LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
School of Industrial Engineering and Management

Master’s Thesis

Purchase process analysis and development in multi-project business

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ABSTRACT

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Conventional approaches to managing single projects are not sufficient in today's organizations, where several delivery projects are often run side-by-side. The multi-project environment sets challenges for traditional single project supply management and purchasing principles, and forces organizations to examine more effective alternative operation methods to current approaches. As projects are constantly and simultaneously being run side-by-side, process-oriented approaches are becoming a topical issue.

The purpose of this master's thesis is to study how the case company's purchasing process can be developed in a multi-project environment. The study is qualitative by nature as theme interviews, statistical data analysis, and benchmarking are applied to identify current purchasing principles and develop future operating methods. The main approach of this research is to explore the uniqueness of delivered projects and compare the findings with current operation methods.

The research findings indicate that the delivered projects are more recurrent than completely unique delivery solutions. Based on the findings a new material classification principle, as well as a new material control model with practical implementation techniques, is developed for the case company. With the help of the development proposal, the supply management organization is able to manage its materials according to their characteristics on a continual basis, rather than separately for each project.

TIIVISTELMÄ

Tekijä: Joonas Korpi **Työn nimi:** Ostoprosessin analysointi ja kehittäminen moniprojektiliiketoiminnassa.	
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Perinteiset projektien hallintaan liittyvät lähestymistavat eivät enää riitä nykypäivän organisaatioissa, joissa useita toimitusprojekteja toteutetaan rinnakkain. Moniprojektiympäristö asettaa haasteita perinteiselle projektiliiketoiminnan hankintojen johtamiselle sekä hankintaperiaatteille, pakottamalla tutkimaan vaihtoehtoisia ja tehokkaampia toimintatapoja nykyisten lähestymistapojen tilalle. Koska projektit ovat jatkuvasti ja samanaikaisesti käynnissä, prosessimaiset lähestymistavat ovat nousemassa entistä tärkeämmäksi aihealueeksi.

Tämän diplomityön tarkoituksena on tutkia, miten kohdeyrityksen ostoprosessia voidaan kehittää moniprojektiympäristössä. Tutkimus on luonteeltaan laadullinen tutkimus missä teemahaastatteluiden, tilastollisen data-analyysin ja benchmarkkauksen avulla pyrittiin tunnistamaan nykyisiä hankintaperiaatteita sekä kehittämään tulevaisuuden toimintatapoja. Tutkimustyön oleellisin lähestymistapa oli tutkia toimitettujen projektien ainutkertaisuutta ja verrata tuloksia nykyisiin toimintaperiaatteisiin.

Tutkimuksesta saatujen tulosten mukaan toimitetut projektit ovat olleet enemmissä määrin toistuvia kuin ainutkertaisia ratkaisuja. Tulosten perusteella kohdeyritykselle kehitettiin uusi materiaalin luokitteluperiaate sekä materiaalinohjausmalli käytännön toteutusmenetelmillä. Kehitysehdotuksen avulla hankintaorganisaatio pystyy hallitsemaan materiaaleja niiden ominaisuuksien mukaisesti jatkuvaluonteisesti projektikohtaisuuden sijaan.

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I also would like to thank my family and especially Maija who has supported me during the whole thesis time and a bit more.

Joonas Korpi
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LIST OF ABBREVIATIONS

AIU Azipod Interface Unit

AD Air Ducts

BTO Build-To-Order

CAU Cooling Air Unit

ERP Enterprise Resource Planning-System

ESCU Electric Steering Control Unit

ETO Engineer To Order

IT Information Technology

LBU Local Backup Unit

MCABC Multiple Criteria ABC

PDM Product Data Management System

R&D Research And Development

RONA Return On Net Assets

SD Steering Drive

SRU Slip Ring Unit

SSU Shaft Line Support Unit

VMI Vendor-Managed Inventory

1. INTRODUCTION

1.1 Background

The ABB Marine & Ports business unit and its Propulsion Products organization are currently carrying out a TITO process development project called Magnet, whereby a new information system is being introduced for the use of the case company. The aim of this information system is to improve the management of different projects and to increase the information and communication about ongoing projects to different organizations around the business unit. As a part of this development project, the Propulsion Products supply management organization commissioned a master's thesis related to the development of the current purchasing process.

Because of recent changes in the business environment and business as a whole, the roles of supply management and purchasing have increased in ABB Marine & Ports. The supply management organization has begun to challenge the efficiency of the current, mainly manually operated, purchasing process, where almost all materials are purchased on a single-project basis and for a specific need. The multi-project environment challenges single-project purchasing principles, and forces organizations to examine more effective alternative operation methods to current approaches. As projects are constantly and simultaneously being run side-by-side, process-oriented approaches are becoming a more topical issue than before.

1.2 Objectives and scope

The supply management organization wishes to develop its purchasing process in a more efficient and flexible direction, by using alternative material classification principles and material control methods and implementation techniques in its daily operations, in a multi-project environment. The objective of this master's thesis is not to fully expand possible development actions on a practical level, but rather to brainstorm alternative operation methods to current practices that could be used in the future. Based on the findings of this study, the purchasing processes of alternative material control implementation techniques can be modeled according to common process modeling principles.

The research problem of this master's thesis can be presented as a question: "How is the supply management organization able to develop its purchasing process in a multi-project environment?" The research problem can be defined with the following research questions:

- What are the main problems of single-project purchasing principles in a multi-project environment?
- What kind of material control methods and implementation techniques can be used to develop the current purchasing process?
- What are the benefits of process modeling, and what modeling methods can be used for?

Due to the extent of the subject, some issues are outlined outside the scope of this master's thesis. First, the study focuses only on direct material purchases related to two specific product series Azipod® propulsion units. Second, the study does not deal with issues related to manufacturing and logistics; even though these entities are essential from the supply chain management point of view, the purpose of this master's thesis is to focus on the development of the purchasing function. Third, the possible development actions needed for the enterprise resource planning system (ERP) based on the results of this study are outlined from the scope of this master's thesis.

1.3 Research methods

The research begins with the literature review, where theory related to the subject is explored. The purpose of the literature review is to establish how the organization, which operates in project business, can develop its operation methods in a multi-project environment. The main theme is to explore the requirements of the multi-project environment, and the factors with a key role in successful multi-project management from the purchasing point of view.

A comparison between the contents of delivery projects and current operation methods has been chosen as the main approach of this study, the purpose of which is to explore the uniqueness of the delivered projects and to compare the findings with current operating methods. Overall, three different research methods are applied to identify the present state and current operation methods of the case company and to develop potential future operating methods. Research material was mainly collected during autumn 2016 from internal and external sources; internally through theme interviews and statistical data analysis, and externally through benchmarking.

The collection of research material started with internal theme interviews, in order to collect information about the current operation methods of the organization and other internal stakeholders in the order-delivery process. The interviews were semi structured, meaning that a list of questions was sent in advance to preselected interviewees. This enabled them to answer questions and freely state opinions about current problems and possible development ideas in general during the interview. The decision of who to select for interviewing was made carefully and on the basis that these interviews could be of use in forming a "big picture" about the current operation methods of the supply management organization, as well as other stakeholders in the order-delivery process.

Because the primary approach of this research was to explore the uniqueness of delivered projects and compare the findings with current operation methods, numeric data were also required. The collection of research material continued with statistical data analysis, whereby numerical data from the case company's ERP system were obtained and analyzed using Microsoft Excel. The aim of this stage was to investigate similarities among existing product structures and actual delivery project structures, in order to form an overall image about their uniqueness. With the help of statistical data analysis, the current operation methods can be explored more closely from a multi-project environment point of view, and depending on the findings, the future operation methods can be planned on a continuous basis rather than separately for each project.

External interviews with representatives from other organizations were conducted with benchmarking. The objective of this benchmarking was to establish how other organizations have dealt with the subjects of this master's thesis. The benchmarking was not expected to provide direct solutions to the research problem; the purpose was rather to obtain new ideas from different business environments, and to investigate the possibility of using these methods in the case company's business environment. New ideas were raised from benchmarking, and with further development actions could be exploited in the creation of the development proposal.

Ultimately, all research findings were gathered together and the development proposal of this study was created.

1.4 Structure of the report

This master's thesis consist of two parts: a theoretical and an empirical framework. First, the theory related to the subject of this master's thesis is presented, to enable the reader to form an insight about its contents from a theoretical point of view. This part focuses on the following contents: multi-project business and environment, process thinking and process development principles, and the role of purchasing in a multi-project environment.

In turn, the empirical part focuses on the research work and describes how the research was carried out. Chapter 4 presents the case company and its products, the supply management organization and its specific business environment characteristics at a general level. Chapter 5 continues with the research methods and describes in more detail how the research was conducted. The research findings are presented in Chapter 6, and the generated development proposal in Chapter 7. Finally, Chapters 8 and 9 conclude and summarize the results of this master's thesis.

2. MULTI-PROJECT BUSINESS

This chapter deals with the basic concepts of project business and a multi-project environment, and illustrates how the focus of organizations has shifted from pure single-project management towards a situation where multiple projects are running simultaneously and continuously. The management of multiple projects sets new challenges for organizations and forces them to seek new approaches in order to achieve a competitive advantage. Processes and process orientation can be seen as a key factor to success in a multi-project environment, and therefore this chapter also covers process-related theory.

