of partnership cooperation. In the VUP project, Nokia has a very close co-operation with its suppliers.

1.3 Research methods

The study is divided into a theoretical part and an empirical part. Theoretical part of the study is based on literature research. Empirical part of the thesis contains interviews from four different companies: Nokia, Osram, Metso Minerals and Konecranes. The idea in the empirical part is to give information about the actual challenges in the companies´ product development and procurement operations. Three of the interviews were focusing on customer company´s views of the subject and one of the interviews (Osram) focused mainly on the supplier's perspective of the subject.

The research study was initiated by interviewing all four participating companies and creating a perception of the subject DFP and about the main problems of the procurement and product design. After the interviews I analysed the interview data and performed literature research on the subject. Based on the interviews and the present literature on the subject, I have made speculations and conclusions about the current challenges in the procurement. In the end, I also suggest ways to improve the procurement operations.

1.4 Structure of the study

Introduction contains the sources for research motivation, aims of the study, research questions and research methods as well as progress of the study.

Chapter two focuses on the theoretical background of the DFP. Section 2.1 contains information about what procurement is, and which operations are included into procurement. Section 2.2 contains theory about the DFX method.

Chapter 3 focuses more on the other two research questions. Section 3.1 handles theory about the product structure, and product strategy, and how those have an effect on procurement. Section 3.2 handles theory about partnerships and alliances. Chapter 4 focuses more on the Nokia VUP's background theory and purposes. The beginning of the chapter in section 4.1 is about the quality management, and the section 4.2 is about the Verification and Validation (V&V) process.

Chapter 5 contains interviews from four different companies: Nokia, Osram, Metso Minerals and Konecranes. Chapter 6 contains results of the research. In section 6.1 all the research questions are answered, and section 6.2 contains discussion about the results of the interviews. In the end of the thesis in section 6.3 I shortly present suggestions for the future research on the topic.

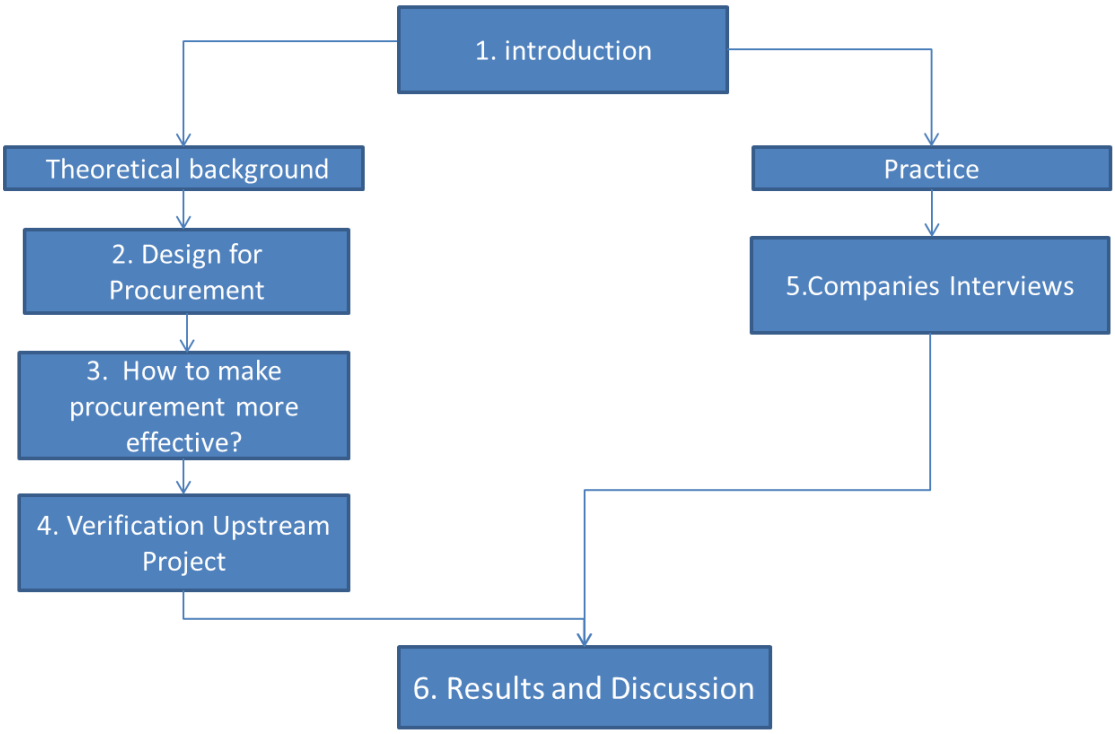

Figure 1. *Research methods and structure of the study.*

2 THEORETICAL BACKGROUND OF THE DFP

Increasing globalization, rapid development of the information technology and on-going changes in customer demands are three major reasons why the business context of companies is rapidly changing. In many companies, purchasing and supply managers are having more strategic roles in their organizations than before. They are focusing more on getting better results from suppliers and doing active management of supplier relationships. Effective purchasing and supply function can make an important contribution to company`s results. (Weele 2005, p. 5)

DFX is a method that has been used for many years to manage product development process from different points of views (the "X"s). Because companies' procurement operations have more a strategic role in the company's business than before, it is important to figure out how DFX method could make procurement operations easier to handle.

2.1 Procurement activities

In Design for Assembly (DFA), popular guidebooks such as "Mechanical Assemblies –Their Design, Manufacturing, and Role in Product Development" by Daniel E. Whitney (2004, Oxford University Press) and "Product design for manufacture and assembly" by Boothroyd et al. (2011, CRC Press) begin with explanation of the actual assembly operations and the importance of assembly. In a similar vein, in order to understand DFP, it is important to first elucidate the procurement activities.

Purchasing relates to the specific functions associated with the actual buying of goods and services from the suppliers (Mangan et al. 2008, p. 76). The purpose of the purchasing department is to deliver the right material, component or module in the right amount to the right place at the right time and at the right price. Usually the purchasing department also has a very important role in locating and qualifying suppliers for the needed products. Other activities for the purchasing department might be determining suppliers, certificate vendors, visit factories, and do background checks of suppliers. (Paquette 2004, p. 5)

Procurement is a wider term than purchasing (Weele 2005, p. 14; Mangan et al. 2008, p. 76). Procurement operations include other necessary activities in order to get the product from the supplier to its final destination. It includes the whole purchasing function, storing and transportation, incoming inspection, and quality control and assur-

ance. (Weele 2005, p.14) Procurement managers are also involved in following up of suppliers and managing the supplier relationships (Mangan et al.2008, p. 77).

Figure 2 shows all the activities which are included in the procurement process.

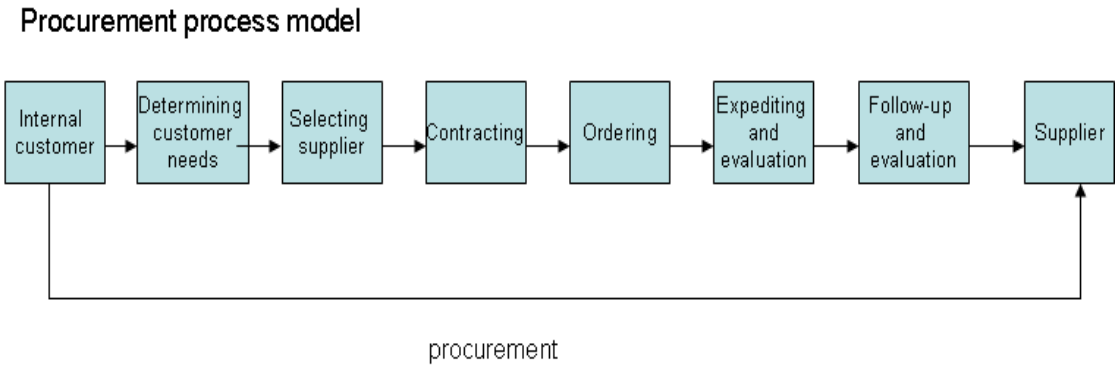

***Figure 2**. Procurement process model. (Modified from Weele 2005, p.14)*

Procurement process starts by identifying the need of buying. After identifying the need of buying, procurement department should determine the specifications for the needed goods and services and select a suitable supplier for the task.

Contract defines what has been agreed between the parties and determines the responsibilities of both parties (Lysons & Farrington 2006, p. 211). A valid contract is an agreement that the law will enforce. Ordering phase determines how much and when the supplier should deliver to company. After ordering the needed goods, the task of the purchasing function is to monitor and control the ordered booking. And finally, the purchasing function needs to follow up and evaluate the final results. (Weele 2005, p. 29)

Procurement function is not limited only to the company´s procurement department. Usually there are many organizations involved to the procurement tasks and responsibilities. Therefore, the procurement function should be comprehended as a cross-functional responsibility between many parties. For example, when determining the specifications for the needed goods, procurement department should co-operate with the Research and Development (R&D) department. (Weele 2005, p. 29)

2.1.1 Procurement strategy

The procurement strategy of a company is tightly linked to the mission of the organization, vision, values and business strategy (Baily et al. 2005, pp. 39-75). Strategy can be defined as being concerned with planning and configuring the organization for the future in accordance with certain stakeholder expectations. In other words, strategy is a long term plan for company's success. (Mangan et al. 2008, p. 36)

Strategy is usually viewed from a top-down perspective, where the first level under consideration is the strategy of the whole corporation and organization (Mangan et al.

2008 p. 36-37). The figure 3 demonstrates the link between the corporation strategy and functional strategy.

Figure 3. *Link between the corporation strategy and functional strategy. (Modified from Mangan et al. 2008. pp. 36-37)*

Corporation strategy determines the overall mission of the entire company and the types of businesses that the company wants to be involved in. Business unit strategy determines how the strategic business unit of the company will compete. Every business unit consists of many functional groups such as marketing and purchasing departments. Each functional group has to make a strategic plan which will support the overall business unit strategy. (Swink et al. 2011, p. 27)

All the decisions made at the top affect the lower level decisions, and on the other hand, when specific functional strategies are under consideration the upper level strategies have to be taken into account. (Mangan et al. 2008, p. 36-37)

Figure 4 shows that the market strategy, process strategy and product strategy should align to each other.

Figure 4. *Different Market, Product and Process strategies. (Modified from Pulkkinen 2007, p. 13)*

The market strategy addresses the question, to which markets the company wants to apply. Market strategy has a very important role in defining the process and product strategies. If a company has large market areas, it often has to have separate strategies to the different market areas. This means that the company has to produce different kinds of products to different markets in order to answer the different needs of the markets. The larger the product selection, the more complicated the entire delivery process usually is. If the different strategies do not match each other, the product does not necessarily match the market needs. (Pulkkinen 2007, pp. 13-14, 90-94).

The procurement operations are also linked to the strategies of the company's other units, and to the strategies of other external parties. Especially Logistics and Supply Chain Management strategy has to be thought from a cross-functional process perspective. (Mangan et al. 2008, p. 37)

Companies should elaborate their strategies to meet the challenges of the dynamic, constantly changing business environment (Mangan et al. 2008, pp.36-37). Employing best practices in procurement ensures that the organization, and ultimately the purchasing manager makes correct decisions. This means that an organization must develop plans that are in alignment with the goals and best interests of the procurement. (Sollish & Semanik 2005)

Obviously, it is impossible to make a universal procurement strategy for all different organizations and companies (Iloranta & Pajunen-Muhonen 2008, p. 117). Procurement activities depend on many strategic level decisions, like in which business field com-

pany works as well as factors like whether the company is global or local (Baily et al. 2005, pp. 39-75). Also strategic level decisions about the product's price, differentiation, and focus as well as the company´s manufacturing investments have substantial effects on the procurement operations (Fixson 2004; Baily et al. 2005, pp. 39-75).

Despite the fact that a general procurement strategy cannot be formulated, there are, however, some procurement strategy choices which almost every company has to deal with. Such strategy choices are make or buy decisions, leasing versus buying, single versus multiple sourcing, storage versus JIT procurement, and the continuity of procurement (contract types).

2.1.2 Make or buy decisions

Make or buy decisions are decisions about the source of materials, goods or services. Make or buy decisions are tightly linked to the company's strategy and the decisions have direct impact on the nature of the company's business. (Mangan et al. 2008, pp. 79-80; Baily et al. 2005, p. 269)

A company needs to evaluate, whether it is more profitable to outsource the part, process or service than it is to produce the part by itself. This decision should be evaluated from many different points of views. For instance, the company needs to appraise how important the part or process is to the company's current or future core competencies. Other important issues which company should appraise are:

1. Does the company have design/manufacturing capability to manufacture the part by itself?
2. Is it more cost effective to produce the part by the company itself than to outsource?
3. Are there suitable subcontractors for the production assignment?
4. How extensive is the variation in quality between purchased items when compared to the quality that the company would have achieved by itself?
5. What is the guarantee of supply?
6. How high is the intellectual property risk?