2.1 Multi-project business and environment

During the past 50 years the nature of work has been shifted from mass production, with stable customer requirements and slowly changing technology, to the current situation, where every product or service may be supplied through bespoke design (Turner and Keegan, 2001, p. 254). Companies have become more project-oriented, and projects and programs are applied in both the industrial and nonprofit sectors. A company or part of a company, such as a division or a profit center, that constantly applies projects and programs to perform relatively unique business processes of a large or medium scope, can be perceived as being project-oriented and operating in project business. A project-oriented company can be defined as an organization that:

- defines "management by projects" as an organizational strategy;
- forms temporary organizations for performing business processes of medium- and large-scope projects;
- manages a project portfolio for different projects;
- has specific permanent organization units, such as manufacturing or purchasing, alongside its temporary units;
- applies new management concept features such as customer and process orientation for supporting and developing the performance of projects; and
- recognizes itself as being project-oriented. (Morris and Pinto 2004, p. 124)

Project business is a form of business that relates directly or indirectly to projects, with the purpose of achieving the objectives of a firm. These objectives are often related to a company's success, and in practice they can include the fulfillment of the owner's, customer's, or other stakeholders' expectations. Almost any type of activity that fits the situation can assist in realizing the company's objectives. Because these activities serve to reach specific objectives for the company, there must be a direct or indirect link between them and the company's strategy. Direct activities that are related to projects may involve, for example, an emphasis on specific objectives of the company during project execution, in addition to the effective and systematic performance of the project. Meanwhile, indirect activities can involve the prioritization of projects and project ideas in order to meet the company's strategic objectives. They may also include discarding project ideas that are not aligned with the company's strategy or suspending projects already in progress, either because of changes in the company's operating environment or a scarcity in the required resources. (Artto et al. 2011, p. 10–11)

Project business can be considered to have two divergent meanings: project business as solutions delivery, and project business as solutions development. **Project business as solutions delivery** entails delivering value-added solutions to external customers. This type of project represents a production or manufacturing function in business, which generates value-added solutions for external customers by solving and satisfying their problems and needs. Solutions may vary greatly, from reorganizing business procedures with supporting information systems, to constructing a power plant or ocean liner that is customized and designed according to the customer's needs. Meanwhile, **project business as solutions development** refers to the situation where a company develops new solutions for its own business. This kind of development can be seen as an investment for the future. Investment is not limited to capital investments such as new machines or facilities, but also includes developmental activities such as research and development (R&D), new product development, changes in organizational structure, or business process development actions. Investment projects contribute to the development of the firm's own business through renewing the business by introducing new products or procedures, or through increasing the efficiency of existing business procedures. (Artto et al. 2011, p. 11)

Generally speaking, single projects and single project management have been studied widely in recent decades, but lately multi-project management has received increased interest in the academic field (Engwall and Jerbant, 2003; Fricke and Shenhar, 2000**;** Hans et al. 2005; Dooley et al. 2005). The need to manage more variable and uncertain projects at different stages of their project life cycle poses new and challenging issues for organizations and their employees (Dooley et al. 2005, p. 467). According to Payne (1995, p. 163), further R&D of multi-project management is necessary because 90% of all projects take place in a multi-project context. Fricke and Shenhar (2000, p. 258) support Payne's view in their study, stating that *"few, if any, actual projects are carried out in complete isolation."*

Engwall and Jerbant (2003, p. 403) defined a multi-project organizational setting as an organizational unit that executes a substantial share of its operations as projects, which are accomplished side by side, and share common available resources. Such a setting may be an outcome of an explicit strategy or an unintended result, where many different projects with independent existence and separate goals run simultaneously. Fricke and Shenhar (2000, p. 239) defined a multi-project organizational setting in a similar way, but added to their definition that projects may vary in size, importance, required skills, and urgency. Many other researchers (Van Der Merwe, 1997**;** Hendriks et al. 1999; Engwall, 2001:6) have also defined the multi-project context in a similar way. "Multi-project" is used to define organizational environments where many different projects are performed at the same time. The terms "multi-project" and "multi-project organization" are usually used synonymously with "multi-project environment."

In this study the multi-project business context is defined as a mix of the above-mentioned concepts, where an organization executes a substantial share of its operations as projects, projects are based on explicit strategy, which are accomplished side-by-side and share the same resources from a common pool, and which vary in size, importance, required skills, and urgency.

2.2 Management of multiple projects

It is typical for several projects to be ongoing simultaneously in an organization (Schwindt and Zimmermann 2015, p. 971). In today's business environment, an increasing number of companies are moving from a single-project organizational structure towards a structure where multiple projects are performed simultaneously. These multi-project organizations work within a wide variety of fields and applications, such as R&D, construction or production, public infrastructure, process reengineering, maintenance operations, and complex machinery. (Hans et al. 2005, pp. 563–564)

In this multi-project environment, the effective management of single projects is no longer sufficient. Managerial focus has shifted towards the simultaneous management of a whole collection of projects as one large entity, and the effective linking of these projects into an ultimate business strategy. (Morris and Pinto 2004, p. 144) While the management of single projects might be difficult, the situation becomes even more complicated when multiple projects are ongoing within an organization. Projects should be viewed as an integrated portfolio rather than a disjointed collection. In managing multiple projects, organization is required to maintain control over a varied range of specialist projects, to balance conflicting requirements with limited recourses, and to coordinate the portfolio to ensure that the optimum strategy-based organizational outcome is achieved. (Dooley et al., 2005, p. 468) In academic articles and literature, the combination of several projects has been explored through portfolio and program management (Artto et al. 2011; Blismas et al. 2004; Project Management Institute 2013; Morris and Pinto 2004). In order to understand these management concepts, one must first understand the relationship between portfolio(s), programs, and projects.

The relationship between portfolio(s), programs, and projects is demonstrated below in the simplified Figure 1. Before the detailed clarification of this relationship structure, it is important to note that an organization may have several project portfolios in use. For example, according to Lehtonen et al. (2006, p. 19–21) project portfolios may be formed in such a way whereby projects are divided into internal and external projects. Internal projects refer to an organization's own development projects (project business as solutions development), whereas external projects refer to delivery projects for different customers (project business as solutions delivery). Generally, a portfolio refers to a collection of projects and programs operating as a group to achieve a company's strategic objectives. Different programs may be grouped within a portfolio, and may consist of projects or other tasks that are managed in coordinated way to support the portfolio and its strategic objectives. Individual projects that are either within or outside the program are also considered to be a part of the portfolio. Projects or programs within the portfolio may not necessarily be interdependent or directly related, but they are linked to the organization's strategic plan by means of its portfolio. (Project Management Institute 2013, p. 4)

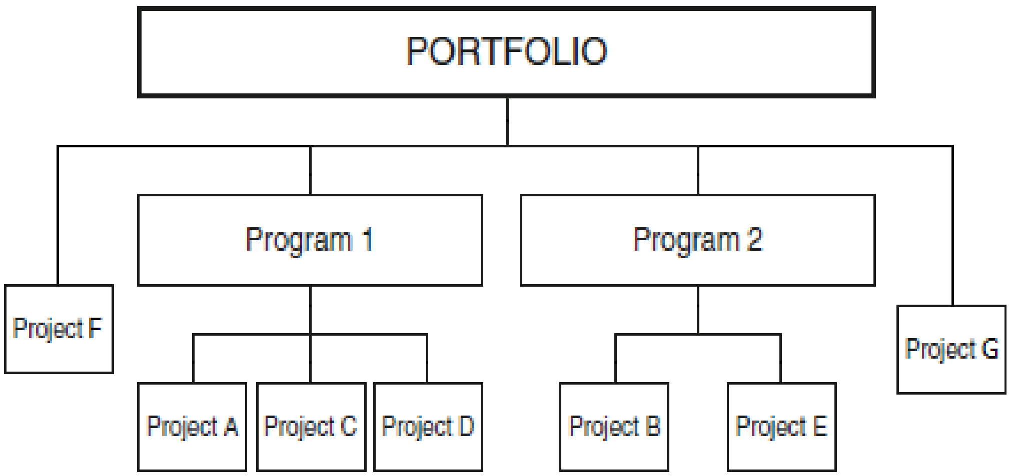

Figure 1. The relationship between portfolio, programs and projects. (modified from Marco, 2011, p. 7)

Portfolio and program management are two very closely related concepts that emerge from academic articles and literature relating to the multi-project environment. (Artto et al. 2011; Turner and Müller 2003; Blismas et al. 2004; Project Management Institute 2013) Program and portfolio management share many features, and often the two concepts are confused with one another. However, they have a different meaning and it is important to describe how they can be differentiated. (Morris and Pinto 2004, p. 261)

Portfolio and program management are both aligned with organizational strategies, but differ in how they contribute to the achievement of strategic goals (Project Management Institute 2013, p. 7). Common to both these concepts is the management of projects as an entity to achieve the organization's strategic targets. However, the management of portfolios is seen more as the implementation of business strategy, whereas programs aim to achieve their own strategic goals without taking responsibility for the entirety of the company or business unit projects. (Artto et al. 2011, p. 304) Moreover, portfolio management aligns with organizational strategy by selecting the right programs and projects, prioritizing the work and required resources between them, and thereby reducing uncertainties. Program management instead harmonizes its projects and controls their independencies in a coordinated way, in order to reach strategic goals and realize special benefits that would not be possible to achieve if projects were managed independently. (Project Management Institute 2013, p. 7; Turner and Müller 2003, p. 7; Blismas et al. 2004, p. 115) In addition, the project portfolio is seen as a permanent group of projects that change with the development of the company's operations. The program, in turn, is often set up in order to achieve a specific goal, which is why it can be considered as a temporary organization. (Artto et al. 2011, p. 303; Turner and Müller 2003, p. 7)

2.3 Characteristics of multi-project business

Project industries differ substantially from the stable and continuous supply chains within “goods and service” sectors (Aloini et al. 2015, p. 1302). From the vast amount of literature available on project management and project marketing, it is possible to distinguish some special characteristics for projects. The main characteristics of the project business are usually described by the DUC model, which more precisely refers to the three elements of discontinuity, uniqueness, and complexity. (Cova and Salle, 2005, p. 355) Usually each project produces unique solutions, and typically between one project and the next there is discontinuity in customer relationships, technical solutions, and production processes (Artto et al. 2011, p. 11). In turn, complexity is created by demands of expertise from the customer and seller, as well as the variety and number of actors involved in a delivery project. In addition to these three characteristics that are named most often, additional features complicating the project business include extensive financial commitment, management of the processual project delivery, adaptation of the internal structure to the external environment, and project portfolio management. (Alajoutsijärvi et al. 2007, p. 2) Because of these special characteristics, the business logic of delivery solutions differs from the logic of repetitive mass -or series production, which can be described by continuous, repetitive, and seamless flows of materials, information, and money (Artto et al. 2011, p. 11).