(Swink et al. 2011, pp. 290-291; Chunawalla 2008, pp. 157-162)

Typical feature of the current Product Development is the increasing volume of subcontracting. There are many reasons to why companies are outsourcing increasingly. For example, the global markets and harder competition are major reasons for increasing outsourcing (Mangan et al. 2008, pp.79-80). Companies are trying to focus more on their main knowhow and leave the other issues to subcontractors (Weele 2005, p.7).

Other reasons for outsourcing are:

- reduce of direct and indirect costs
- increased flexibility
- shared risk
- building alternative supply recourse
- helps to provide better customer service (quality)
- be more globally visible and learn new things from suppliers

(Mangan et al. 2008. p. 80; Lysons & Farrington 2006, pp. 400- 401; Weele 2005)

In many cases, the companies simply do not have the knowledge and recourses to develop all the solutions. Using subcontractors helps the company to have more recourse on their other activities and makes the whole product development process faster. (Weele 2005, p. 7)

In order to be able to confront increasing amount of suppliers, companies need to work closely together with suppliers in areas of manufacturing, logistics, services, and product development. This means new challenges in the purchasing and supply functions of the companies. The companies also need to rethink their position in the value chain. That requires a clear view on what they consider to be their core versus non-core activities. According to the present views on the subject, the non-core activities should increasingly be outsourced to specialist suppliers. (Weele 2005, p. 7)

2.1.3 Selecting the supplier

Outsourcing is not without risks. Effective supplier management begins with selecting the criteria for the evaluation of the suppliers and ensuring that the right supplier gets chosen. Selecting the right supplier is critical to the success of the company's products and the whole company's success. (Cousins et al. 2008)

To achieve good results, the correct mechanism is required and the selection must be performed systematically. Outsourcing process must be linked to the strategic objectives of the organization. (Swink et al. 2011, p. 291)

In general, the supplier selection can be divided into three different situations:

1. the new task situation
2. the modified rebuy
3. the straight rebuy

When a company decides to buy a new product from an unknown supplier, the buying is called the new task situation. The situation in which the company purchases a new product from a familiar supplier is called the modified rebuying, and the situation in which the company wants to purchase a known product from a familiar supplier is

called the straight rebuying. The straight rebuying is the most common situation in buying. Using current suppliers saves time and reduces sourcing costs. In the straight rebuy situation also the uncertainty level is low because the conditions of the contract are already known. In the first case (the new-task situation), instead, the uncertainty risk level is very high because the whole situation is new for the company. (Weele 2005, p. 31)

Another important consideration in outsourcing is whether to select single sourcing or multiple sourcing. Multiple sourcing has some advantages, e.g. prices might be lower because of competition aspect, and in case there is a problem in the delivery, a back-up plan of choosing another supplier can be used. Still, it should be pointed out that single sourcing requires less recourses from the purchasing company than multiple sourcing. Usually companies have large amount of suppliers, and they could benefit from a reduction of the suppliers. Using too many suppliers increases the complexity of the business and makes communication and control more difficult to handle. (Mangan et al 2008, p. 79)

The first stage in the selection of the suppliers is to qualify the suppliers who can meet the requirements of the product and process standards. The criterion varies between different companies and industries, but usually there are two important aspects that have to be prioritized in the process: manufacturing capabilities and financial viabilities. (Cousins et al. 2008, p. 62) Other criteria that might be worth considering are previous performance, price, service, and earlier relationship with the purchasing company. Also the flexibility of the supplier to respond to changes in the product specifications, and changes in delivery or quantity are very important issues if the purchasing company is not completely sure what it wants to purchase and when. After determining all the potential suppliers, the purchasing department has to choose the actual criteria which finally should lead to some supplier to be selected. (Mangan et al. 2008, p.77)

The evaluation and supplier selection process varies depending on what company purchases. If the purchases are strategically important to the company's business, account for a large amount of spending, or are from a new supplier, the suppliers' capabilities are usually evaluated in detail. This is in contrast to the situations where the spending is in a smaller level and the purchases are noncritical to company. (Swink et al. 2011, pp. 293-296)

2.1.4 Supplier relationship management

Relationships with suppliers can take many forms depending on the circumstances. Sometimes the suppliers only receive and fill orders, but occasionally they work very closely together with the buying company in many activities. The relationships types between the supplier and the buyer can be divided into four different categorises.

1. Adversarial relationship
2. Arms-length relationship
3. Relationship that acknowledges acceptance of mutual goals
4. Full partnership

(Swink et al.2011, pp. 294-295)

Traditionally, the relationship between the supplier and the client company is typified by distrust, limited communications, and short-term business contracts, which is why this type of relationship is commonly known as the adversarial relationship. Arms-length relationship is a relationship in which there is a better trust level between the parties but the contract is still limited to simple purchasing transactions. If the supplier and buyer have an acceptance of mutual goals, a major step towards collaboration is taken. In full partnership both parties work together closely, they have mutual goals and highly integrated operations. (Swink et al. 2011, p. 294-295)

Suppliers and buyers can have both formal and informal relationships, but usually it is more secure to make a contract with the supplier to ensure that the supplier's delivery responds to the requirements defined by the customer company (Simchi-Levi & Kamisky 2003, p. 157). That is why contracts and contract law has a very central part in the purchasing process.

A contract consist two elements:

1. An agreement, and
2. Its enforceability by law

A contract comes to existence when there is an offer by one party and acceptance of that offer by another party. (Chunawalla 2008, p. 288)

In a purchasing contract both parties are defining the services to be provided, the charges and the rights and responsibilities on each side of the trade. In beforehand, it is important to assess things that might cause problems and evaluate the consequences, and also to consider how these issues might be solved between the parties. Risk can be reduced by different payment conditions and insurance arrangements. (Iloranta & Pajunen-Muhonen 2008, pp. 305-308) It is extremely important to ensure that all aspects of the trade are clearly defined so that the potential future disagreements can be avoided (Cavinato et al. 2001, p 540).

Contract strategy has a major impact on the timescale and the overall cost of the project. There are many alternative strategies available and each contract should be formulated with the specific job in mind. (Bower 2003, p. 58) Typically, the purchasing department uses a wide variety of different kind of contract documents during the business

with different suppliers. The type of contract depends on which kind of needs the company has, and which type of purchasing is being made. (Sollish & Semanik 2005, p. 89)

Usually, the purchasing contract defines at least the following functions:

1. Who are the parties
2. Date of agreement
3. What is planned to be delivered (quantity and price)
4. Time schedule of the delivery
5. The data which will be delivered
6. Terms and conditions
7. Directions for packaging and shipment
8. How should the company react if something is not the way it should be (warranties)

(Cavinato et al. 2001, p. 544)

Types of contract strategy are usually classified by their payment system. One of the most commonly used purchasing contract types is Purchase Order. Standard Purchase Order can be used in repetitive purchases as well as in one time purchases. Purchase Order contract defines all the requirements of that particular order, which includes the price being paid. In Purchase Order contract, the buyer takes the risk that the price of the purchased material or goods may raise. (Sollish & Semanik 2005, pp. 89-90)

Another commonly used contract type is the Fixed Price Contract. The contract minimizes the risks of the buyer and maximises the risks of the seller. That is why in cases when this type of contract is used, the seller usually wants a higher share of the profit in the price quoted. Essentially, Fixed Price Contracts are contracts, where prices are agreed to in advance of performance. (Sollish & Semanik 2005, pp 90)

Cost reimbursable contracts are usually used in situations where the initial research and development engineering or the capital investments are high and the financial risk is great. This type of contract assures for the supplier that the buyer will at least cover at a minimum agreed upon costs. (Sollish & Semanik 2005, p. 91)

Time and materials contracts are used when there are no acceptable ways to determine what could be reasonable price for the given specific project. The contract determines the maximum price the cap which cannot be exceeded. (Sollish & Semanik 2005, p. 92) Table 1 shows how the risk allocation changes in different contract types when the costs increase.

Table 1. *Most common types of purchasing contracts and risk allocation when the costs increase.*

Payment system	Risk on Buyer	Shared risk	Risk on Seller
Standard Purchase Order	X		
Cost Reimbursable Contract		X	
Time and Materials Contract		X	
Fixed Price Contract			X

As Table 1 demonstrates when the costs increase in Standard Purchase Order the buyer has to purchase the goods at a new, higher price. In Cost Reimbursable Contract both buyer and seller share the risk if the costs increase, because the buyer will have to cover at least the minimum agreed costs. Even though in Time and Materials Contract the risk is mainly on buyer, when the predetermined cap is reached, the risk is shared between the buyer and seller. In Fixed Price Contract the cost increase make the seller to suffer the losses.

There are also a wide variety of other contract types that are used in more special circumstances. These include for example Letters of Intent contracts and Licensing Agreements. Letter of Intent outlines an agreement between the company and the supplier before some terms have been agreed or specified. Licensing Agreement is needed when another company has secured ownership rights to a specific intellectual property. (Sollish & Semanik 2005, p. 92)

Above presented contract types are only the most common types of purchasing contracts and inside these contract types, the terms still vary a lot. Also, these contracts are used in a variety of ways. (Sollish & Semanik 2005, pp. 90-92)

2.1.5 Expediting and evaluation

When a company has an on-going relationship with supplier, it is necessary to measure the supplier's performance against some goals which the customer company has set. The customer company should identify the critical performance attributes which are important to their business. For example quality, delivery, cost reduction and service are some of the most important attributes. (Swink et al 2011, p. 300) Relevant measure systems will provide an important input to the decision making (Cavinato et al. 2001, p 357). Evaluation should be a continuous process, and the suppliers should receive regular feedback from the client company. Especially changes in the business environment make it essential to conduct an analysis periodically to monitor the mutual relationship. (Ostring 2003, p. 9)

One commonly used way to give feedback is to use scorecards. Scorecards are used to report the suppliers' performance on key performance indicators which the client company has set. (Swink et al. 2011, p. 300) Another commonly used method is categorical plan, in which the idea is to ask various departments of the company to give informal evaluation records from each major supplier. Each department prepares a list of performance factors that are important to them, and each major supplier is evaluated against the list of factors provided by the different departments. The evaluation can be performed in a meeting that is kept at regular intervals. After the factors are weighted for relative importance, an overall group evaluation is assigned to each supplier. (Burt et al. 2003, p. 492)

In Weighted Point Plan method the idea is to rate suppliers against three factors: quality, price and delivery schedule. These three factors are given relative weightages out of 100 points. Usually quality rating number is the acceptable lots per cent times to the chosen weightage, price rating number is the difference per cent between the lowest price and the net price multiplied by the chosen weightage, and delivery schedule rating is the percentage of delivery promises kept. Ideal supplier will get a rating of 100 points. (Burt et al. 2003, p. 493-494)

Cost Ratio method evaluates suppliers by dividing purchasing and receiving costs by the value of shipment received from suppliers. The higher the ratio of the costs and the shipments is, the lower rating the supplier gets. (Gopalakrishnan 2006, p 204)

Every company should also have evaluation methods for its own purchasing and supply performance. Evaluation methods should determine how well the purchasing function has met its business goals. The methods should also evaluate the purchasing function's effectiveness, and recognize the operational problems of the business. A good measurement method also determines how well functional purchasing strategy and the organizational strategy are aligned to each other, and guides to make the needed improvements. (Cavinato et al. 2001, p. 358)

2.2 Design for X Method

The DFX method is both a philosophy and a methodology that can help companies to change the way they manage their product development process. A generic definition to the DFX method could be that the DFX assists in making decisions in the product development related to products, processes and plants. (Huang 1996, pp. 3-12) The method examines how well the product development succeeds from the selected point of view (X). The method should also provide ways to make the point of view X easier to handle. (Lanz 2010) The DFX focuses on improving a subject product but often it is also concerned in improving the subject`s business process (Huang 1996, pp 3-12).

Each “X” is a characteristic of the product, its production or its lifecycle that is important in some context (Whitney 2004, p. 379).

The DFX method has been used in many manufacturing industries and fields of mechanical engineering for many years. The DFA method was first discovered in the 1960s in the University of Salford, UK. Later in the 1980s the DFA method extended into Design for Manufacturing (DFM). (Whitney 2004, p. 416) The DFX toolbox has expanded quickly during time, and over the past few years the DFX has become an important element in the product development. (Huang 1996)

There are many reasons why the DFX method is used. The DFX method can help companies to be more competitive in many fields. The DFX method can for example improve product quality, compress the cycle time, reduce the life-cycle costs, increase flexibility and productivity and help to satisfy the customer needs in a better way. (Kuo et al. 2001) Usually the main purpose is still to reduce total costs (Lanz. 2010). The DFX method is most useful when it is used early in the design process, when the changes are still easy to make (Whitney 2004, p. 379).