Despite these special characteristics of projects, projects and routine business operations are both types of process, which also share a number of similar characteristics such as goals, time focus, resources, inputs, and outputs (Smyrk and Zwikael 2011, p. 1). Variety, size, and type may differ, but for example in both cases, whether on a construction site or for the manufacturing process, the required materials must be available on demand, in the correct quantity, and with the required quality. Management of the required materials is a part of both business types, not only from the cost point of view, but particularly because their unavailability on time, or in quantity or quality, can cause delays to the project schedule or the manufacturing process, as well as increased costs with a loss of productivity. (Munier, 2013, p. 151)

Blismas et al. (2004, p. 118) studied the multi-project environment in the construction industry and the factors that influence project implementation. The most important finding of their research was that, unlike single projects, the multi-project process was ongoing and repetitive. Within the programs of the case study client's portfolios, streams of projects were continually designed and delivered within the organization. The authors also noted that workflow and continuity concepts, which are inherent in manufacturing theory, also have significant scope for applicability within the construction multi-project environment. However, issues such as uniqueness, variations in delivery scope, poor project definition, and the general uncertainty surrounding an organization's portfolios do not allow the direct adoption of mass production principles such as those used in the car industry. As in manufacturing operations, the multiple projects relied all on suppliers and resources arriving and contributing to the process at the correct times and required rates. Any disruption to this continuity had major disruptions to all subsequent operations further on in the process.

The views of Xu et al. (2012, pp. 225–226) support the above-mentioned conclusion about the repetitive nature of multi-project processes. Xu et al. (2012) stated that while some of the projects are unique, many are routine and recurrent, and share similar schedules and material supplies. These so-called recurrent projects are widely seen in many industries, for example in engineering–procurement–construction (EPC) industries and build-to-order (BTO) manufacturing, where standard components are combined in different ways to build complex and customized products such as houses, ships, or aircrafts to customers. As companies standardize their processes and components to streamline their operations, these recurrent projects are becoming increasingly popular in practice. Projects are often managed on a one-for-one basis, while supply chains are managed continuously to meet demand from multiple projects. However, this type of one-for-one approach fails to take advantage of the similarities across recurrent projects. One way to improve the efficiency of multiple project execution is to explore the similarities among projects, and to plan them on a continual basis rather than separately for each project. (Xu et al. 2012, pp. 226–227)

2.4 Processes as a part of a multi-project business

The core belief in process thinking is that a specific chain of activities is established to produce the maximum value for the customer. This value needs to be managed, and the process produces the operative result of an organization. Project business, and for example delivery projects, is one form of business where value is created by the effective execution of projects, in other words through efficient processes. A project is a one-time process realization and is typically carried out as processes in the case of large-scale entities, such as ships, aircraft, heavy machinery, computer systems, or buildings. (Laamanen and Tinnilä, 2009, p. 52, 65) Generally, a project passes through many intra- and inter-connected stages during its life cycle. Phases such as inquiry, offer, contract, projection, and manufacturing are usually followed by operations and maintenance actions. Hundreds, or even thousands, of activities are involved in project business, and many suppliers and sub-suppliers are linked to meet the requirements of a particular customer. The processes of an organization that operate in project business can typically be categorized into more specific process levels, such as management, concept development, sales, engineering, supply management, manufacturing, logistics, operation, and maintenance. (Sandhu and Gunasekaran, 2004, pp. 674–676)

Because projects are typically unique, it is a temporary form of an organization. Projects have a clearly defined, time-bound objective, which is carried out with the provided resources. However, as noted above, the multi-project environment can include different types of projects which are running in various stages of their life cycle. Even if the projects vary in terms of delivered or developed solutions, they also share many common traits. (Laamanen and Tinnilä, 2009, pp. 65–66) In terms of the effective operation of organizations, it is essential to consider how several projects and their essential processes should be managed, controlled, and developed in order to achieve organizational strategic targets. One strategic issue in the multi-project environment is integration between different projects (Macheridis and Nilsson 2011, p. 6). According to Boznak (1988), project integration in the multi-project environment can become the key to a company's productivity.

Processes are linked to a company’s organizational structure through its objectives and used resources; they may require resources from all functions or business units of the organization. The role of processes in an organizational structure can vary from essential to subsidiary, because a company can manage its operations using management principles that are not process based. Some organizations may function purely in a process-based way, but usually processes are linked to an organization’s structure by their objectives, as well as the resources they have access to use. Such a structure is typically referred to as a matrix organization. (Martinsuo and Blomqvist 2010, pp. 6–7) In addition to process-based and matrix structures, the structure of an organization may also be functional or projectized (Project Management Institute 2013, p. 21).

2.4.1 Processes in organizations

According to Salminen (1994, p. 6), all activities within an organization can be described by different processes. They are the core of the business, because most of the work is done through them and the diversity of processes is a source of competitive advantage (Morris and Brandon, 1994, p. 56). Sometimes the assumption is made that the concepts of process and process management only apply to highly structured transactional work, but these concepts also adhere to, for example, developmental processes, which center on highly creative tasks (Hammer, 2011, p. 11). Processes and business process are commonly found in academic articles; but what is the difference between these two concepts, if any? According to Martinsuo and Blomqvist (2010, p. 4), in entrepreneurship business processes and processes may be considered as different concepts; business processes refer to processes that create profit, whereas processes may be any type of process in an organization. In contrast, Laamanen (2001, p. 19) uses the term business process as a synonym for process. In this master’s thesis, “process” is a synonym for business processes.

Davenport (1993, p. 5) describes a process as a structured and measured set of tasks, which has been designed to produce a desired output for a certain market or customer. A process implies a strong emphasis on how work is done within an organization. It includes either one or a series of dependent activities, the aim of which is to transform one or several inputs into one or several outputs that meet the requirements of an external or internal customer. (Champy and Hammer 1994, p. 34; Roberts 1996, p. 18; Hannus 1994, p. 41) “External customers” refers to third parties, for example to customers or suppliers, whereas “internal customers” are a company’s internal activities, for example a performer of the next process step (Laamanen and Tinnilä 2009, pp. 99-100). According to Hammer (2011, p. 11), using a process means positioning individual work activities (whether routine or creative) in the larger context of the other activities with which they combine to create results; in other words, all work is a process.

Laamanen (2005, p. 154; 2001, p. 20) defines business process in a similar way, and Figure 2 illustrates his view. According to his definition, business process is a repetitive set of functions and recourses, which are used to transform inputs into outputs in order to gain appointed business targets. Input is the material or information needed to implement the process. It can also be an event that triggers the process, for example, a request for a quotation received by a company or supplier. Output is the material or information produced from a process. Feedback represents a customer’s or stakeholder’s response to the process activities, and allows analysis of how the process has been implemented from a customer’s perspective. (Laamanen and Tinnilä, 2009, p. 104-116) From the process management perspective, it is essential to set business-derived targets for processes, and to understand, monitor, and use the feedback in development actions. Process feedback is not only the results obtained from output actions; it is just as important to obtain feedback from other process functions and examine how they reach the appointed targets. (Martinsuo and Blomqvist 2010, p. 5)

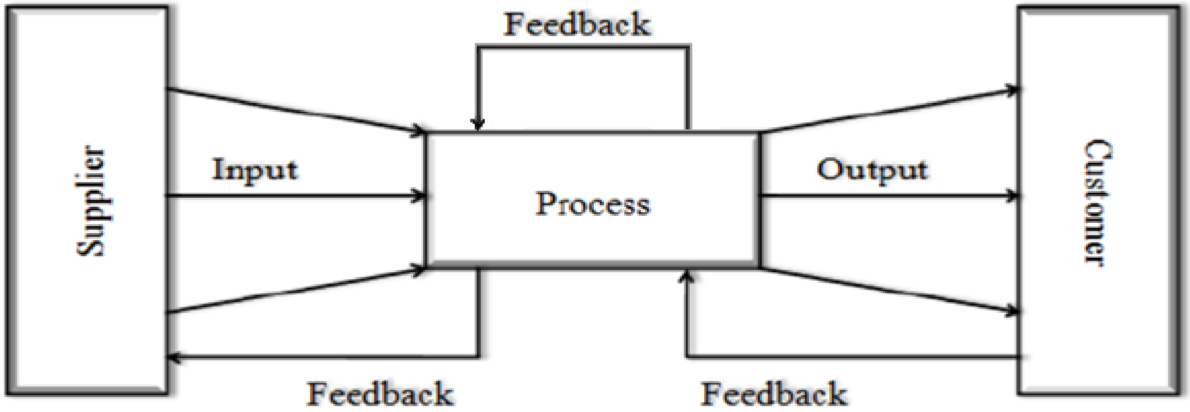

Figure 2. Business process. (modified from Laamanen 2005, p. 154)

Processes can be categorized in several ways. For example, Hammer (2011, p.11) categorized them into core processes, support processes, and govern-processes. In this master's thesis processes are studied as core and sub processes, as these are considered a more direct classification of the above-mentioned support and govern-processes. The core process often comprises more than one function within the organizational structure, and its activities have a significant impact upon how the organization operates. When the core process is too complicated to be described at the activity level, it is usually separated into sub processes. (Harrington et al. 1997, p. 2) The main purpose of the core process is to satisfy customer needs. It creates value to the external customer and cuts through organizational boundaries, for example in terms of the order-delivery process (Kiiskinen et al. 2002, p. 28). A sub process is a part of the core process that performs a specific objective in order to support the core process. Furthermore, the sub process can be divided into different activities and tasks. Activities are functions within a process or sub process, and are usually executed by one unit or a single person. Activities include specific tasks that usually follow an instruction, which is intended to advise exactly how work should be performed. (Harrington et al. 1997, p. 2) Figure 3 illustrates the above-mentioned relations between the core process, sub processes, activities, and tasks.

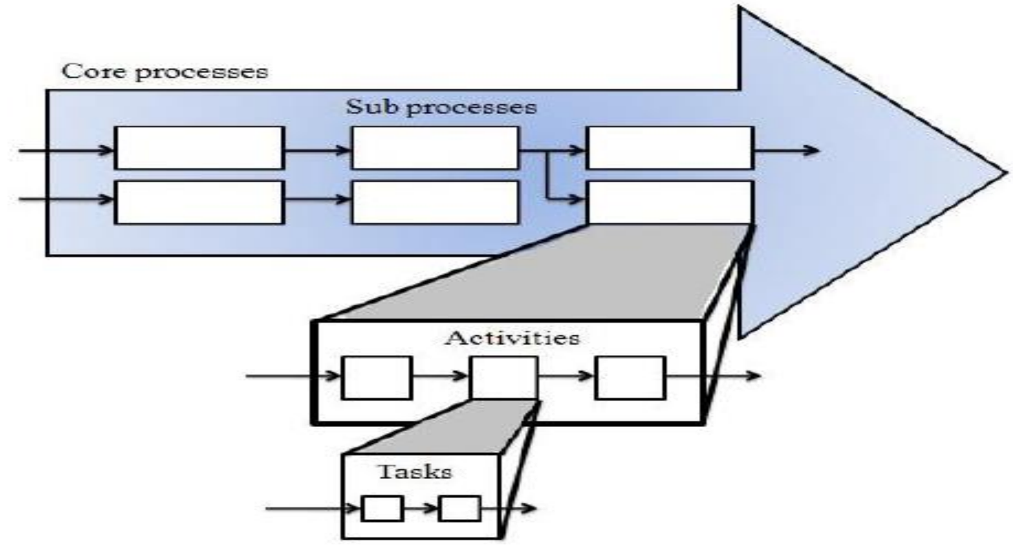

Figure 3. Process hierarchy. (Harrington et al. 1997, p.2)

2.4.2 Business process development

Process development focuses on improving how work is done (Utterback 1975, p. 642). Pisano (1996, pp. 29–30) defines process development as an organization's ability to produce a product or series of products, which involves the physical artifacts of production techniques, operational procedures, and routines employed to produce products. According to Davenport (1993, p. 12), a process approach to business is usually marked by a strong emphasis on creating better working procedures. For an organization to be successful, it must provide a product or series of products with high standards and use the potential of processes to generate and deliver them. According to Laamanen (2001, pp. 204-205) the purpose of process development is to improve the quality and performance of activities by resolving and correcting problems that have been identified in operation.