It would be ideal to use multiple DFX tools to obtain overall optimal solutions, but this is rarely possible because of limited resources. Usually the DFX tools are applied one at a time. The DFA and Design for Variety (DFV) should be used to rationalize product assortments and structures before other type of DFX tools are used. (Huang 1996, p. 10)

It is important to realize where exactly the problem is before choosing the right DFX to use. Choosing specific DFX tool depends on factors like availability, applicability, and vendor experience. Successful DFX tools focus on a few important aspects to evaluate the design decisions and their interactions. (Huang 1996, pp. 4-10)

In the book “Mechanical Assemblies - Their Design, Manufacture, and Role in Product Development” (Oxford University Press, 2004) Daniel Whitney examines DFX method from two different point of views. Whitney divides the method itself into two different categories: smaller DFx and larger DFX. Smaller DFx method concentrates on smaller aspects like improving single parts, from which one engineer can benefit himself. Larger DFX method focuses on larger aspects than smaller DFx. The product is considered as a whole rather than as divided into individual parts and the product is defined in its context in the factory, supply chain and the rest of the product’s life cycle. The whole organization can benefit from the larger DFX method. When starting a new product development project, the first step is to consider product’s modules, lifetime, variations and functionality aspects. After basic product structure decisions, product decisions can be examined through the larger DFX perspective. After the larger aspects, the focus can be moved on the smaller issues, DFx point of views. (Whitney 2004)

In order to gain results from the DFX method, the DFX method requires cooperation and information sharing between the different departments of an organization.

For example, DFA and DFM tools encourage cooperation between designers and manufacturing engineers, and in the DFQ method the quality management and design management are bound together. (Huang 1996). In order to get the procurement effective and easier to handle with DFP method, there should be more co-operations with the procurement and research and development (R&D) departments.

The success of the DFX methods can be evaluated for example by using a scoring system that rates design alternatives against some criterions. Also, testing of the design with a system in which a prototype of the product is evaluated against its design objectives is a good way to find out whether the method produced profit for the company. (Bralla 1998)

2.2.1 The responsibilities of design engineers in product design

The responsibilities of design engineers encompass all aspects of design. A design engineer is responsible not only for the characteristics of the part, but also for the behaviour and the life-cycle properties of the product. (Pulkkinen 2007, p. 53) Product design also has wider scale influences on the flexibility of marketing strategies and to the whole organization's success in the rigorously competing business world. (Kumar 2009, p. 154)

Architectural decisions on the product have a direct impact for example on the types of manufacturing processes. (Ulrich 1993) In addition, material choices affect the production because some materials are suitable only for some manufacturing processes, and on the other hand, some processes are only suitable for some materials. Accordingly, materials and processes should be chosen systematically. This means that the designers should have broad knowledge of the available materials and manufacturing technologies. (Pulkkinen 2002, pp. 11-12) Because architectural decisions concerning the product are made already in the early phases of the innovation process, the R&D function often has a major role in defining the product architecture. (Ulrich 1993)

Product design affects also manufacturing-related operations. This is why product design and production design should not be handled separately. (Bralla 1998, pp. 35-36) Decisions on design have a major impact on supply chain decisions like the number and location of suppliers, as well as on contractual relations with suppliers. (Fixson 2004) A good product design also takes into account all the manufacturing-related functions and tries to make these tasks to be achieved in less time, with less effort and with less cost (Kumar 2009, p. 154).

Currently, design engineers have to work in a very complicated global business environment. One major challenge in the current business environment is that often manufacturing and product design may take place in different countries. Product designers have to be aware about the conditions where manufacturing will take place, because these conditions affect production capability and product's costs. (Bralla 1998, p. 105)

It is quite common that a component or whole parts of the product are outsourced. In such cases the suppliers are part of the product design process and consequently their decisions also affect the overall production costs. (Pulkkinen 2002, p. 19) Accordingly, design teams should look beyond their own organizations to other associated organizations in the value chain in order to make competitive products. (Kumar 2009, p. 156) Also, when production is outsourced, there are various functions involved in the realization and sale of the product that have to be taken into account. In addition, design engineers have to often make compromises between different conflicting objectives, such as product quality versus production cost. (Bralla 1998)

2.2.2 Design for Procurement

It is not easy to define, what DFP actually is. There are many different opinions and viewpoints about what DFP is. Furthermore, depending on the context, DFP can also be related to many subjects. DFP's main purpose is to make companies' procurement operations easier to handle and more effective.

It can be noticed that some previously defined DFX methods are already taking companies' procurement operations into account to some extent. DFP can for example be related to other DFX methods, like DFA, DFM, Design for Logistics (DFL), Design for Quality (DFQ), Design for Cost (DFC), Design for Modularity, to name a few.

The DFA and DFM methods focus on the reduction of products assembly and manufacturing costs, making assembly easier and more reliable by simplifying the products and manufacturing process. The simplification of products is achieved by reducing the number of products´ parts. Process time and costs can be saved by using standard parts rather than using designed parts. (Whitney 2004, p. 384-385) Part simplification and fewer parts save time and costs (Fixson 2005). It can be seen that today the companies try to focus on the bigger picture instead of single parts and optimization of a single phase. For example, Conceptual DFMA method combines product structures and single components' comparison to whole production processes, including the supply chain. (Pulkkinen 2005)

Using Design for Modularity method has many benefits. Increased modularity of a product improves the information and material flow from development and purchasing to storing and delivery. For purchasing, it means lower logistics and material costs and it makes possible to purchase complete modules instead of individual parts. (Huang 1996, pp. 358-362)

Cost controlling is one of the procurement department's most important purposes. DFC method concentrates on reducing the direct and indirect costs of products. To make more cost-effective design decisions, design engineers need more information

about the impact that various design alternatives have on production costs. (Huang 1996, p. 197)

Quality is first designed, and after that it is built into product (Huang 1996). DFQ method's objectives are to design a product that meets the customer requirements, design a product that minimizes the effects of potential variation in manufacture of the product and products environment, and continuously improve product reliability. (Kuo et al. 2001) Because quality control and insurance can be included in the procurement department's activities, DFQ method helps also procurement operations.

Effective Logistics functions can make a major difference in the final costs of a product. DFL concept concentrates in controlling logistics costs and increasing customer service levels (Simchi-Levi & Kaminsky 2004, p. 169). DFL method aims to reduce the size and weight of a product because these usually directly affect logistics costs. (Swink et al. 2011, p. 116)

3 HOW TO MAKE PROCUREMENT MORE EFFECTIVE?

As mentioned in the previous chapter, the procurement department should not be considered as a separate function but as a cross-functional unit. The product development decisions made in the company also affect the procurement process. The kind of products company produces and product structure decisions have a major impact on procurement operations.

Because outsourcing is becoming more and more popular, companies need to cooperate more with the suppliers. Strategic partnerships and early supplier involvement (ESI) into the new product development process can affect the company´s effectiveness in many fields.

3.1 Product structure

A product can be seen both in functional and physical terms. A product can have many individual functional operations that contribute together to the whole performance of the product. A product can also be seen to consist of different parts, components and modules which are together making the whole product. (Ulrich & Eppinger 2008, p. 164).

Variety is the range of different product models which the firm can produce within a particular time of period in order to respond to different market demands. (Ulrich & Eppinger 2008, p. 168) With variants the design of the product becomes more challenging (Pulkkinen 2007).

Component standardization is the use of the same component in a multiple products and is closely linked to product variety. Standard components can be manufactured by the company or by the suppliers. Standard products can be used if component implements are commonly useful functions and the interface to the component is identical across more than one different product. Even though component variation is more of an issue for manufacturing and for sourcing than it is for product development, the use of standard components can also lower the complexity, costs and lead time of the product development. (Ulrich 1993)

Product architecture is the scheme by which the function of a product is allocated to physical components (Ulrich 1993). This includes information about how many components the product consist of, how these components work together, how components are

build and assembled and how they are used and disassembled (Fixson 2005). Product architecture can be a key driver of the performance of the manufacturing company and relates to product change, product variety, component standardization, product performance, and product development management (Ulrich 1993). Product architecture decisions are also linked to many strategic decisions across the domains of product, process and supply chain (Fixson 2005).

Products and product structures can be examined also from the company´s procurement perspective (Huhtala & Pulkkinen 2009). Making rational decisions on the product architecture the company can decrease product complexity and increase product similarity. Architectural decisions on products include decisions on the complexity of individual components, number of components and product family aspects. Number and type of components affects the number and location of suppliers. Commonality across components allows lowered pooling risk and the way components interact with each other can affect which strategies for postponement and late customization can be realized. Increased commonality also improves material availability. (Fixson 2005)

3.1.1 Modularization

Product modularity and process modularity are the key drivers that enable a standardization strategy that lowers inventory costs and increases forecast accuracy. Modularity can also decrease the costs of variation. (Simchi-Levi & Kaminsky 2004, p.169).

A specific assembly or part of a system can be called a module. Modularity design's purpose is to produce different products by combining standard components and sharing the same assembly operations for a part of their structure. The figure 5 demonstrates eight different kinds of modularization types.

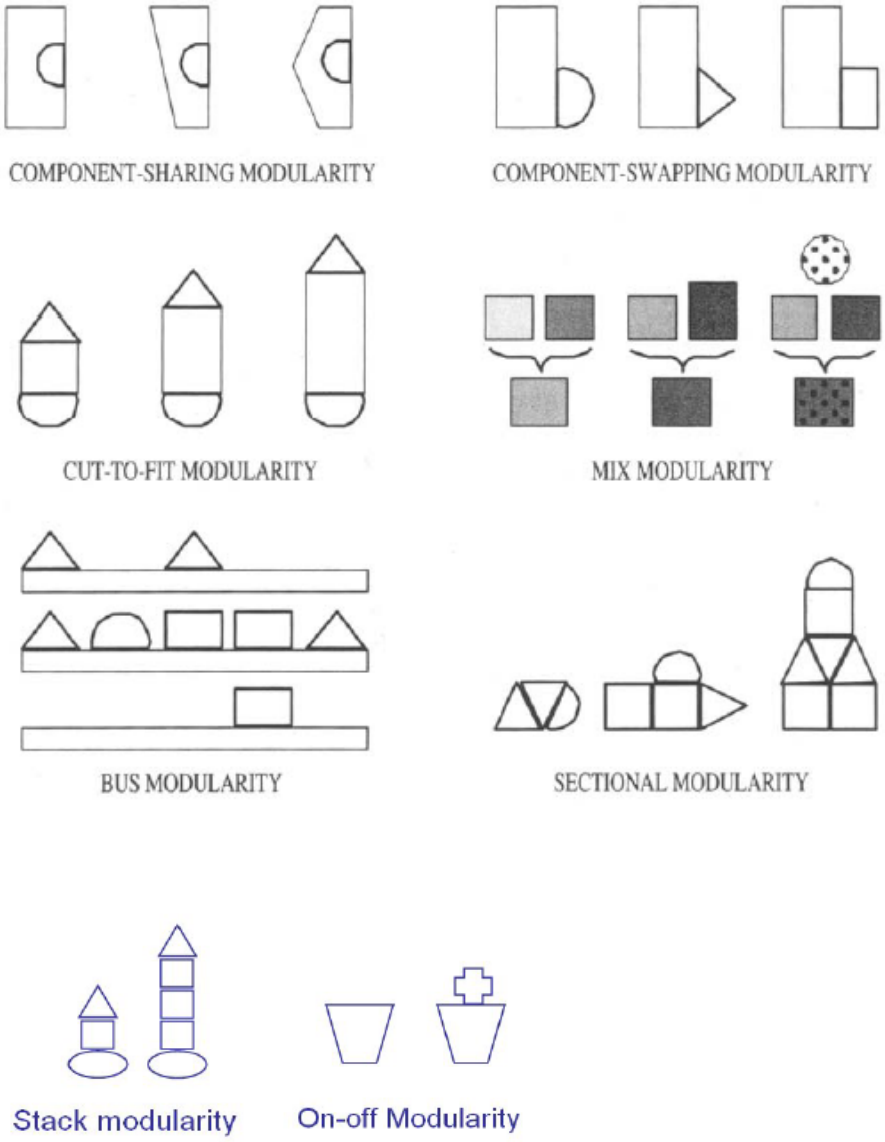

Figure 5. *Different types of modularization. (Adapted from Lehtonen 2007, pp 48-49, original images from Abernathy & Utterback "Patterns of Industrial Automation",Technology Review 1978, and Elgård & Miller "Designing Product Families", Proceedings of the 13th IPS Research Seminar, 1998)*

Plus modularity is a design philosophy in which the main goal is to design as few modules as possible, but still satisfy every customer's needs. Basically every module is based on the customer's needs. In some cases plus modularity can be an effective way to design new products, but in some cases it only makes the design process more complex. (Lehtonen 2007, pp. 61-62)

Modularity makes it possible to purchase complete and standard modules instead of individual parts. Modularity also reduces the material costs because fewer parts are needed to build the product. These factors reduce the workload in purchasing and also means lower logistics costs.

3.1.2 Product strategy

Product family can be defined as a group of products, which have both similar and different qualities. Many companies have realized that in order to answer better to the needs of the customers in different market segments, there has to be more variability in the products. On the other hand, the product development life cycle has to be fast and production costs have to stay low. (Huhtala & Pulkkinen 2009, p. 164-165) Many companies are struggling to provide as much variety for the market as possible with as little variety between the products as possible (Simpson et al. 2006, p. 1).

Product strategy affects both the company´s competition strategy and the purchasing process. There are four different kinds of product types; standard products, configured products, partly configured products and one of kind products. Standard products are designed only one time, and after that, the product is manufactured exactly the same way every time. (Pulkkinen 2007, pp. 84-85) Also the sales and delivery process is in standard products always the same (Lehtonen 2007, p. 72).

By using configured products, companies can answer to different market needs better. Configured products are standard products with variants defined by the customer and partly configured products are variants defined by the company. (Pulkkinen 2007, pp. 84-85) Configuration is a compromise between the standard products and one of a kind products. Configuration is in other words a way to meet the customers' requirements more economically. (Lehtonen 2007, p 72) By reusing components across the product families, both the development cost and time can be lowered in multiple projects (Fixson 2005).

One of a kind products are produced only one time. (Pulkkinen 2007, pp. 84-85) The whole product is designed based on the customer needs. Because these products are unique, also the sales and delivery process is always one of a kind. (Lehtonen 2007, p. 72) If the product is one of a kind, the purchaser does not necessarily have an earlier experience about this kind of products and the purchasing contracts are made only one time, which makes the whole purchasing function more challenging. The projects of one of a kind products are also often short-term and quite fast. The realization of the product is often carried out in a hurry which is why the products are often also not optimally designed. (Iloranta & Pajunen-Muhonen 2008, pp. 174-175)

Figure 6 demonstrates the sales delivery processes of different product strategies. Every sales delivery process starts by the customer's proposition and ends by delivering the product to the customer. The sales delivery process of the standard products is presented in the inner circle. Sales delivery process of the partly configured products is demonstrated in the second circle from the centre and sales delivery process of the configured products is demonstrated in the third circle. The outer circle demonstrates the sales delivery process of one of kind products. (Pulkkinen 2007, pp. 90-91)

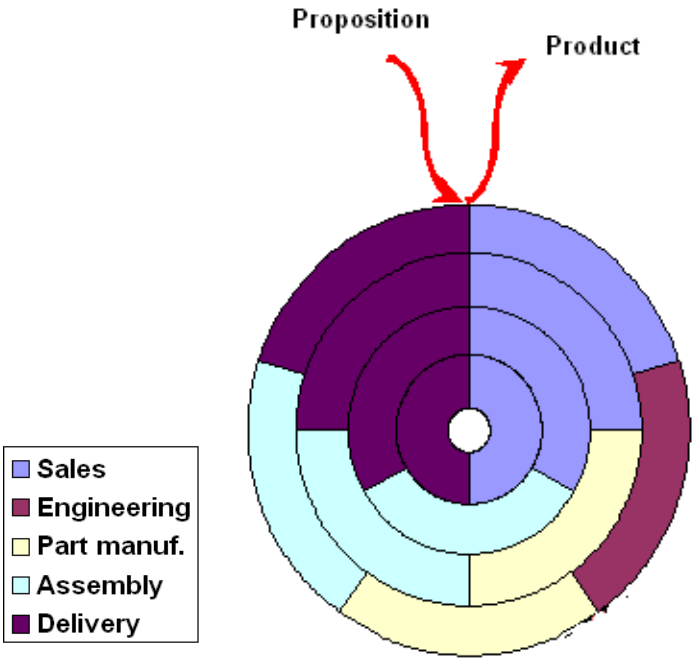

Figure 6. *The sales delivery processes of different product strategies. (Pulkkinen 2007, p 91)*

The figure 6 shows that the standardized products have the shortest sales delivery process. Only a few activities are required. The more customer centred design is, the more complicated and time consuming is the sales delivery process. (Pulkkinen 2007, pp. 90-91)

Figure 7 demonstrates the product development process of the different types of products. As in figure 6, the innermost circle demonstrates the product development process of the standard products and the outermost circle demonstrates the product development process of the project products. In the middle are the product development processes of the partly configured products and configured products.

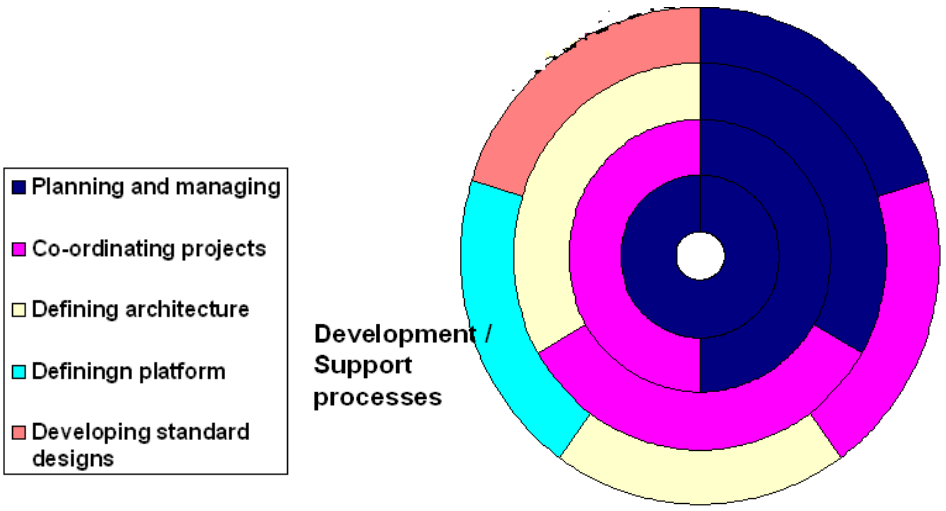

Figure 7. *Product development process of the different products. (Pulkkinen 2007, p. 91)*

Also the product development process for project products is more complicated and multitasked than it is for configured products. Standard products require only little planning and managing control. The more customer-centered the design is, the more complicated is the product development process.

3.1.3 Platform- based design

Platform-based design is a way to balance product differentiation and commonality. Product platform can be defined as a product family´s basic unit. (Pulkkinen & Huhtala 2009) Platform is a set of assets shared across a set of products (Ulrich & Eppinger 2008, p.40). A platform can be developed in many ways. One way to develop a product platform is to use assembly or functional modules. (Lehtonen 2007, p. 82)

Effective platform based product development can allow a variety of derivative products to be created more quickly and easily. Platform-based product family design can reduce product complexity without a significant increase in costs or development time. (Ulrich & Eppinger 2008, pp. 180-184). It is a way of sharing components and production processes across the platform of products. Platform based product family development can help companies to develop differential products, increase flexibility and increase their market share. Other benefits of platform-based design are reduced development time, reduced development and production costs, and improved ability to upgrade products. (Simpson et al. 2006, p. 3) The more the platform is used, the more useful it is to the company. Reuse makes the whole company´s process more effective. (Lehtonen 2007, p. 87)

There are also still some problems in platform-based product development. For example car industry has had complaints that the resulting products are too similar. If the

products have too much commonality it can affect to the whole company´s brand image. Another issue is that if there are flaws in the platform it affects all products instead of only affecting one product. Defining the product platform and product family´s commonality is probably the most challenging aspect in product design. (Simpson et al. 2006, p.3-5)

3.2 Strategic Partnerships

Traditionally multiple sourcing, competitive bidding, and short-term commitments have been typical purchasing strategy approaches (Cavinato et al. 2001). Presently, many companies are focusing more on their core skills and leave the other non-core activities to suppliers. This enables the companies to adapt quickly to changing marketing needs, but this way supplier relationships also become more important in the company's business. Recourse-based theory, on the other hand, believes that a company does not survive on its own because the company is constantly interacting with the business environment. Based on resource theory, co-operation reduces insecurity and risks. (Valkokari 2009, pp. 56-58)

Strategic partnerships and alliances are often defined as relationships between two or more parties that share the risk and rewards of a business venture. A partnership includes also cooperation between parties toward a common goal. In reality there is often a limited shared risk and reward, and also limited common vision and goal between the client and the supplier company. (Wincel 2004, pp. 38-39; Simchi-Levi et al. 2004, p.112) By working together, partners expect to create better solutions than they could create alone. (Swink et al. 2011, p. 295)

Partnerships can be divided into two different categories:

1. Project-specific partnering
2. Long-term partnering (also called strategic partnering or strategic alliance)

Project-specific partnering usually lasts only the time of a single project. The arrangement can be between the owner and a single supplier, but more commonly it is between the owner and several contractors. Project partnering is typically used in larger, complex and risky projects. Long-term partnering lasts usually for a specific time and is most commonly between the owner and single supplier. In long-term partnering, client company has a need for a certain type of project over a set length of time, but is unable to define each project at the start of the partnership period. (Ward 2008, p. 58; Broome 2002, p. 277)

Before starting a partnership, the company has to evaluate if the cooperation benefits are bigger than the required resources (Valkokari 2009). Partnering cannot be considered in all circumstances. Whether the partnering can be considered depends on the type of business relationship the parties have, and the partnerships potential payback expectancy. Building strategic alliances and partnerships requires time, commitment of resources and information sharing before it can success. Knowing the supplier is just as important as knowing the company's own organization thoroughly before entering into a joint venture. Each participant should also have a clear view about the joint venture's mission and goals before starting the partnership. (Wallace 2004, p. 49-52) Figure 8 below illustrates a model for partnering.

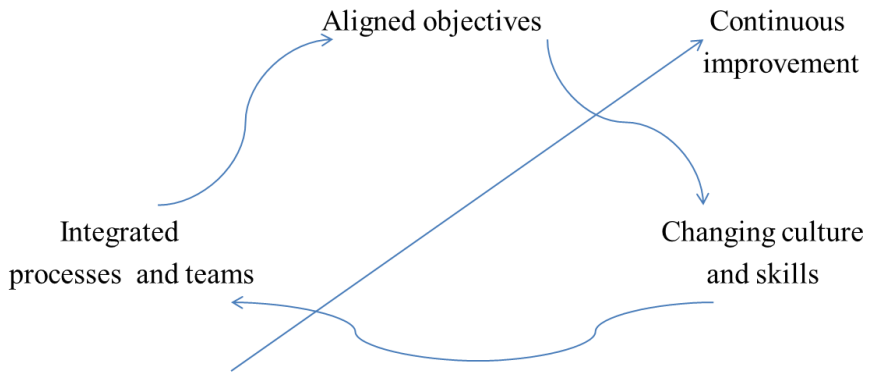

Figure 8. *A model for partnering. (Modified from Broome 2002, p. 15)*

In general, people as well as companies act in a certain way because they perceive it to be in their interest. That is why aligned objectives are the key driver that enables partnership to succeed. Both client and contractor organizations have benefited from acting certain ways in the past. Changing skills between the organizations can lead to new innovations and better ways to make business. Different organizations can also achieve better trust level and lower their barriers when they allow their processes and teams to become more integrated. Integrated processes and teams also lead to greater efficiency because work is performed faster and at a lower cost than before. In partnership type of co-operation the companies should continuously try to do things differently and better than before. (Broome 2002, pp. 15-16)

Successful partnerships can bring many new possibilities to improve the company's own and the suppliers' competitiveness. From strategic network point of view, the five competitive advantages of networks are:

1. Coordination in different know-how areas
2. Learning and developing new/better things
3. Volume advantage
4. The optimal splitting of the market structures
5. The development of the information management systems and recourse policy

(Valkokari 2009, pp. 56-58)

In a partnering relationship team members can work together to achieve the highest level of quality and safety of the project. Closer co-operation between the parties can provide an environment that encourages finding new and better ways of doing business. (Bower 2003, p. 103) Similar goals and co-operation in the network can be a strength which helps companies to develop new innovations and stay more competitive. (Cavinato et al. 2001) Partnerships can be helpful by improving quality, product development, and logistics efficiency as both parties are able to share information about forecast, sales, supply requirements, production schedules, and problem alerts in advance. (Mangan 2008, p.78) The challenge is to operate at the same time in with different suppliers and networks. Many organizations could benefit from the selective use of strategic alliances and partnerships.

3.2.1 Early Supplier Involvement

It is important that the company's design team identifies the relevant life-cycle stages of the design and product development. These stages might be engineering, production, marketing, finance and suppliers. When a new product is designed and specified, the company needs consider the timing of supplier involvement. Early supplier involvement (ESI) can be described as a practice that brings together one or more selected suppliers with the buyer´s product design team early in the product development process. (Lysons & Farrington 2006, p. 253)

Effective product development can be achieved by involving suppliers into the development process of new products and engaging selected suppliers into the goals and targets of the company´s business performance. (Rungtusanatham & Forza 2005) Integrating suppliers into the product development process of a new product has a direct impact on design decisions of manufacturing process and supply chain decisions. ESI allows the company to focus on the integration of systems and the overall functionality of a product, rather than spending time on detailed technical design of multiple complex systems. When companies work together to develop new products, they often also share the financial and legal risks of development. (Swink et al. 2011, p. 104) Cooperation makes it possible to obtain critical recourses, and invest to new market opportunities

and supplementary core competencies. (Cavinato et al. 2001, p. 169) Involving suppliers early in the product development has also been believed to be related to the company's productivity, speed and quality of the product as well as lower product development costs (Belt 2009, p. 24; Lysons & Farrington 2006, p. 254) It can also improve interchange of knowledge and information between the companies and help in the process of determining product specifications. Suppliers can also give helpful information about the manufacturing and materials availability.