Enhancing the performance of organizations through processes can occur by transformation to a process-oriented organization structure, implementation of a new single process or processes, radical reengineering of existing processes, or implementing improvements of varying scale into current processes. (Champy and Hammer 1993, p. 25; Martinsuo and Blomqvist 2010, p. 8) Most process development actions can be divided into two categories: process improvement and process innovation actions. Process improvement refers to minor and specific changes (also known as continuous process improvement) to existing processes by simplifying and streamlining them. Process innovation refers to process redesign and reengineering, which is characterized as being radical, where current policies, practices, and procedures are examined critically, re-thought, and then revolutionarily redesigned in order to achieve better performance. (Buzacott 1996, p. 768; Melão and Pidd 2000, p. 109; Trkman et al. 2007, p. 118; Lee and Chuah 2001, 688)

Different process improvement techniques and models have been developed in recent decades, but it a critical view is recommended before applying existing models as they are. Most of these models have been developed for a specific purpose and environment, and are therefore not universally applicable, nor will they fit every organization's needs. According to Martinsuo and Blomqvist (2010, p. 8), all development practices vary in their implementation stage, but the basic stages of process development can be identified as shown in Figure 4.

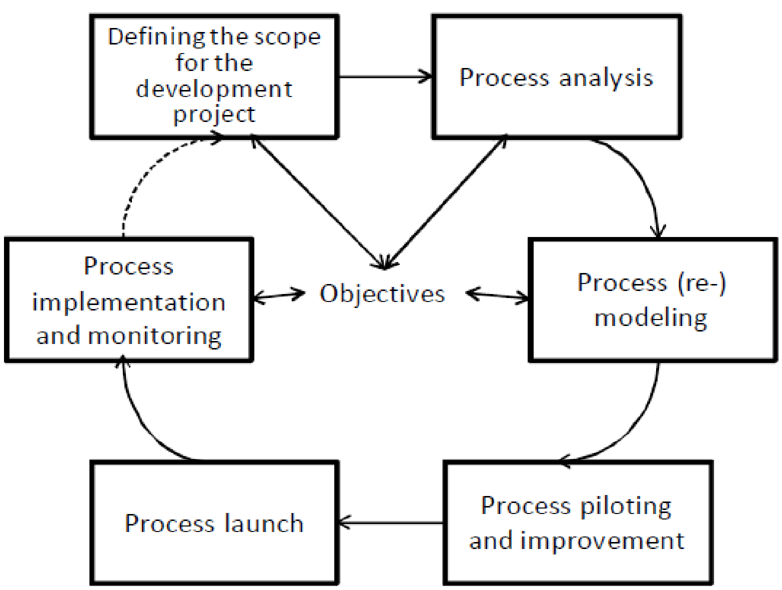

Figure 4. Basic stages of process development. (Martinsuo and Blomqvist 2010, p. 8)

The trigger for process thinking and process development in organizations can result from different circumstances. Development actions can be divided to into reactive, proactive, or innovative, depending on the initiation of development activity. Reactive development actions usually begin when an organization detects some change that initiates development requirements. An example of a reactive development could be a poor result from a customer satisfaction measurement, which is typically detected by a difference from the appointed targets. Proactive development is characterized by a prediction of the future and the conclusions drawn from it. Development activities are then performed before customer satisfaction or the organization's performance are influenced. Meanwhile, innovative development attempts to seek completely new and radical solutions, which are often the result of decisions made at the management level. (Laamanen, 2001 pp. 205–206)

Before beginning process development actions, it is important to specify the scope of the development project and choose the process or processes that will be affected. A company's objectives have an essential role in defining the scope of the development project, and the available data related to current processes can also assist in this. When the scope has been defined, it is necessary to obtain as much reliable data regarding the existing processes as possible. If completely new processes are involved in the development project, this data is concerned with how value-adding activities of the process have been performed previously, or how some other organizations have implemented this process. It is useful to collect both general measurement data (if available) about the process, and data that illustrate the functionality of the process. Various data collection methods such as interviews, group work, data mining from past performance, observation of the process, or process simulation can be used to analyze the process. The current state of the process should be compared to the appointed performance objectives: does the current process achieve desirable results, and what types of shortcoming can be observed? (Martinsuo and Blomqvist 2010, pp. 8-9)

After conducting an analysis of the process, the next stage is to identify areas for process development and to model the target process. Occasionally the entire process (or the whole process architecture) is redefined based on customer expectations and needs. However, more commonly this redefinition deals only with a limited part of the process, such as sub processes, interfaces between processes, or process organizing or resourcing. When describing the existing state of a process (AS-IS), it is effective to proceed from start to end, tracking value-adding activities as well as information and material flows as they occur. Conversely, target process (TO-BE) description is often best accomplished from end to start, and in such a way that the process reaches its appointed objectives. (Martinsuo and Blomqvist 2010, pp. 9; 13)

Before the actual process launch the process should be piloted (tested), either in a simulated or actual work environment. Piloting enables a process to be observed and supported, while making final corrections and adjustments to the process model. Piloting is advisable before the extended implementation of the process, since the process can have a significant impact throughout the organization, and it will be expensive to implement a faulty or defective model. The piloting stage provides useful data about the revised process, such as whether it is worthwhile, and whether it solves the problems detected in earlier operating activities. (Martinsuo and Blomqvist 2010, p. 9)

In the extended implementation of the process, old practices, guidelines, and routines are replaced according to the new process practices. All parties who participate in the process are trained and instructed how to implement the new process and adopt their new roles. Monitoring and control systems are assimilated to serve the new process, and connections and interfaces to other systems and processes are restructured. It is important that the organization's operations model and management system support the implementation of the process, and that communication about the process is consistent. Process implementation and monitoring entails the execution of the entire customer-to-customer chain to fulfill organizational strategic objectives, and the systematic gathering of feedback from the process for continuous improvement actions. The process should be managed and steered constantly, which is to say that someone should be responsible for the resources, implementation conditions, and performance of the process. (Martinsuo and Blomqvist 2010, p. 9-10)

Process piloting and improvement, process launching, and process implementation and monitoring steps are not covered in more detail in this master's thesis. The scope of this study is on the analytical and modeling level, where alternative operation modes are examined for the case company. The three steps mentioned above are part of the further actions that should be taken into account in more detail by the case company if they implement the generated development proposal.

2.4.3 Process modeling

Process modeling is often considered to be the most important part of process development and process management (Laamanen 2001, p. 78). A process model, which is the result of modeling, can provide comprehensive understanding about processes and enable their analysis (Aguilar-Savén 2002, p.129). According to Davenport (1993, p. 148), the purpose of process modeling is to aid the understanding of activities and tasks related to the business function and how data flows between work units. Laamanen considers that a process model points out the critical and all other definitions that are important for the comprehension of the process. The model usually includes other critical dimensions, such as recourses used in the process, output, tools and methods, personnel, an environmental description, and boundaries and interfaces with other processes. (Laamanen and Tinnilä 2009, p. 123) According to Ungan (2006, p. 400), good management of processes is very much dependent on how well they are understood. In turn, understanding a process requires that it be documented, in other words, modeled.

The purposes of process modeling can be classified in various ways and within different categories. One way to classify its objectives may be as follows:

- **Communication**. Increasing understanding and facilitating communication of business processes may be the main objective of process modeling (Luo and Tung 1999, p. 314; Luukkonen et al. 2012, p. 21; Trkman et al. 2007, p. 120). Designers should describe the existing and improved processes, agree on a common representation, and share their knowledge about business processes with other employees. Simplicity and clarity are perhaps the most desired features of a modeling method for the purpose of communication. (Luo and Tung 1999, p. 314)
- **Analysis.** Analyzing and improving existing processes may be another primary use of business process modeling, as it provides a clear picture of the current business state (Luo and Tung 1999, p. 314; Luukkonen et al. 2012, p. 21; Trkman et al. 2007, p. 120).

To efficiently identify the best process, process designers should establish alternative representations, simulate process behaviors, and measure process performance (Luo and Tung 1999, p. 314).

- **Control**. The managing and monitoring of business processes can also be a purpose of using process modeling (Luo and Tung 1999, p. 314; Luukkonen et al. 2012, p. 21). Given the many interrelated processes within a firm, process designers need to oversee process operations, manage process relationships, and review process performance (Luo and Tung 1999, p. 314).
- **Harmonization of the operations.** Harmonizing operations at a national or organizational level is related to changes in an organization's business structure or operation. This could also refer to the implementation of a new supporting information technology (IT) system that should be fitted to the organization's operational models. **(**Luukkonen et al. 2012, p. 21; Trkman et al. 2007, p. 120)
- **Automation.** Striving to standardize and automate repetitive manual stages with the use of IT **(**Luukkonen et al. 2012, p. 21).
- **Identification of outsourcing opportunities.** By using business process modeling, the core parts of a business system can be identified and less important parts can be outsourced to external suppliers (Trkman et al. 2007, p. 120).