The risks of the ESI are losing control of intellectual property and becoming too dependent on partners, and this can cause the company to lose control of the innovation project. Because of these factors, every company needs to evaluate the risks and the benefits of the ESI and make decision based on that information. (Swink et al. 2011, pp. 104-105)

4 VERIFICATION UPSTREAM PROJECT

Nokia has an on-going project called Verification Upstream Project (VUP). In VUP, the product development team of Nokia is working in very close cooperation with the suppliers. The purpose of VUP is to answer to the current challenges in mobile phone business. During last decade, mobile phone business has gone through major changes. Popularity of the mobile phones has increased remarkably and the numbers of models have increased rapidly. Also, the purpose of the business is not only to produce mobile phones, but all kinds of mobile devices like cameras, music players and gaming devices. Competition is also quite hard and there is a big need to keep the costs down and product development time fast. (Perttula 2007, p. 77-102)

The purpose of VUP is to shorten the Nokia´s product development cycle by finding errors earlier and to build trust throughout the supply chain. Finding errors earlier basically means that the verification function is transferred more to the suppliers by integrating module suppliers closer to Nokia`s product development process. (Pulkkinen 2010) The following chapter introduces theory about the VUP project.

4.1 Quality Management

Quality can be defined in many ways. One definition is that quality is the degree in which customer requirements are met. A quality of a product or quality of a service means that both the supplier and the customer agree on requirements and these requirements are met. Quality assurance concerns in keeping up the methods and procedures of quality control system by actually checking that they are efficient and they lead to the defined objective. (Weele 2005, p. 193)

Traditionally, quality costs have been divided into three different categories:

1. Prevention costs
2. Appraisal costs
3. Failure costs

Prevention costs are costs of all activities specifically designed to prevent poor quality in products and services. For example, costs of quality planning, quality improvement projects and supplier and process capacity surveys and evaluations are prevention

costs. Appraisal costs are costs that arise when some things need to be inspected in order to verify that they are correct. These include e.g. the costs of incoming inspections, product, process and service audits and the cost of associated materials and supplies. Failure costs are the costs that arise when products or services do not conform to the requirements, or to the customer or user needs. There are two types of failure costs, internal and external. Internal failure costs are costs, which occur before the product has been delivered to the customer. For example, all rework like redoing inspection, redoing testing, and material review are internal failure costs. External failure costs are costs, which occur after the product has been delivered to a customer. Such costs are for instance customer returns, warranty claims and product recalls. (Burt et al. 2003)

Testing is a tool to prevent the risk of failures and related to quality. (Belt 2009, pp. 25-26; Burt et al. 2003, p. 136) To reduce costs and to shorten development cycle, testing must be optimized (Belt 2009, pp.49).

4.2 Verification and validation

Product requirements are the basis for the new product development process. In the beginning of the new product development, a product is given certain requirements, which the new product should fill up. New product requirements can be set by many parties, such as legislative authorities, the company's administration and production. The most critical requirements, however, are still set by the company´s customers. Customers' needs and requirements are usually the starting point to the whole product development project. Answering to the customers' requirements is very important for the product to succeed. (Perttula 2007)

During the product development process, it is possible to examine how the requirements are realized. The requirement examination process can be divided in two different phases: verification- and validation (V&V) processes. The purpose of the verification process is to make sure that the product corresponds to its requirement list. The purpose of the validation phase is to make sure that the user or client is satisfied with the final product. In other words, the validation phase makes sure that the product corresponds to customer's real requirements. Figure 9 illustrates the differences between the verification and validation processes. (Perttula 2007, pp. 14-15)

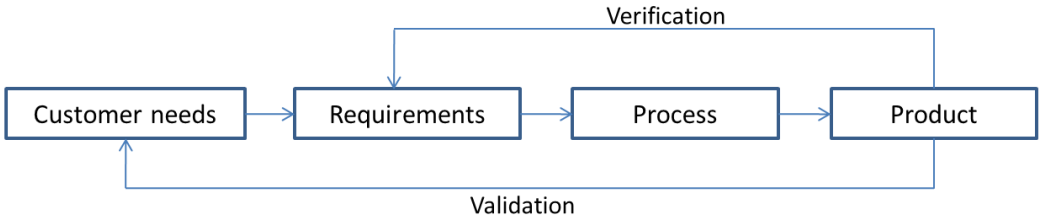

Figure 9. *Verification and validation processes. (Perttula 2007, p. 15)*

Many products can easily pass the verification phase but fail the validation phase. This is because the customers' requirements may change during the product development process. In addition, there is always a risk that some requirements given from a customer are misunderstood, or customer does not understand all the technical requirements of the product. (Perttula 2007, p.88)

The main purpose of the V&V process is to collect data from product development to the management and other company`s stakeholders. The information helps in decision making concerning the future of the product development projects. (Perttula 2007, p 15) V&V process is a potential way of deducting uncertainty (Belt 2009, p. 34). The process helps to eject significant risks of failures of the product development (Perttula 2007, pp. 14-15). Growing complexity of the products is a big challenge for the product and system testing. A major reason why V&V has become more a critical factor in information and communication technology is because it has been estimated that V&V activities take between 30 to 60 per cent of the entire costs in high technology product development (Belt 2009).

There are many verification and validation methods which can be used, and different methods are suitable for different products. The best known V&V method is probably the testing method. The testing method includes functionality testing, testing in the working conditions and reliability testing. Testing can be done to a whole system or to a part of the system. (Perttula 2007, pp. 20-21) Testing can be seen as a cost-avoidance activity because testing is usually cheaper than the costs of fixing and repairing. (Belt 2009, p. 26).

The analysis method is product testing without the real physical product. Analysis can be realized for example by simulation or by a mathematical model. The analysis method should always be used when possible because it is much more cost effective than the testing method. (Perttula 2007, p. 22-23) Simulation tool is very helpful when it is unclear what exactly should be tested (Belt 2009).

Verification by comparison can be used when a product or part of it has been verified earlier. The comparison method can also save project costs. The assessment method contains research, demonstration, and review phases. The assessment method is a very suitable method if the real product prototypes do not even exist yet. (Perttula 2007, pp. 19–24).

Traditional system development models often conceive V&V process as a separate error detection process that takes place after the product integration, and close the product launch. Nevertheless, changes in the product requirements can often occur in a very late phase of the product development and this can cause a need to repeat the testing, causing unnecessary waste of resources. The later the misunderstood requirements are fixed the more expensive the process will be. (Belt 2009, p. 34-39)

The V&V process should start in a very early stage of the product development project. This way it is possible to minimize the failure risks of the product development project. One approach to the V&V process is Incremental Verification, in which the idea is to start the process already from the technology, module and component field. The purpose of Incremental Verifications is to decompose the products´ requirements into smaller sub-requirements which can be verified separately. In practice, this means using more simulation and analyses methods. (Perttula 2007, pp. 95-97)

Traditional way to develop products is to focus on only one functionality of a product at a time. This approach is called the point-based method. This method goes through the product requirements by either passing or failing them. A good feature in the point-based method is that it is fast, but the problem lies in its inflexibility. (Perttula 2007, pp. 98-101)

The set-based verification is a more information-based approach to the verification process. The set-based method is especially useful when the requirements are changing many times during the product development. In the set-based verification, more information is collected from the product through verification and validation than is collected in pass/fail decisions. This helps later if the product requirements change, because it is possible to return to earlier information and check whether the product meets the new requirements without repeating some testing phase again. The downside of set-based methods is still their slowness. Figure 10 shows how the focus of set-based and pass/fail verification methods should change during the different phases of the new product development process. (Perttula 2007,p. 98-101)

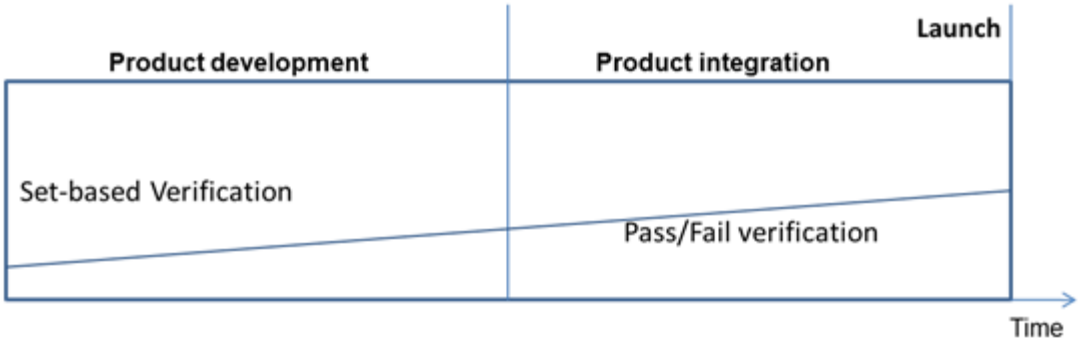

Figure 10. *Set-based verification and pass/fail verification methods. (Perttula 2007, p. 101)*

As the figure 10 shows, set-based verification is most useful in the early phase of the product development process, when product requirements still can change. The closer product development comes to a product launch, the more important is the role of the pass/fail verification methods.

In general, as companies focus on their core operations, increasing amount of suppliers becomes a new challenge for the V&V process. Companies should make clear rules of the responsibilities between the different suppliers. This way, repeated of testing can be avoided. Also, companies' own product development could be divided into different units. In order to increase efficiency of the product development, companies should also harmonize the V&V processes between the different units. (Perttula 2007, p. 80-94)

5 COMPANY INTERVIEWS

This chapter contains interviews from four different companies: Nokia, Osram, Metso Minerals and Konecranes. All the interviewed companies are global companies with relatively large and global supplier networks. Three of the interviews (Nokia, Metso Minerals and Konecranes) focus on client companies´ views on the main difficulties in the product development and procurement, and issues concerning the co-operation with the suppliers. Osram interview focuses more on the supplier's point of view on the co-operation with Nokia. All the interviews were performed in Finland in spring 2011.

5.1 Nokia

Nokia is the world`s leading mobile device producer. Nokia is a global company, which has its headquarters in Espoo, Finland. Nokia has research and development in over 16 countries all over the world. Sales and marketing operations are located in over 160 countries. (Nokia 2011)

Interviewees Dr. Antti Perttula and Mr. Tuomo Mörsky are working in Nokia´s Tampere unit, and the interview focus was on Nokia`s picture, camera and flash solutions. Dr. Perttula is responsible for quality gate in Nokia, and Mr. Mörsky is Project Leader in LED flash and Camera Solutions.

5.1.1 Product development process

Dr. Perttula and Mr. Mörsky find that Nokia´s major problem in the product development at the moment is that the development process of new products is too slow. Products do not go to the markets as fast as they should. Another challenge is that Nokia makes products which do not correspond to every customer's needs and requirements. One of the reasons is that Nokia makes products for a very large market so it is difficult to make products which would satisfy every customer`s needs. One challenge in the product development is also that the whole product development process is too expensive. Mr. Mörsky also thinks that some of the reasons for the problems in the product development problems may be related to Nokia`s management methods. The management methods are not optimal for the development processes of new products. However, this problem is being addressed at this moment.

Nokia uses many kinds of Product Development processes. The product development processes are mainly Nokia´s self–developed and these processes have changed slowly in time. Nokia`s product development processes are still constantly under evaluation for improvements. Earlier, different components had their own product de-

velopment processes, which all strived for the same goal, but a couple of years ago the company standardized hardware processes more similar. Nokia also strives to make more modular products and perform concurrent product development as much as possible. In software development Nokia uses Agile models, in which the whole project is divided into smaller parts and every team makes their own part of the project.

The importance of suppliers to Nokia's business has been noticed and Nokia is trying to take suppliers into account more than before in every aspect. Nokia tries to take suppliers into account for example by trying to make sure that Nokia`s processes are similar to the processes of the suppliers.

Nokia uses many kinds of verification and validation methods. However, at present Nokia is trying to move this function more to the suppliers. VUP tries to manage component and module suppliers' quality efficiently by integrating module suppliers closer to Nokia`s product development process. The project goals are to find errors earlier, and harmonize the whole verification function. The basic idea is that when the supplier reaches a certain quality level, Nokia can trust the suppliers work and transfer the whole verification function to supplier. The effectiveness of the VUP changes between different suppliers. Some of the suppliers have already a very good quality control of their products, and consequently these companies may find that the VUP only means extra work for them. On the other hand, some of Nokia`s suppliers do not have any particular kind of quality control of their own, and the VUP can be very useful for these companies. If a supplier company is considered to already have a good quality control, Nokia tries to take into account the opinions of such a company about how the verification should be performed.

Verification is performed at a very early stage of the product development. In some cases, the verification is performed already before the actual supplier has been chosen. For example, the picture quality control of cameras is organized as follows: Nokia sends the requirements to different suppliers, and suppliers send a simulated version of the product back to Nokia.

Recently, it has been realized at Nokia that the product flaws are usually due to misunderstandings in requirements, or the requirements are not clear enough. Especially in hardware there are many suppliers to a same component, and because of this the requirements have to be clear enough to every supplier so that the final result would be the same. The requirement list is always discussed with the supplier and together with the supplier, Nokia tries to make sure that the requirements are reasonable. It is very important that all of the suppliers understand the requirements in the same way, as this is important in avoiding potential misunderstandings.

5.1.2 Supplier relationships

There are many factors which affect the supplier selection by Nokia. The criteria for supplier selection also vary between the different parts and components. For example, in standard components the cost is probably the main criterion, whereas in more critical

parts such as in the camera technology also other criteria like capacity, supplier location and quality aspects have to be taken into account.

The suppliers are being evaluated practically all the time. The evaluation of the suppliers is actually part of the Nokia`s VUP. Sourcing unit has still their own criteria about how to estimate supplier operations, and Research and Development unit has its own criteria. Product Development unit has to evaluate more e.g. technological aspects. However, sourcing unit also takes part in the VUP project and there is substantial co-operation between the Product Development unit and Sourcing unit in the project. One method used by Nokia to evaluate the suppliers is to use score card methods. In the score card method, the basic idea is that there are specific evaluation criteria and different suppliers are given numerical evaluation based on the experience how well the supplier has met the evaluation criteria. Another simple method which Nokia uses is the subjective method, in which the evaluation is based on the general idea how the co-operation has gone so far.

In the product development, Nokia aims to have long partnerships with the suppliers. Nokia is regularly in contact with the suppliers and with partners, with which they have collaborative development projects. Especially, Nokia aims to have long partnerships in fields in which it is still possible to have new ideas and innovations. For example in cameras it is assumed that there are still possibilities to produce better products.

Nokia reacts mainly positively to the suppliers' feedback, but occasionally the information has to be taken critically due to various cultural and business-related factors. For example, Dr. Perttula mentioned that from China they get almost always only positive feedback, and also that some suppliers tell that co-operation works satisfyingly only if they get orders from Nokia. Consequently, the information which they get from suppliers always has to be taken critically. It has been noticed, however that if Nokia reacts openly to the suggestions from the suppliers, the suppliers correspondingly react more openly to the suggestions from Nokia.

Nokia`s production has been transferred to places near the customer, for example in China and this also applies to Nokia`s suppliers, which wish to place their production close to Nokia`s production. Nokia's aim is that the suppliers' products would come straight from the suppliers' production lines to Nokia´s factory, so that there wouldn`t be any component or module storing stage between the Nokia and its suppliers.

5.2 Osram

Osram is a global company which has its' headquarter in Munich, Germany. Osram`s main products are lamps and lightning systems. Osram is one of Nokia`s many suppliers. To Nokia, Osram manufactures for example flash applications, optical sensors and infrared LEDs. Company has co-operated with Nokia for almost 12 years.

The interviewees from Osram were Ms. Sylvia Weise and Mr. Elias Tsiatas. Ms. Weise is responsible for Nokia`s projects' quality aspects and she is also involved in Nokia`s VUP project. Mr. Tsiatas is in charge of Nokia as Osram`s customer.

Both Ms. Weise and Mr. Tsiatas think that the VUP with Nokia has been very useful to both parties. Part of the VUP has been developed by Osram, together with Nokia. A very important aspect for the project to succeed has been that the entire company is involved in the project. Every department which is somehow involved in the product development process is also involved in the VUP.

VUP helps Osram to verify the product better, and it helps the product to reach a certain quality. VUP has been a very useful project because there are many aspects involved. For example, VUP includes simulation and reliability testing but also characterization of the whole product. Osram sees that VUP is more than just a quality tool. VUP is more like a process tool for the whole product development process. VUP has helped Osram to manufacture better products. For example the simulation tool has been developing much further with Nokia.

Osram uses many kind of verification and validation methods. Verification starts at a very early stage of a new product. Ms. Weise mentioned especially robustness testing, in which stress above the normal conditions is applied to the product in order to identify the weak points of the product. Osram tries to bring robustness testing as a part of the Nokia's VUP.

Robustness testing helps finding weaknesses in the used materials and helps to make some inferences about the product itself. Robustness testing is a very helpful tool, especially if the testing is done in a very early stage of the project because then it is easier to change the direction of the project. The further the product development project proceeds, the harder it is to make changes to the product and the worst case scenario is that the whole product concept has to be changed.

From theoretical verification tools, Osram uses Failure Modes and Effects Analyses (FMEAs) in different time points of the development project, in order to identify critical points of the project. Company uses for example design FMEAs, product FMEAs and process FMEAs. Another theoretical tool which company uses is called Lessons Learned method. In this method, the basic idea is that after the project the entire project team meets and gives feedback about the things that could have been made in a better way. Lessons Learned method gives important information to the future projects.

When Nokia decides to change some qualities of the product in the middle of the product development process, the information occasionally arrives in a very late phase to Osram. Sometimes Osram wishes that they would have been given information earlier about the change that was going to take place. Especially, if the change is substantial it would be helpful to have an earlier notice about it.

Nokia responds to Osram's improvement ideas mainly positively, but sometimes their respond is circumspect. For example, concerning the product improvements Nokia

is somewhat careful because Nokia wants to make sure that there are also other suppliers that can supply the products, if necessary.

5.3 Metso Minerals

Metso is a global corporation with three different business segments: Mining and Construction Technology, Energy and Environmental Technology, and Paper and Fibre Technology. Metso Minerals Oy is one of Metso corporations´ global business units, which has focused into mining and construction business. Metso Minerals' engineering, production, procurements and sales are performed in more than 50 countries. Factories are located all over the world, e.g. in China, India, USA, New Zeeland, South Africa, Brazil, and Australia. (Metso Minerals 2010)

The interview took place in the Tampere factory of Metso Minerals. The Tampere factory of Metso Minerals produces mainly crushing plants, especially track-mounted crushing plants as well as other track-mounted screening plants. There is some cooperation in product development between the other Metso Minerals factories. Some of the products which are made in Metso Minerals' Tampere factory are also made in other Metso´s units. Metso Minerals' products are mainly configured products. Development time for the larger products is several months. Over 90% of the products made in the Tampere factory are exported.

Interviewees Mr. Joonas Aaltonen and Mr. Juhamatti Heikkilä have both worked for Metso Minerals' Tampere factory for several years. Mr. Aaltonen has his background in mechanical engineering as Chief Designer and also in subcontracting as Sourcing Manager and Category Manager. Mr. Aaltonen is currently Development Manager in Metso Minerals and is in charge of engineering Process Development. Mr. Heikkilä is Manager of Crushing and Screening products.

5.3.1 Product development process

Mr. Aaltonen and Mr. Heikkilä find that at the moment the most important problems in the product development in Metso Minerals are related to the product data management control. The product data management systems have been changed a lot during the past few years and this has caused some problems concerning company`s information management and the management of change. About a year ago, Metso Minerals started to use a new Enterprise Resource Planning (ERP) system SAP. Mainly the current problems are related to communication (data management) between the product development and the purchasing department. One major issue to be solved is how the purchasing department could get data in such a form that would allow them to purchase the right version of the given part at the right time. The whole new ERP systems' role (SAP) is very different compared to the previous data management system, which main-

ly causes the above mentioned temporary information management problems. SAP is already used in almost every Metso Minerals manufacturing plant, and in the near future also in every sales unit. In addition, there are product life-cycle management studies in which SAP system has quite significant role.

In the future, one big challenge also is the need to design and develop global products for the global markets. This causes issues in the material management, information management, production methods and in the quality control. Every task has to be thought from the global perspective. Global thinking also makes the company's procurement function face new challenges. Metso Minerals has to make sure that materials are available in every country where the products are made, and that production is possible even with different devices. On the other hand, product's time to market has to be very fast, therefore it is all about handling a very complicated process fast.

Other Metso Minerals' challenges in the product design are cost competiveness and higher quality requirements. Cost effectiveness would be easier to handle by focusing only on one company at a time but this is on the other hand in conflict with the company's global thinking.

Metso Minerals uses mainly Metso Innovation process model, but product development process methods vary in different projects. In technical solutions, the suppliers can be chosen already at an early stage of the project. This allows the supplier to be involved in the whole product development process. Nevertheless, the supplier involvement time varies between the different products. Some suppliers are only involved in the prototype model design and production, and in the real production the company may change the whole supplier into another supplier.

Metso Minerals uses many kinds of verification and validation methods. Metso Minerals` aim is to start verification already in a very early phase of the product development project by using tested components and modules. From analyse methods, Metso Minerals uses simulation tools and mathematical analyses. For example, the crushing process and automation systems are being simulated. FEM analyses and strength calculations are also guiding product testing and design. The results from the mathematical analyses give important information about the life time of the product.

Metso Minerals has also prototype testing programs. Prototypes are tested in a real life use setting. This way company gets feedback from its customers. Risk management is taken care of by making more than one prototype of each new product. At the time of the testing, there cannot be too many new features in the product, as many new features would make the flaws difficult to find out. For example, if the technology system is new, then the components and modules should be already tested and used before, so that it is easier to find out where the flaw is.

Suppliers are primarily responsible for the quality of their products. Suppliers that deliver more critical parts are evaluated more precisely than the standard component suppliers. Also the quality of the new suppliers is evaluated much more in detail.

5.3.2 Supplier relationships

There are many factors that affect the selection of suppliers by Metso Minerals. Usually the big picture, rather than a single factor, decides which supplier is used. Suppliers may also change if the supplier cannot answer to the competition or in some cases the supplier changes because the suppliers' capacity is needed in another function. Globalization is also bringing new challenges to the selection of the suppliers. All of the solutions have to be globally effective. Some of the manufacturing has been transferred to the low-cost countries. Also, sometimes parts have to be manufactured near the customer, and in these cases the supplier has to be chosen by the location.

Suppliers are being evaluated regularly. The frequency of evaluation depends on two different aspects:

1. On which quality level the supplier is, and
2. Which kind of products the supplier is manufacturing to Metso Minerals

For example, if a supplier delivers strategically important structures, the supplier's operations are being evaluated more carefully than if a supplier delivers only standard components. Also, the new suppliers are being evaluated more often. Methods that are used to evaluate the suppliers are e.g. sample tests to the factories, and audits. Costs are also being controlled continuously and suppliers are always required to commit to some predetermined overall cost goal. Because of the constantly harder cost competition, Metso Minerals has over the past few years searched new suppliers from low cost countries, which in turn brings new challenges related to different cultures and manufacturing issues.

Typically, the suppliers of Metso Minerals are long term suppliers. Metso Minerals has only a few strategic partnerships. The contracts that Metso Minerals makes with the suppliers are usually valid only for now, which means that Metso Minerals isn't obliged to order any specified amount of products from the supplier. This enables Metso Minerals to evaluate at regular time points how satisfying the co-operation has been so far, and make adjustments accordingly. With technology suppliers, Metso Minerals sometimes makes much shorter contracts, mainly because occasionally the technology solutions might end up to be only short experiments. In addition, there are some suppliers which are only used to fill the temporary need for additional capacity. These contracts are typically short-lasting because there are many suppliers that can produce similar products.

Metso reacts usually positively to the feedback from the suppliers. Nonetheless, as Metso Minerals always has to find globally profitable solutions, some of the suppliers' suggestions may at times turn out to be difficult to put into practice. There are also a few challenges in the closer co-operations with the suppliers. Especially, in terms of exchanging information about production processes, there may now and then arise difficulties. For instance, suppliers do not necessarily want to share information about the manufacturing methods of a particular component or a module, because they want to keep the knowhow to themselves and maintain their position in the market. Some of the information can also be confidential, which may further hamper the information exchange.

5.4 Konecranes

Konecranes is one of the world's leading companies in lifting business. Konecranes serves lifting solutions and services in manufacturing and process industries, nuclear industry, ship yards and harbours worldwide. Konecranes has also its own production and engineering all over the world. (Konecranes 2009)

Konecranes is divided into a few separate business units. The interview focused on Konecranes Ports unit which is located in Hyvinkää, Finland. Hyvinkää Ports unit is a global business unit where all of the Ports unit's projects are controlled. Ports business unit is focused on the marketing of products, product design and delivery. All of the manufacturing is subcontracted.

Konecranes Ports unit has many products in the portfolio, and the production encompasses both standard and fully tailored products. The products of the Ports business unit are generally large and very demanding products in many aspects. Products are mainly modular, and even some bigger product structures are readily designed modular. Product selection does not vary much between the countries, only some of the safety related standards vary. Products are designed mainly keeping an eye on the global perspective.