Modeling is not an end in itself; the need for modeling usually originates from planned development actions, an identified problem in the current operation, or a need for current state analysis. The model should provide a "sufficient understanding" to enable further development actions to be made. Therefore, decisions about the modeling scope and accuracy level must be made, for example by asking questions such as: "Is it important to highlight the most significant factors in strategic planning which affect the operation?", "Is the purpose to create an overview about the organization's activities as a basis for optimization of the system?", "Is the modeling intended to develop performance by improving the existing processes in a better and more efficient direction, or by reengineering completely new processes?" or "Should a process be modeled so accurately that it can be precisely coordinated or even automated?" **(**Luukkonen et al. 2012, p. 21)

Steps in process modeling

Laamanen and Tinnilä (2009, p. 124) have suggested starting process modeling with a general description for the modeled process based on essential background questions about the process. The framework created by Laamanen can be seen as a supportive function for the graphical process modeling phase, where process-related information collected from different sources is gathered together in the form of a concrete process model. Some example questions that might be included in the general description phase are as follows:

- Deployment
    - Where is the process deployed?
    - How does the process start and end?
    - How is the process planned and how is its efficiency assessed?
- Customers, their needs and requirements
    - Who are the customers and key stakeholders?
    - How do customers use the process output and what are their requirements?
- Mission
    - What is the mission of the process and how is its fulfillment measured?
    - What are the critical activities and how is their performance measured?
- Input and output
    - What is the process input and output?
    - How should the information be managed?
- Process chart
    - What are the rough steps in the process?
    - What kind is the process chart?
- Responsibilities
    - What are the most important roles and teams?
    - What are the most important activities and critical decisions related to the roles and teams?
    - What are the process polices or guidelines? (Laamanen and Tinnilä 2009, p. 124)

The identification of processes should start from the company's actual operating environment, as well as from the broader value or network chains where it operates. In order to start forming the process architecture and identifying essential processes, it is necessary to determine who are the key customers from the business point of view and what kind of value chain the customers, company, and suppliers form together. Alternatively, it is possible to refer a value network if the business actively networks with competitors, legislators, and other partners in addition to its customers and suppliers. Figure 5 illustrates a typical value chain. (Martinsuo and Blomqvist 2010, p. 11)

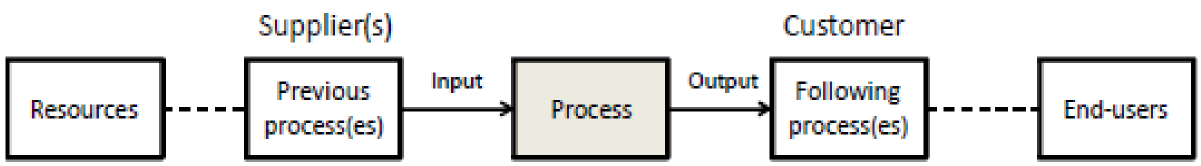

Figure 5. Example of a value chain. (Martinsuo and Blomqvist 2010, p. 11)

When the entire value chain or network has been identified, it is possible to define the processes that are critical for the company and which bring the most value for customers (Martinsuo and Blomqvist 2010, p. 11). These critical processes, which are referred to as core processes, are usually described at a rough level using the process map method. The basis of a process map is to illustrate the company's core functions, customers, subcontractors, and other interest groups. (Hannus 1994, pp. 43-44) A process map is usually an aggregate-level presentation of the business model and revenue technique of a specific organization or company (Laamanen and Tinnilä 2009, p. 126). It usually presents several different core functions and is too complicated to be described at a detailed level here. Figure 6 shows an example of a company's process map.

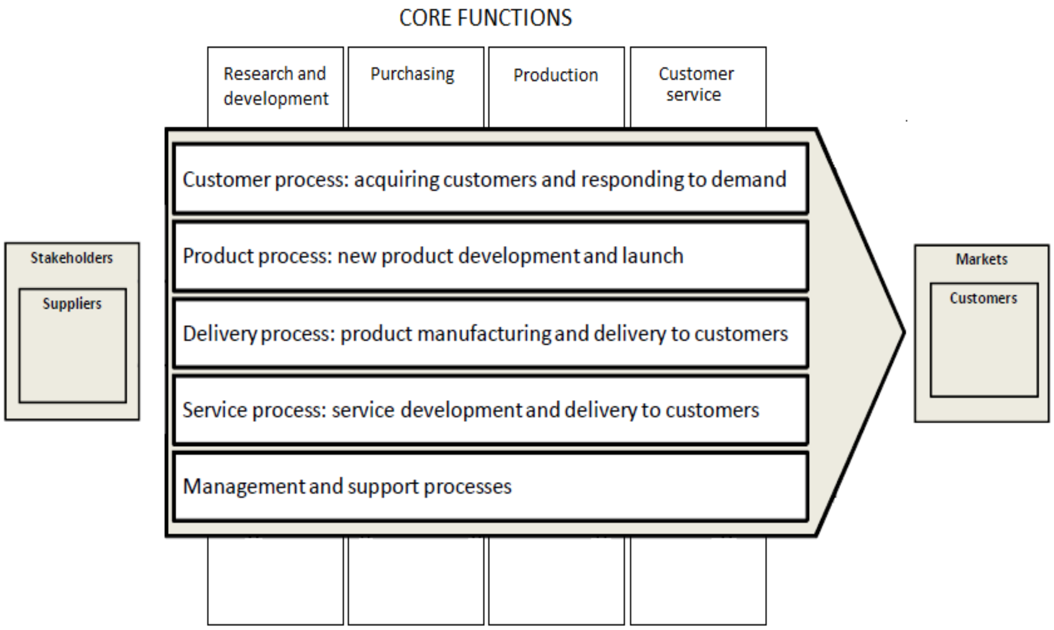

Figure 6. Example of a process map, showing a company's core processes and their value-adding purposes. (modified from Hannus 1994, p. 44; Martinsuo and Blomqvist 2010, p. 12)

In terms of efficiency, the core processes in particular need to be examined on a more detailed level, where the required resources are allocated to each task. In such cases, highly detailed descriptions and practical instructions might also be needed to ensure proper implementation of a process. In a detailed description, the following elements are differentiated: the tasks being controlled and monitored, interdependences between tasks, and roles and responsibilities in performing the activities. Sometimes it is also useful to describe the tools and information that are required in tasks. However, when making a detailed process description it is worth making a clear distinction between two types of situation:

- If the process is planned to always be carried out in the same way, a detailed description is necessary so that all people involved in executing the process have consistent information.
- If the process involves uncertainties and it is not necessary to implement it in precisely the same way each time, the description does not need to be particularly detailed; in this

case a phase-specific task list may be sufficient. (Martinsuo and Blomqvist 2010, p. 13-14)

There are several different modeling methods for making detailed process descriptions, and no single method has achieved the status of standard practice (Martinsuo and Blomqvist 2010, p. 14). According to Aguilar-Savén (2002, pp. 144-145) the following methods may be used for process modeling: the flowchart technique, data flow diagrams, role activity diagrams (RAD), role interaction diagrams (RID), a Gantt chart, the integrated definition for function modeling (IDEF), colored Petri-nets (CPN), object oriented methods, and the workflow technique. So which method would be the best among these options? Before choosing any method for modeling, it is important to identify the purpose of the models. Different techniques are suitable for different solutions; for example, one model may be designed to describe a process, while another model is intended to build a control process system. (Aguilar-Savén 2002, p. 131)

The most common and traditional ways of describing processes are process flowchart techniques (Hannus 1994, p. 46). A flowchart is a formalized graphic representation, which uses different symbols for the definition, analysis, or solution of a problem for a program logic sequence, work, manufacturing process, organization chart, or some other equivalent formalized structure. The flowchart principle enables visualizing a process from a different perspective level simply, quickly, and flexibly. It also helps in recognizing the logicality of a process's flow and identifying possible bottlenecks or inefficiencies where the process can be streamlined or improved. However, a basic flowchart does not provide any detailed information about the responsibilities or performers of the process, and in that regard, it can be seen as a one-dimensional description of a process. (Aguilar-Savén, 2004, p. 134;144) By expanding the limitations of a conventional flowchart with an extra dimension (swim lanes), the cross-functional flowchart allows the reader to not only examine the processes, but also the attributes related to specific processes, along with the categories they belong to. Usually the category is a specific stakeholder, but it can also be a machine, a project phase, a resource, or some other relevant attribute.

Guidelines for modeling

Although flowcharts are widely used for process modeling, according to Laamanen (2001, p. 77) they should not strictly be used for describing a process. The process can be described by any other proven technology that can be understand by anyone. The actions should be modeled in such a way that the process could be read as a story or watched like a film. (Laamanen 2001, p. 92) Another challenge related to process modeling is the decision of the accuracy of description. There is no unambiguous rule for the accuracy of a process chart, but some guidelines for process modeling have been presented in the literature.

According to Laamanen (2001, p. 79-81), the process should be described accurately so that the functional logic is clear. An overly detailed model makes the process chart unclear and complicates the understanding of the process. For this reason, the critical functions and decisions related to the process should be possible to identify in order to promote their accomplishment. For example, a variety of different symbols in the process chart are not essential, because they make the process chart unclear and therefore do not assist in the understanding of the process. The most important thing is to draw up a clear chart so that the reader can understand the process as quickly as possible.

Laamanen (2001, p. 76) suggests the following elements for a good process description:

- Includes critical issues of the process;
- shows the dependencies between issues;
- helps to understand both the entity's and one's own role in achieving the objectives;
- promotes cooperation between people who are working in the process; and
- allows acting flexibly according to the situation.