Konecranes' Ports unit has cooperation with the other Konecranes corporations´ units. In particular, the Ports unit uses same kind of components and technology as is used in the other Konecranes units.

Interviewee Mr. Hannu Oja is technology leader in Konecranes Ports unit. Mr. Oja is responsible for all of the technology, R&D, and engineering of the products of the Ports unit. Mr. Oja has worked in Konecranes Ports unit for over 11 years.

5.4.1 Product development process

The biggest challenges in the product design for the Ports unit of Konecranes are at the moment related to the time-controlling of the product development process. The main

problem in the time control is that the product development process is too slow and new products end up to the market too slowly.

Globalization has also affected the operations of Konecranes in many ways. The organization structures of Konecranes have recently become leaner and products are nowadays manufactured to many countries all over the world. This means that the designers have to know a lot more about the production methods than before, and the solutions usually have to appear very simple, and furthermore, the solution has to feature properties that allow it to be manufactured with very simple methods. Communication problems between the suppliers and Konecranes have also increased and the material deliveries are more difficult to compare.

The product development model used by the Konecranes Ports unit is based on Cooper`s Stage Gate model. This product development model is only used in bigger projects, and the model actually serves more as a project management tool rather than as a product development tool.

Verification methods are used depending on the project, and different methods are also used in the different phases of the project. Even though company still uses more traditional methods like calculation and functional testing methods, the role of simulation methods has increased remarkably. Because products are very technical and the automation system has a very large role, some features are still possible to change even at a very late phase of the project. Testing of the Konecranes Ports unit products is mainly made by Konecranes itself. Testing function has been centered in Konecranes Hyvinkää unit. External testing is performed in collaboration with a few research institutions.

5.4.2 Supplier relationships

Konecranes has over the years focused more on their main knowhow, and because of this, the business networks associated with Konecranes have expanded remarkably. Focusing on the core activities frees company´s recourses to other areas and makes it possible to manage many processes at the same time. This helps also in the time-controlling of the product development projects. The general trend has been that the smaller suppliers are excluded from the networks and Konecranes focuses more on bigger suppliers. Bigger suppliers have more production capacity, and they have capability to expand their functions, if needed.

Konecranes aims to use more than one supplier in orders as this keeps the costs more competitive. This also helps avoiding situations in which the only supplier does not have capacity to deliver the product in the required time.

Konecranes usually makes one year agreements with the suppliers concerning the price but the co-operation contracts are valid only for now and these contracts are extended once a year.

Suppliers are regularly audited. The suppliers that are critically important for Konecranes are audited annually. The Purchasing department has its own evaluation criteria, such as the quality and capability of the suppliers.

With some of the suppliers, Konecranes Ports unit has closer co-operation, but with some of the suppliers the interaction with Konecranes is limited in selling products. Suppliers which have close co-operation with Konecranes usually supply more critical parts or materials. Close cooperation usually means that the supplier is involved in the development projects of Konecranes. In these projects, the suppliers' products may be developed more suitable to Konecranes, or the suppliers are involved in projects where Konecranes is not the only buyer.

Mr. Oja finds that it is possible that the VUP implemented by Nokia could also be put into practise in Konecranes Ports unit for some parts. Some of the part system suppliers' don´t necessary know the final destination of a product, and that is why all of the requirements cannot be specified so precisely. The practical examples of this kind of problems are the harbour products which are used by the sea. The part system suppliers' don´t necessarily have any kind of experience from this kind of special environment. The VUP project should be put into practise first with only one supplier, and if the co-operation would work well and the results would be good the VUP project could be carried on with the other suppliers.

Konecranes has overall positive views about their suppliers and their feedback, and suppliers are increasingly involved in the product development projects. The organization structures in Konecranes have changed recently, and at present the product designers themselves have to do rather important decisions at an early phase in the product development process. Because of this, the suppliers' feedback is considered highly valuable. Konecranes has also recently launched a new supplier innovation model. The main idea in this model is that the suppliers can present their ideas for Konecranes products or the process. Some of the ideas of the suppliers have already been developed further. While it is obvious that the suppliers are not only after better co-operation with Konecranes but primarily work for their own interests, the propositions made by the suppliers have to be reviewed critically. Fundamentally, this means a thorough evaluation of the gains and expenses of the proposed idea.

6 RESULTS AND DISCUSSION

In this chapter, the results of the research and their validity are discussed. At first, all the research questions presented in the introduction part are answered. Section 5.2 contains discussion about the results of the interviews and section 5.3 contains discussion about the research method and suggestions for the future research on the topic.

6.1 Answering the research questions

1. *What is DFP?*

One of the main purposes of this thesis was to perform a literature search about what DFP means. DFP methods' purpose is to make the procurement processes easier to handle and also more effective. Because procurement is a wide term and it contains many tasks, procurement function should be understood as a cross functional responsibility between many parties and not only as a task of the procurement department. DFP method means greater co-operation and information sharing between the Procurement department and R&D department. The work results of design engineers have a major impact on complexity of the procurement function. By decreasing product complexity and focusing more on design's life-cycle effects, designers can decrease products overall costs and reduce development time.

At present in many industries purchased goods and services account for a large percentage of products costs. Each company needs other companies to cooperate with in order to survive in the increasing competition. This is the reason why also designers should co-operate with other organizations associated in the value chain. In order to make competitive products, designers need to share more information for example about the specifications of the needed goods.

DFP can be related to other previously defined DFX methods (see chapter 2.1.1). Many DFX methods are already taking procurement process partly into account. Design for Assembly, Design for Manufacturing and Design for Modularization methods focus on simplifying the products and manufacturing process. The simplicity of the design is more and more important, especially now because production can take place anywhere in the world. Simple design gives more flexibility to choose the supplier and it also reduces purchasing work.

DFC method concentrates on reducing overall costs, and DFQ's purpose is to improve product reliability. DFL method focuses for one part on controlling transportation and customer service issues. DFP method encompasses all of these above mentioned

methods, which is why DFP method could be seen as a larger point of view than these previously mentioned DFX methods.

It is clear that companies should pay more attention on procurement function, especially today because companies have to outsource more due to harder competition. Effective procurement function could enable companies to meet their strategic objectives better and improve the performance as a whole. Effective procurement function could help to reduce total costs, improve product quality and shorten the product development time. DFP could be a method to help to reach the business goals.

2. *How does company strategy affect procurement function?*

Strategy is company's theory about how it is going to sustain its competitive advantage. The procurement function cannot be effective if company's other strategies do not align to each other, as was discussed in chapter 2.1. The market strategy, product strategy and delivery strategy should all aim to the same goal.

The procurement process should be taken into account already at a very early phase. If the procurement function is complicated it will also slow down the product development process, and vice versa. When a company defines the kind of markets the company wants to compete in, and what kind of products the company wants to produce, the company should also think what these decisions mean to the company's procurement process.

Usually the more customer-centred the products are, the more complicated and slower is the entire procurement process. Also, if there are many market areas in which the company wants to compete the procurement becomes correspondingly more complicated. On the other hand, it is rarely anymore possible that a company would produce only mass customized products. Configured and platform based products could be a good compromise between the mass customized products and fully customized products. If the configured product variations are designed carefully to answer different customers' needs, the sales delivery process could shorten and be more efficient without doing any compromises to customers.

3. *How does product structure affect procurement operations?*

Decisions on product structure have a major impact on procurement operations. Product architecture decisions have direct impact on the processes and supply chain decisions. A design engineer is responsible for the behaviour and the entire life-cycle properties of the product.

Product development and purchasing time can be reduced by using more standard components. Modularization and platform-based products are effective ways to reduce product complexity. Modularization of the products enables standardization strategy and reduces products overall costs. It also reduces purchasing work because it enables

to purchase larger entities. Table 2 summarizes how different market strategies and product development strategies influence procurement operations.

Table 2. *Summary of the answers to the research questions 2 and 3.*

	Beginning of product lifecycle		
Strategy	**Market**	**Product Development**	**Production & Supply**
Mass	Mass markets	Modularity for quick response	Make to Supply, Make to order
Systemic customization	Configuration	Platforms for variety	Assembly to order, Make to Order
Project	Negotiations, bidding, references	Agility to provide quick response	Engineering to Order

4. How companies could benefit more on their co-operations with the suppliers?

As companies are focusing on their core competencies, suppliers' significance will play more important a role, when they take over all the non-core business activities. These non-core activities do not only include manufacturing of the parts and components, but increasingly other functions such as information systems, accounting, maintenance, office support services and engineering design are being outsourced. That is why effective supply management is very critical to the success of every company. (Swink et al. 2011)

By collaborative co-operations with the suppliers companies could have many advantages. Companies can benefit from suppliers' different backgrounds and knowhow, and vice versa. By collaborating with suppliers, companies can find creative ways to reduce costs and improve products quality. Collaboration can help to produce better products and it can even lead to new innovations. Collaboration can also make the company's processes more effective.

Many companies and organizations could benefit from the selective use of strategic partnerships. Companies should collaborate more especially with those suppliers who deliver more critical components or parts.

6.2 Results of the interviews

The main goal of the interviews was to find out the real challenges of the companies in the procurement process. Nokia's VUP project was used in this thesis as an example of supplier relationship management method. One purpose was to explore, whether the VUP method could be useful in other companies as well.

6.2.1 Current challenges in the Product Development and Procurement

All of the interviewed companies are developing very different kinds of products and their customer markets are fundamentally different. Product strategies of these companies can be divided in three different categories. Nokia's products are platform-based and modular. Metso Minerals' products are mainly partly configured, which means that the company itself has defined variations for the products. The products of Konecranes are mainly project products, even though they have also standard products in their portfolio. Table 3 summarizes the interviewed companies' differences in customer strategies, product development processes and in product management point of view.

Table 3. *Summary of main differences between interviewed companies in product development approach.*

Company	Operations and customers	Product Development Process	Product Management
Nokia	Global, Mass Markets	Many process models (in software: Agile)	Modularity for variety and Concurrent Engineering
Metso Minerals	Global, Customization	Metso innovation process model	Modularity for life cycle
Konecranes	Global , Projecting business	Based on Stage-Gate model	Modularity for delivery

Even though the products and markets of the interviewed companies are completely different, there are still some similarities between these companies. All of the interviewed companies are global and relatively large. All of these companies have wide supplier networks and they struggle in a complex business environment, with increased competition and high cost-competiveness pressures.

Global business environment makes the entire product development and procurement process much more difficult. Because products are designed globally and products can be manufactured in countries all over the world, every designer has to know much more about the different production methods, materials and other production-related factors than before. For example, manufacturing devices and material availability may vary in different countries. Product designers need to be aware of many things at the same time and make solutions that are globally effective. This difficulty was especially seen in the factories of Metso Minerals and Konecranes.

Global markets can also be complex and difficult because each country is different. Globalization increases communication problems due to various cultural and language related factors. This problem was found in all the interviewed companies.

Large market areas make it hard to answer every customer's needs. There is a need to design a lot of variations of the products and still keep the costs down and product development cycle fast. Also the increased complexity of the products, especially in technologically driven products, affects the product development time and to procurement. Time controlling is major problem in Nokia and Konecranes. New products do

not reach markets as fast as they should. In the Osram interview there could be seen one issue related to this problem: when Nokia wants to change some qualities of the product during the product development process, the information sometimes arrives to Osram in a very late phase. This lengthens the whole product development time because Osram might have to start developing everything from the beginning.

Globalization also requires a lot from the information management systems. Technology innovations are radically changing all aspects of the business including procurement operations. (Cavinato 2001) One of the most important current problems in the product development and procurement in Metso Minerals are related to new product data management systems' control. The main problem was that the purchaser does not get the information at the right time.

6.2.2 Supplier relationship management

Increasing volume of subcontracting is affecting also the product development. Designers need to manage all of the suppliers' work. This means that they are responsible for the suppliers to understand the requirements of the product correctly and that the responsibilities of both parties are clear. Also quality control and process synchronization are areas in which designers have to be actively involved. (Perttula 2007, p 94)

There are many aspects that influence the selection of the suppliers in all of the interviewed companies. Criterions vary between the different components and parts. All of the interviewed companies also regularly evaluate the suppliers' performance.

Nokia aims to have long partnerships with the suppliers, especially in fields in which it is still possible to have new ideas and innovations. Nokia's on-going project VUP is a good example of what kind of benefits closer co-operation with the suppliers can produce. From Nokia's perspective, the VUP project can shorter the new products' development cycle and improve Nokia's product quality. By transferring verification function to suppliers Nokia also avoids extra work because they do not have to repeat testing as they can trust the suppliers work. This way Nokia has more resources available for other tasks.

Nokia's supplier Osram gave also very positive feedback about the VUP project. Also Osram sees that it has benefited from the VUP project. VUP has also improved Osram's product quality. Because companies are working together to make the verification function better, it has helped to develop verification tools like simulation much further.