3. THE ROLE OF PURCHASING IN A MULTI-PROJECT ENVIRONMENT

Effective purchasing is critical for project management. For many organizations, materials and components purchased from external suppliers represent a substantial portion of the cost of the end product. Effective purchasing can significantly enhance the competitive advantage of an organization operating in project business. Depending upon the specific type of project, over 50% of the total cost can be attributed to purchased parts, supplies, and services, and for many high-technology projects, this purchasing fraction can approach 90%. (Morris and Pinto 2004, p. 632; 643)

3.1 Development of the purchasing function

Many terms and concepts are used in the literature on purchasing. However, no agreement exists about the definition of these terms. Terms such as procurement, purchasing, buying, and supply management are used interchangeably. (van Weele 2002, p. 14) According to van Weele (2002, p. 14), purchasing can be defined as: *"Obtaining from external sources all goods, services, capabilities and knowledge which are necessary for running, maintaining and managing the company's primary and support activities at the most favorable conditions."* Purchasing may concern a large variety of different items. In general, purchased materials and services can be categorized into raw materials, supplementary materials, semi-manufactured products, components, services, finished products, investment goods, and maintenance, repair and operating (MRO) materials. (van Weele 2002, pp. 22-23)

The importance of purchasing to an organization cannot be exaggerated. Purchasing has previously been described in a narrow and operational way, where good "purchasing practices" are considered as buying the correct equipment, materials, and services for the organization in the right quality and quantity, at the right time. (Aljian 1984, p. 3; Cousins et al. 2008, p. 7; Axelsson and Wynsta, 2002, p. 17) According to this approach, price, delivery, and quantity are seen as the key drivers for successful purchasing. This approach seems to be in accordance with common sense and follows from most traditional operations management texts, but the area of management has been taken into little consideration. (Cousins et al. 2008, p. 7)

In recent decades, the growing importance of supply chain management has led to increasing recognition of purchasing. As a result, the role of purchasing has evolved and expanded as a continuous process, from buying via procurement to supply management. (Axelsson and Wynsta, 2002, p. 15, 17; Paulraj et al. 2006 p. 107) The importance of purchasing to organizational competitiveness is being increasingly noted, and it has evolved from an operative buying function into a strategic function (Carr and Smeltzer, 1997, p. 199; Paulraj et al. 2006, p. 107). Moreover, purchasing plays a key role between external suppliers and internal organizational customers in creating and delivering value to external customers (Chen et al. 2004, p. 505).

The development of purchasing and its various tasks can be viewed as presented in Figure 7 (Burt and Dobler 1996, p. 37).

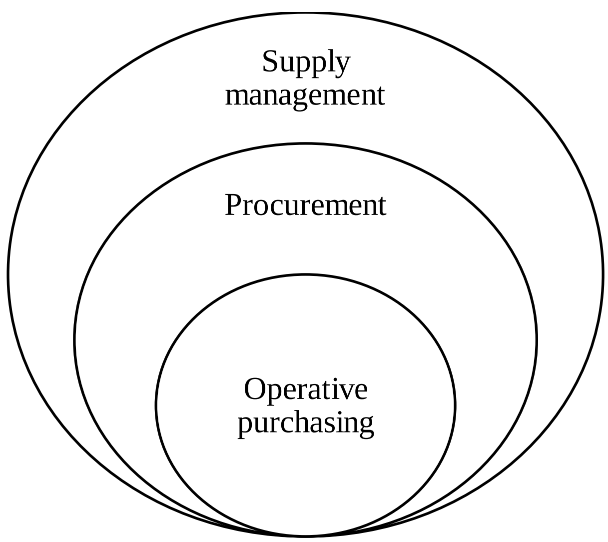

Figure 7. The development of purchasing and its variety of tasks. (Burt and Dobler 1996, p. 37)

According to Burt and Dobler (1996, p. 37) the main tasks of purchasing can be described more specifically, as follows:

- **Operative purchasing:** includes identifying requirements, establishing the market situation, negotiating with suppliers, tender comparison, selecting the most suitable supplier, placing the order with the selected supplier, and monitoring and controlling the order.

- **Procurement:** includes all operative purchasing activities, formulating material specifications, identifying the materials needed for purchase, value analysis, market surveys, and supplier quality management.
- **Supply management:** includes all operative purchasing and procurement activities, supplier assessment and development, designing different partnership and strategic alliance courses, delivery field observations, strategic material management planning, continuous improvement planning, and enterprise-level strategic planning.

3.2 The importance of purchasing for an organization

Because of the increasing competition in the business environment, companies are constantly seeking new competitive advantages and a sustainable competitive position. The focus on purchasing is based on the fact that it has huge potential to create value, and to increase the efficiency and profitability of organizations (Dubois, 2003, p. 365). This is as a result of the ongoing trend towards specialization, meaning that every organization specializes in an increasingly smaller range of value-added activities in its production processes. This focus on core activities has led to outsourcing activity, where an increased share of required materials and goods are outsourced from different suppliers. (Axelsson et al. 2005, p. 4; Dubois, 2003, p. 365; Eriksson, 2005, p. 52) Managing the cost of these purchased goods or services is essential for companies that spend a high percentage of their sales revenue on parts and material supplies, and whose material costs represent a larger portion of their total costs **(**Karpak et al. 2001, p. 209).

The importance of purchasing for an organization can be explained more accurately by return on net assets (RONA) calculations. Even small purchasing savings can lead to an improvement in RONA calculations, which can occur in two ways:

- Through the reduction of all direct material costs, which immediately leads to an improvement of the company’s sales margin, which in turn increases the RONA. A number of actions may lead to lower material costs, such as introducing new suppliers, competitive tendering, or seeking substitute materials.

- Through a reduction of the net capital employed by the company, which positively influences the company's capital turnover ratio. There are many actions that can lead to lower capital employed, for example longer payment terms, reduction of inventories, supplier quality improvement, and leasing agreements for required equipment. (van Weele 2002, pp. 18-20)

The above-described effects of purchasing savings on a company's RONA can be illustrated with a DuPont chart. Figure 8 presents an example how a 2% saving on purchased materials and services may lead to a 12.1% RONA improvement (van Weele 2002, p. 18-19).

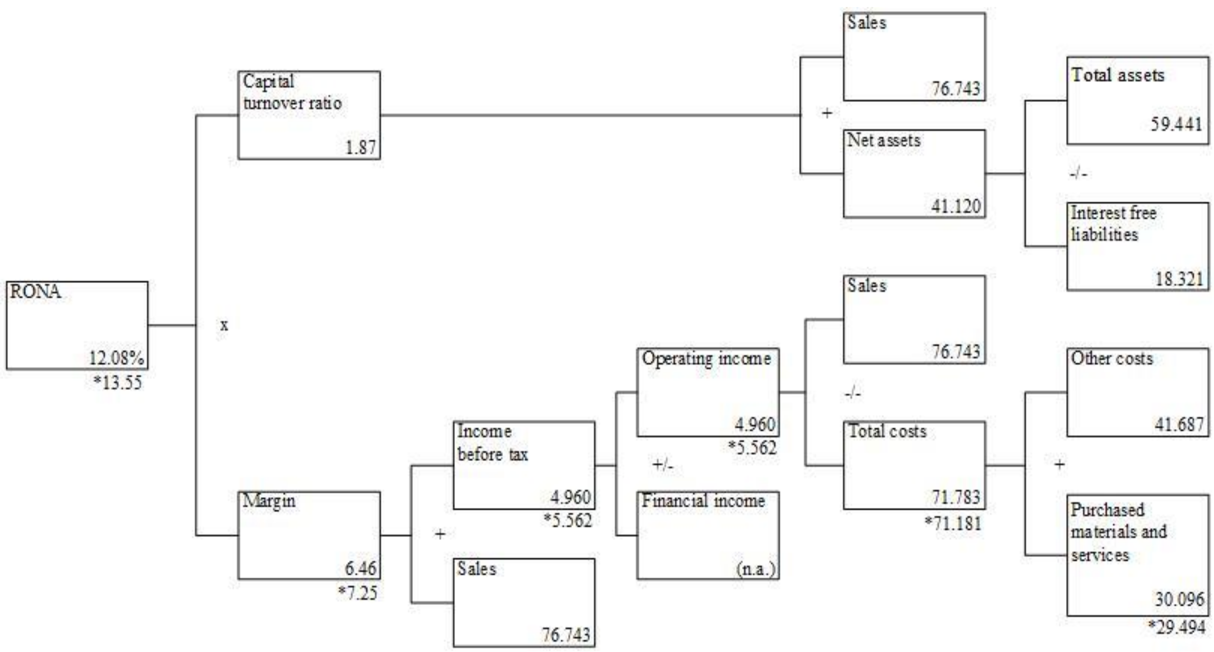

Figure 8. DuPont analysis. (van Weele 2002, p. 19)

In addition to these immediate savings on purchasing prices, the purchasing function can also contribute to the improvement of a company's competitive position indirectly, through innovations in purchased items and in the purchasing process itself. In practice, indirect contributions often turn out to be more substantial than direct savings in purchasing. An indirect contribution can take place, for example by product standardization, special stock arrangements with suppliers, product or process innovation, increasing flexibility, and fostering purchasing synergies. The numerous opportunities for improvement are not limited to this list. In summary, it is obvious that companies can benefit significantly from effective purchasing and supply strategies. (van Weele 2002, pp. 20-22)

3.3 The purchasing process

According to Baily et al. (2005, p .4) a purchasing process is a set of stages directed at achieving a required output. Various tasks or stages can be included in the purchasing process, and it can be depicted as a sequential chain of events leading to the acquisition of supplies, as illustrated by Figure 9. Purchasing, along with activities such as production, warehousing, and transportation, is one of the links in the supply chain, or the sequence of processes by which required supplies are converted into finished products and delivered to the final customers. (Baily et al. 2005, p. 4) Purchasing can be seen as one sub process of the order-delivery process, by supporting it to achieve the desired customer satisfaction. Purchasing as a sub process involves different activities and tasks, which are covered in more detail in this chapter.

Figure 9. The purchasing process chain. (Baily et al. 2005, p. 4)

Many different theoretical and practical descriptions of the purchasing process can be found. This is understandable, because between different organizations it can vary significantly with the nature of the order, existing contracts, or the business environment where an organization operates. A typical way to purchase materials, goods or services is a bid-and-order procedure, whereby purchasing regularly receives purchase requirements, based upon which it issues tenders for potential suppliers, who subsequently respond by submitting price quotations with terms of delivery. The purchasing function typically selects a supplier after comparing the tenders and negotiations, to obtain the best overall terms based on price, delivery, quality, and other factors. After receipt of the purchase order, the supplier manufactures and delivers the goods to the receiving department, and sends an invoice to the accounting department. Following the confirmation and acceptance of the delivered goods, the accounting department issues the payment to the supplier in line with the purchase order. It is important to note that purchase requisitions may also be call off purchasing orders against the specific contract between buyer and seller. In these cases, the purchasing process differs from the above-mentioned description with regards to the bid-and-order procedure. (Parikh and Joshi 2005, p. 1046; Ritvanen 2011, p. 39)

van Weele (2002, p. 14) developed the purchasing process model, which schematically illustrates the main activities within the purchasing function as shown in Figure 10. According to van Weele (2002, p.14) the purchasing function does not include responsibility for materials requirement planning, materials scheduling, inventory management, incoming inspections, or quality control. However, in order for an organization to have an effective purchasing function, it should be closely interlinked with these operations.