VUP is a good example from partnership type of co-operation where both parties get benefits. Companies can avoid doing extra work because they do not have to do the same things twice. This saves development time from both of the companies, and they can have more available resources to other tasks. Additionally, companies can develop together further new ideas and produce better products.

Because of the growing complexity of the products and increasing amount of suppliers, the testing function can get very complicated. In order to reduce costs and still keep the product development time short, the testing function should be optimized. Compa-

nies should harmonize the V&V process between the different organizations in order to increase efficiency and produce competitive products.

Konecranes finds it possible to realize Nokia's VUP project for some parts. Product quality could be improved by doing closer co-operation with some of the more critical suppliers. The co-operation could focus more on getting the requirements of the products clear to the suppliers. Some of the suppliers of the Konecranes are not aware at the moment of all the requirements of the final product. This same issue has also been realized in Nokia that product flaws are usually due to misunderstandings about product requirements. Closer co-operation in requirement-defining phase could help to produce better products to markets.

Metso Minerals makes usually long-term agreements with the suppliers, but in technology solutions contracts are sometimes for only a short time. For Metso Minerals it is sometimes difficult to do closer co-operation with the suppliers. Some suppliers want to keep the knowhow to themselves so they do not want to share any information to Metso Minerals. Also in some contracts the information about the manufacturing methods can be confidential. Metso Minerals has mainly relatively long contracts with the suppliers, but it does not have very close co-operation with them.

Table 4 summarizes the differences between the interviewed companies in frequency of the supplier audition and the usual contract time span.

Table 4. *Summary of differences in supplier audition and contract time span.*

Company	Suppliers audition	Contract time span
Nokia	Continuous (audition is part of the VUP project)	Long partnerships in fields in which it is possible to make improvements
Metso Minerals	Frequency of auditing depends on suppliers' quality level and product type	Long term suppliers
Konecranes	Critical suppliers are audited annually	Usually one year agreements

6.3 Suggestions and future research

The focus of this thesis was on the impact of the product development on the procurement operations. The persons that were interviewed on this topic, however, represented the product development organization of their company, not the procurement organization. Consequently, this thesis is based on the product development-based perspective on the topic. In order to have a broader perspective on this topic, interviews of people involved in the procurement operations should be made, and the ideas of the two different organizations about the DFP could be evaluated and compared. This could, for example, create more information about the different contract types and supplier evaluation methods.

The DFP method examines procurement function from the product development point of view. In the future it would be interesting to examine product development from the procurement point of view and see how the procurement function could help to make product development more efficient.

REFERENCES

Abdelkafi, N., Blecker, T. & Pero, M. 2010. Aligning New Product Development and Supply Chains: Development of a Theoretical Framework and Analysis of Case Studies. DET2009 Proceedings, AISC 66. pp. 1399-1419.

Baily, P., Farmer, D., Jessop, D. & Jones, D. 2005. Purchasing Principles and Management. 9th ed. London, UK, Pitman. 427p.

Belt, P. 2009. Improving verification and validation activities in ICT companies – Product development management approach. Oulu, Finland, Oulu University Press. 72p.

Boothroyd, G., Dewhurst, P. & Knight, W.A. 2011. Product design for manufacture and assembly. 3th ed. Boca Raton, FL, USA, CRC Press. 649 p.

Bower, D. 2003. Management of Procurement, Construction Management Series. London, UK, Thomas Telford Ltd. 260 p.

Bralla, J. 1998. Design for Manufacturability Handbook. New York, USA, McGraw-Hill Professional Publishing. 1361 p.

Broome, J. 2002. Procurement Routes for Partnering A Practical Guide. London, UK, Thomas Telford Ltd. 395 p.

Burt, D., Dobler, D. & Starling, S. 2003. World Class Supply Management The Key to Supply Chain Management. 7th ed. USA, McGraw-Hill. 689 p.

Cavinato. J., Kauffmann, R. G. & Goldstein, S. 2001. Purchasing Handbook: a Guide for the Purchasing and Supply Professional. USA, McGraw-Hill. 1099 p.

Cavinato, J. 2006. Supply Management Handbook. 7th ed. USA, McGraw-Hill. 961 p.

Chunawalla, S. A. 2008. Materials and Purchasing Management. Mumbai, India, Global Media. 367p.

Cohen, S. & Roussel, J. 2004. Strategic Supply Chain. USA, McGraw-Hill. 338 p.

Cousins, P., Lamming, R., Lawson, B. & Squire, B. 2008. Strategic Supply Management, Principles, theories and practice. UK, Prentice Hall. 308 p.

Gopalakrishnan. 2006. Purchasing and Materials Management. New Delhi, India, Tata McGraw – Hill. 439 p.

Fixson. S. K. 2005. Product architecture assessment: a tool to link product, process and supply chain design decisions. Journal of Operations Management, 23, 3-4, pp. 345-369.

Huang, G.Q. 1996. Design for X Concurrent engineering imperatives. UK, T.J. Press. pp. 489.

Huang, G Q., Zhang. X.Y. & Liang. L. 2005. Towards integrated optimal configuration of platform products, manufacturing processes, and supply chains. Journal of Operations Management, 23, 3-4 pp. 267-290.

Huhtala, P. & Pulkkinen, A. 2009. Tuotettavuuden kehittäminen –Parempi tuotteisto useasta näkökulmasta (in finnish). Helsinki, Finland, Teknologiainfo Teknova, Esa Print. 431 p.

Iloranta, K. & Pajunen-Muhonen, H. 2008. Hankintojen johtaminen: ostamisesta toimittajamarkkinoiden hallintaan (in finnish). Jyväskylä, Finland, Tietosanoma Oy. 498 p.

Konecranes. [WWW]. Referred April 12. 2011. Available: http://www.konecranes.com/portal/eng/about_us/

Kumar, S. & Anil Suresh, N. 2009. Operations management. Delhi, India, New Age International. 290 p.

Kuo, Tsai-C., Huang, S. H. & Zhang, H-C. 2001. Design for manufacture and design for `X´: concepts, applications, and perspectives. Computer and industrial engineering 41, 3, pp. 241-260.

Lanz. Minna. 2010. DFX-tools and methods. Tampere University of Technology. Lecture material from the course “Design for X”. 50 p.

Leenders, M., Johnson, P, F., Flynn, A. & Fearon, H. 2006. Purchasing and Supply Management With 50 Supply Chain Cases. 13th ed. USA, Mc-Graw-Hill. 564 p.

Lehtonen, T. 2007. Designing modular product architecture in the new product development. Doctor of Technology Theses. Tampere University of Technology, Tampere, Finland, Department of Production Engineering. Publication 713. 222 p.

Lysons, K. & Farrington, B. 2006. Purchasing and Supply Chain Management. 7th ed. UK, Ashford Colour Press. 709 p.

Mangan, J., Lalwani, C. & Butcher, T. 2008. Global Logistics and Supply Chain Management. UK, John Wiley & Sons, Ltd. pp. 372.

Metso Minerals. [WWW]. Referred April 13. 2011. Available: http://www.metso.com/corporation/about_eng.nsf/WebWID/WTB-041026-2256F-55957?OpenDocument

Nokia. [WWW]. Referred April 13. 2011. Available: http://ncomprod.nokia.com/about-nokia/company

Novak, S. & Eppinger, S. 2001. Sourcing by design: Products complexity and the Supply Chain. Management Science 47, 1, pp. 189-204.

Ostring, P. 2003. Profit-Focused Supplier Management: How to Identify Risks and Recognize Opportunities. USA, AMACOM Books. 256 p.

Paquette, L. 2004. Sourcing Solution: A Step-by-Step Guide to Creating a Successful Purchasing Program. USA, AMACOM Books. 239 p.

Perttula, A. 2007. Challenges and Improvements of Verification and Validation Activities in High Volume Electronics Product Development. Doctor of Technology Theses. Tampere University of Tehnology, Tampere. 157p.

Pulkkinen, A. 2010. Workshop on Design for Procurement. Tampere University of Technology, Tampere. 12 p.

Pulkkinen, A. 2005. Asennusmyönteinen suunnittelu ja muut “myönteisyydet” (in finnish). Mechanical Assemblies seminar, autumn 2005. Tampere University of Technology, Tampere, Finland.

Pulkkinen, A. 2002. Seminar on DFMA for postgraduate students by A. Pulkkinen & A. Riitahuhta (in finnish). Tampere University of Technology, Tampere, Finland. 101 p.

Rungtusanatham, M., Forza, C. 2005. Coordinating product design, process design, and supply chain design decisions Part A: Topic motivation, performance implications and article review process. Journal of Operations Management 23, 3-4, pp. 257-265.

Schomburg, E. 1980. Entwiklung einesbetriebstypologichen Instrumentariums zur systematichen Ermittlung der Anforderungen an EDV-gestutzte Productionsplannungs-und steuerungssysteme im Maschinenbau. Dissertation. Aachen. RWTH Aachen University.

Selladurai, R. S. 2003. Mass customization in operations management oxymoron or reality. The International Journal of Management Science 32, 4, pp. 295-300.

Simchi-Levi, D., Kaminsky, P. & Simchi-Levi, E. 2004. Managing the Supply Chain: The Definitive Guide for the Business Professional. USA, McGraw-Hill. 308 p.

Simpson, T., Siddique, Z. & Jianxin, J. 2006. Product platform and product family design: Methods and Applications. USA, Springer Science+Business Media. 548 p.

Sollish, F & Semanik, J. 2005. Purchasing and Supply Manager´s Guide to the C.P.M Exam. USA, Sybex. 525 p.

Swink, M., Melnyk, S., Cooper, B. & Hartley, J. 2011. Managing Operations Across the Supply Chain. USA, McGraw-Hill. 575 p.

Ulrich, K & Eppinger, S. 2008. Product Design and Development. Fourth edition. USA, The McGraw-Hill Companies. 368 p.

Ulrich, K. 1995. The role of product architecture in the manufacturing firm. Research Policy 24, pp. 419-440.

Valkokari, K. 2009. Yhteisten tavoitteiden ja jaetun näkemyksen muodostuminen kolmessa eri tyyppisessä verkostossa (in finnish). Finland, VTT publications. 278 p.

Wallace, R. 2004. Strategic Partnerships: An Entrepreneur's Guide to Joint Ventures and Alliances. Chicago, IL, USA, Dearborn Trade, A Kaplan Professional Company. 224 p.

Ward, G. 2008. Project Manager's Guide to Purchasing: Contracting for Goods and Services. UK, Gower Publishing. 233 p.

Whitney, D.E. 2004. Mechanical Assemblies – Their Design, Manufacture, and Role in Product Development, New York, USA, Oxford University Press, Inc. 517 p.

Wincel, J. 2004. Lean supply chain management: a handbook for strategic procurement. New York, USA, Productivity Press. 229 p.

Weele, A. 2005. Purchasing and supply chain management: analysis, planning, and practice. 4th ed. London, UK, Thompson Learning. 364 p.

Interviews:

Interview at Nokia in 15.2.2011. Interviewees: Perttula, A. Mörsky, T. Interviewer: Martikainen, A.

Interview at Osram in 18.2.2011. Interviewees: Weise, S. Tsiatas, E. Interviewer: Martikainen, A.

Interview at Metso Minerals in 21.2.2011. Interviewees: Heikkilä, J. Aaltonen, J. Interviewer: Martikainen, A.

Interview at Konecranes in 9.3.2011. Interviewee: Oja, H. Interviewer: Martikainen, A.

APPENDICES

Appendix 1.

Questions for the companies (Nokia, Metso Minerals, Konecranes)

1. Product design:
- What are the main problems in product design at the moment?
- Does Your company use a specific product development model?
- How does Your product development model serve the co-operation with the suppliers?

2. V&V process
- What kind of V&V methods does Your company use?
- Who are involved in the V&V process?
- How early does the V&V process start?
- Is there any co-operation with the suppliers in the V&V process?

3. Suppliers
- How are the bids asked from the suppliers?
- Is there a classification for the suppliers?
- What is the duration of the agreements that are usually made with the suppliers?
- How often are the suppliers audited?
- How useful do You find the suppliers' feedback?
- Are suppliers suggesting more radical changes at the moment?

4. Organization and information management
- Are Your company's operations still Finland-centered?
- Are the products made near the customer?
- What kind of information management systems does Your company use?

Appendix 2.

Questions for Osram

1. What kind of products do you manufacture and deliver to Nokia?

2. Your company is part of Nokia's Verification Upstream Project (VUP). What kind of views and experiences do You have so far on this project?
- Do You think VUP is useful?

3. What kind of V&V methods does Your company use?

4. Which people from Your company are involved in the V&V process?

5. How early do You start the verification?

6. How does Nokia give information to Your company about changes in products?
- How early do You receive a notice that a change is going to take place?

7. Do You communicate with Nokia about Your ideas on improvement of the products and about the quality control? And how does Nokia respond to these suggestions?

8. Do you have Your own ongoing projects on quality control?

9. Nokia has an information management system called Lotus Notes which is common to all of the suppliers. Are You satisfied with this program? Is it easy to use and is it flexible to changes in projects?