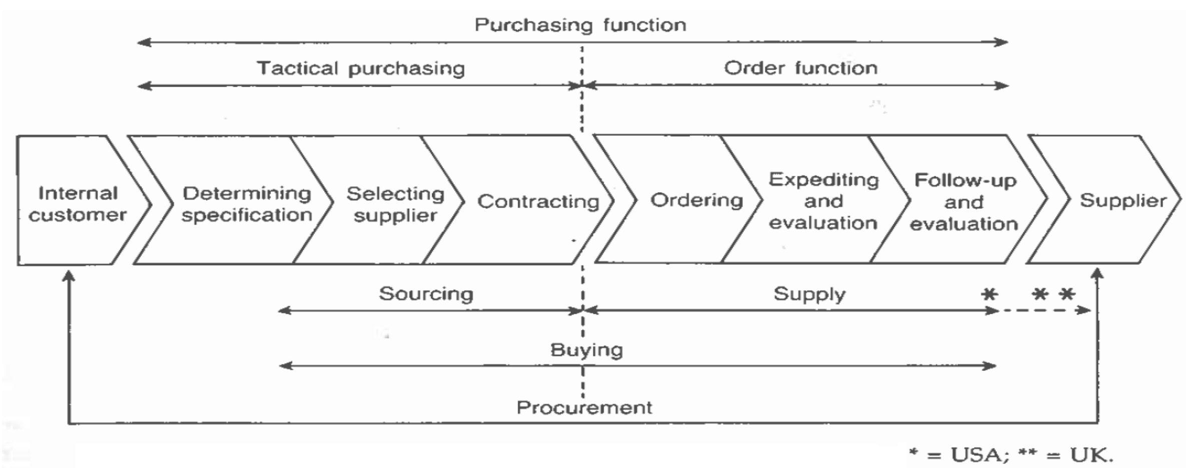

Figure 10. The purchasing process model. (van Weele 2002, p. 15)

This purchasing process covers the following activities:

- Determine the specification (in terms of required quality and quantity) of the goods and services that need to be bought.
- Select the most suitable supplier, for example through competitive bidding or negotiations.

- Prepare and conduct negotiations with the supplier or suppliers if needed in order to establish an agreement.
- Place a purchase order with the selected supplier.
- Monitor and control the order (expediting).
- Evaluate and follow up the suppliers (settle claims, keep product and supplier files up to date, evaluate supplier rating and ranking). (van Weele 2002, p. 14)

3.4 Purchasing strategies

As purchasing receives more attention from companies, the focus on purchasing strategies and their implementation into corporate and operating strategies is also increasing (Quayle 2006, 27; Zeng 2000, 219). In order to have an effective corporate strategy, the purchasing aspects must be taken into consideration. If a company does not have a strategy for obtaining the right materials and services in the right terms and from reliable suppliers who can add value to the company's business, the corporate strategy cannot be effective. (Quayle 2006, p. 27) A company's competitive advantage increasingly relies on its ability to create superior purchasing strategies within complex supplier networks (Svahn and Westerlund 2009, 173).

Organizations usually have a large number of products and variety of suppliers, in an effort to improve their performance and profitability. However, not all purchased materials and supplier relationships should be managed in the same way (Gelderman and van Weele 2005, p. 21; Hesping and Schiele 2016, p. 101). Accordingly, professional purchasing requires differentiation and some sort of classification between these resources. Purchasing portfolio models can assist companies in identifying purchasing strategies that fit specific product categories, especially those regarded as being more essential to business from the purchasing point of view. (Gelderman and van Weele, 2003, p. 207) Portfolio models within purchasing have grown in their usage, in academia as well as in practice, and portfolio analysis has become the dominant approach to what the profession regards as operational professionalism (Gelderman and van Weele, 2002, p. 31).

3.4.1 ABC Analysis

For quite some time ABC analysis, also called Pareto analysis, was the only tool available to differentiate between purchases (Gelderman and van Weele 2005, p. 21). In the traditional ABC analysis, materials are ranked in descending order based either on annual dollar usage, material unit price, or annual demand. The top materials, with the highest annual dollar usage, are placed in group A and usually receive the most management attention. Meanwhile, the materials with the least annual dollar usage are placed in group C and receive the least management attention. The remaining materials are placed in group B, where the management attention may vary. This classification is based on Pareto's observation about the uneven distribution of national wealth, whereby the majority of the population controls only a small portion of the wealth. (Chen et al. 2008, pp. 35-36) This is also known as the 80/20 rule, and for example, from the purchasing point of view, this could be reinterpreted as 20% of purchased materials forming 80% of the total purchasing costs. Figure 11 presents this example.

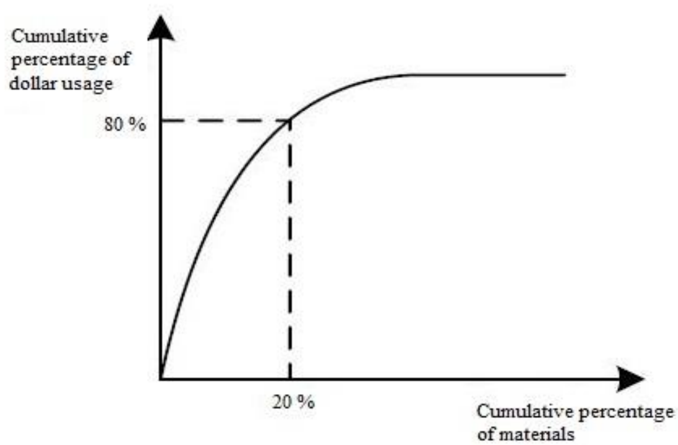

Figure 11. An example of ABC analysis from the purchasing point of view. (Chen et al. 2008, p. 36)

Traditional ABC analysis has been criticized because of the amount of attention that management pays to materials dependent on a single criterion, their financial value, while it ignores other attributes such as obsolescence, substitutability, supply risk, criticality, and lead-time, which can all play a significant role in the real business environment. Lately it has been recognized that these attributes are important for operation and they should be taken into account in material classification principles. To solve this problem many multiple-criteria ABC classification (MCABC) methods have been proposed in the literature during the past few decades. (Gelderman and van Weele 2005, p. 21; Chen et al. 2008, p. 36)

One of the first frameworks was Flores and Whybark's MCABC classification model in which, depending on the nature of the industry, another critical criterion in addition to financial value was selected for the material classification. With the MCABC classification approach, it is possible to create different kinds of categories for purchased materials and further to apply different material control rules to them. The typical outcome of the MCABC classification model principle is a 3x3 matrix, as shown in Figure 12. A company may implement different types of classification models depending on whether it is used for sales, purchasing, or stocking activities. (Flores et al. 1992, p 74)

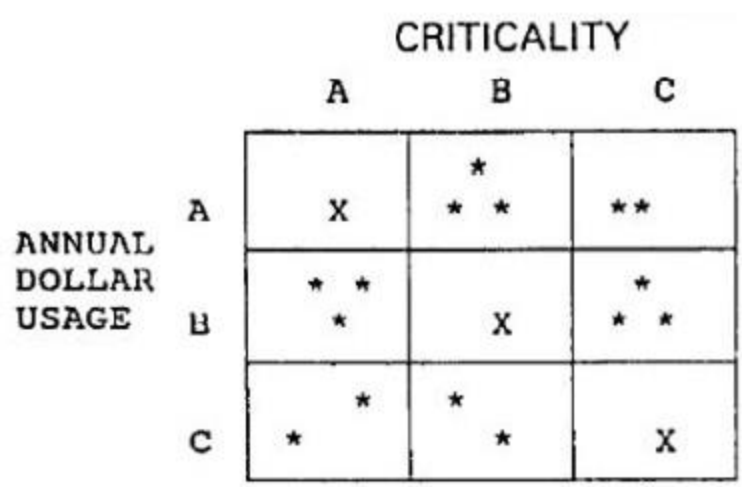

Figure 12. Outcome of the MCABC classification. (Flores et al. 1992, p. 73)

3.4.2 Kraljič matrix

One of the most commonly used approaches today is the Kraljič matrix (Kraljič, 1983, p. 110), which classifies purchased materials using two dimensions: strategic importance and supply risk. An organization's need for a supply strategy depends on these two factors. Strategic importance refers to the cost of materials and their impact on profitability (profit impact). Supply risk refers to the complexity of the supply market gauged by supply scarcity, pace of technology, materials substitution, entry barriers, logistics cost or complexity, and monopoly or oligopoly conditions. The result is a 2x2 matrix, which classifies the required materials into four quadrants, namely non-critical, leverage, bottleneck, and strategic purchases, and offers generic strategic recommendations and tactics for purchasing these materials. Figure 13 presents the Kraljič matrix.

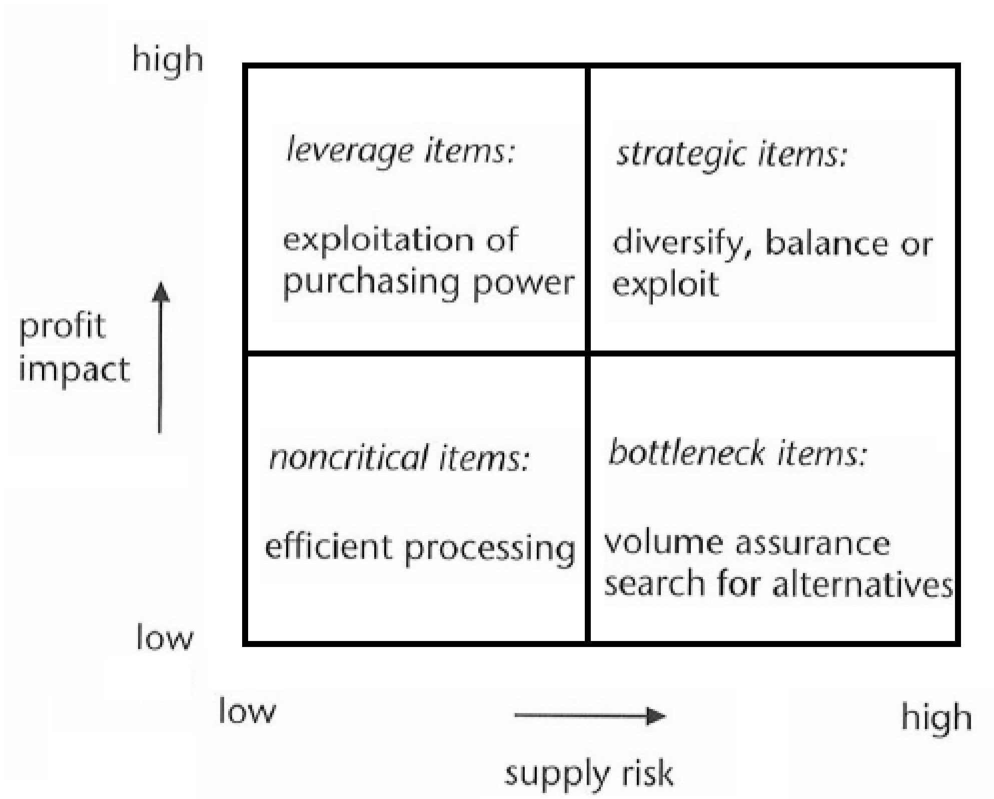

Figure 13. The Kraljič matrix. (Gelderman and van Weele 2005, p. 20)

According to Kraljič (1983, pp.111-112), non-critical purchases have low strategic importance and are ordered frequently from many different sources. Purchasing tactics for these materials focus on reducing transaction costs through product standardization, and efficiently processing both order volume and inventory optimization. Leverage purchases include strategically important expenditures in a large marketplace with many alternative suppliers. This diversity enables the exploitation of full purchasing power, volume optimizations, vendor selection or substitution, targeted price negotiations, and a mixture of contract and spot purchasing. Bottleneck purchases have low strategic importance, but are available only from a small number of suppliers and therefore have a high supply risk. The relevant tactics to bottleneck materials focus on volume insurance, control of vendors, and security of inventories. Finally, strategic purchases are critical for both profitability and operations, and these materials can be obtained from a limited number of qualified sources. Strategic materials require more collaborative and long-term supply relationships between parties, risk analysis, accurate demand forecasting, and logistics, inventory, and vendor control.

However, in the early 2000s the authors of several studies suggested moving away from advocating strict adherence to the recommendations of the Kraljič matrix, noting that not all purchased items in the same quadrant have to be managed in the same generic way. In the traditional view, as presented above, each quadrant of the Kraljič matrix requires generic tactics, and so most of the recommendations are limited exclusively to a single portfolio quadrant. From these recommendations it might be assumed that, for example, only non-critical purchases require efficient processing, while the exploitation of purchasing power and volume optimization are limited to leverage purchases only. (Hesping and Schiele 2016, pp. 101-102)

Hesping and Schiele (2016, p. 112) confirmed that the earlier critique of a deterministic adoption and implementation of the generic recommendations for each portfolio quadrant was justified. Their study shows that purchasing teams do not limit certain purchasing tactics to single portfolio quadrants, but apply them to all quadrants. This result suggests rethinking the usage and application of the Kraljič matrix and management tools in general, because they are unlikely to provide the definite answer to strategic and tactical problems. Rather than providing mutually exclusive recommendations for choosing the right strategic and tactical approaches, the Kraljič matrix may be more usefully considered as a conceptual space for debate and dialogue to bring together actors with different viewpoints in such a way that strategic choices can be made. (Hesping and Schiele 2016, p. 102)

3.5 Purchasing costs

Rather than concentrating on price alone, the purchasing department should understand the total cost of ownership in project purchases. By integrating strategic cost management into the design of products and processes, supply chain organizations can achieve better financial performance results in terms of cost reductions and improved working capital. Transaction costs can play a significant role because long negotiations and heavy bidding processes are typical for projectized industries such as construction, shipbuilding, aerospace, and aviation. Because of the particular characteristics of each project delivery, they are usually distinguished from each other at some level and need to be managed differently. (Lintukangas et al. 2014, p. 36; Ahola et al. 2008, p. 88) In most cases, bid-and-order procedures promote the selection of a vendor that offers the required supplies with the lowest costs (with the same quality and other terms as other vendors). This practice ensures lower direct acquisition costs and may lower uncertainties related to changing product specifications between projects. Alternatively, it can create higher transaction costs and increase overall purchasing costs, because comparing a large number of received tenders requires many resources. (Parikh and Joshi 2005, p. 1047; Ahola et al. 2008, p. 88)

According to Cova et al. (2002) the more clearly the targeted requirement can be specified and the more straightforward it is for the buyer to compare tenders, the more rigid the approach selected by the buyer should be. Closer buyer–supplier relationships can offer many technical, financial, and strategic advantages (Monczka et al. 1998, p 554). The use of purchasing policies that rely on a closer relationship between buyer and supplier may help to achieve the following benefits:

- High costs of competitive tendering can be avoided;
- buyers need to deal with fewer suppliers, which reduces the costs required for managing the supplier base;
- long-term contracts enable benefits for both the buyer and the seller; and
- sharing risks and rewards between buyer and seller may result in creative and beneficial outcomes for both transacting parties. (Ahola et al. 2008, p. 89)

In addition to the above-mentioned benefits, closer buyer–supplier relationships can also assist in simplifying and streamlining the purchasing process by eliminating certain intermediate processes. (Yeo and Ning 2002, p. 260)

Moreover, many organizations handle both large and small purchases through the same standardized purchasing process, which introduces purchasing inefficiencies and increases overall purchasing costs. Regardless of the purchase size, the purchase order has the same overhead cost. For small purchases, this means a relatively high overall purchasing cost compared to large purchases. For organizations with a high proportion of small purchases, a standardized purchase process can adversely affect the overall purchasing costs. In addition, bid-and-order procedures require a large lead time for any purchasing needs. For small purchasers, this causes unnecessary inefficiency in the process, and delays in the delivery of urgently required materials. (Parikh and Joshi 2005, pp. 1043-1047)

4. THE CASE COMPANY

This chapter briefly describes the case company and the business environment where it operates, and introduces its products on a general level. The company's purchasing function and some of its notable characteristics will also be discussed, in order to obtain a bigger picture of its operating principles, its role in the case company, and how the business environment affects its operation methods.

4.1 Company and product presentation

The Finland ABB Marine & Ports units in Helsinki and Hamina develop electrification and automation solutions for the marine industry. The unit is responsible for the global development of maritime industry solutions in ABB. Its brand product is the electric Azipod® propulsion system, which contributes to fuel efficiency, energy efficiency, and drivability of cruise ships, icebreakers, ro-ro ships, and tankers. (ABB, 2016a) In addition to new system development and production, the Azipod® service organization in Finland provides services for ensuring system reliability, high availability, and low life cycle costs in ship operation (ABB, 2016c). Globally, ABB Marine & Ports' business industry employs over 1,700 people in 20 countries (ABB, 2016a).

The first Azipod® propulsion system was introduced about 25 years ago, and the system has become established in maritime business. Azipod® is a podded electric propulsion unit with a variable-speed electric motor, which drives a fixed pitch propeller located in a submerged pod outside the ship hull. The pod can be rotated around its vertical axis to direct the propulsion thrust in any direction, so that even the largest vessels can be maneuvered with decimeter-scale accuracy. Since ships do not require rudders, stern transversal thrusters, or long shaft lines inside the ship hull, this allows for significant freedom in ship design and construction. Notably, in ice-going vessels the system improves the performance of ships in ice operation. (ABB, 2016b, p. 3;ABB, 2016d)

Other important benefits of the system include reduced fuel consumption and CO_2 emissions, which are reduced by improved hydrodynamic efficiency and the power plant concept. Improved hydrodynamic efficiency is the result of optimal hull design and reduced hull resistance when the traditional shaft line and related brackets are eliminated. A pulling type propeller operates in an optimal environment with the highest efficiency, while the power plant concept adjusts fuel savings by optimizing the loading of the diesel engines. The power management system connects or disconnects diesel generator sets to the network depending on the vessel's power requirements, reducing both inefficient low load operation and running hours of the diesel engines. (ABB, 2016d; ABB, 2016e) Compared to the normal shaft line vessel, the improvement in hydrodynamic efficiency can be up to 20% depending on the application (ABB, 2016b, p. 3).

ABB Azipod® product portfolio

The ABB Marine & Ports product portfolio includes different members of the Azipod® product series: Azipod® propulsors for the highest ice classes (Azipod® VI and Azipod® ICE), Azipod® propulsors for ships (Azipod® XL, Azipod® XO, Azipod® CO, and Azipod® DO), and Azipod® propulsors for high thrust and dynamic positioning vessels (Azipod® CZ and Azipod® DZ). (ABB, 2016e) The Azipod® X is a next-generation design from the classic Azipod® V, and is a more modular and standard design aimed at easing the customization, manufacturing, and procurement processes. It offers better performance in the form of easier operation and maintenance actions. (ABB, 2010, pp. 3–9) Azipod® propulsions covers propulsion unit needs from 1.5MW up to more than 22MW with single, twin, triple, multiple, or hybrid propulsion unit combinations (ABB, 2016b, p. 4). The Azipod® C and D series are currently produced in China, while the Azipod® V, Azipod® X, and Azipod® ICE series are produced in Finland. Figure 14 presents the ABB Marine & Ports propulsion units and thrust applications.

Figure 14. ABB Marine & Ports propulsion units and thrust applications. (modified from ABB, 2016b, p. 3)

In addition, different Azipod® products are offered for different sea conditions, and each propulsion type also has a specific type code which is used in the ship's concept design stage. A more specific type code is set for the product during the advanced design stage. The type code describes the specific technical details of the product to be delivered. The type designation is as follows: Azipod® [1] [2] xxxx y, where [1] refers to type (C/X/V/D), [2] informs the operation conditions (I/O/Z), xxxx is the diameter (mm) of the propulsion motor, and y is the length of the propulsion motor (S/M/L for synchronous, A for asynchronous). An example could be: Azipod® VI 1600 A. (ABB, 2010b, p. 6)

4.2 Key characteristics of business

In order to obtain a clear picture of a key driver of this master's thesis, a brief description of the ABB Marine & Ports business environment and its characteristics are now described. There are some special features that have an impact on ABB Marine & Ports purchasing function and the way it operates in a multi-project environment.

The first is that ABB Marine & Ports is strongly project-oriented and operates in project business where medium- or large-scope projects are constantly performed. It operates as a solutions provider, where the Azipod® propulsion systems generate value-added solutions for external customers. Its customer base is diverse, including cruise lines and Arctic shipping companies operating icebreakers. The customers to whom ABB Marine & Ports deliver its products are not usually the end customers; the Azipod® propulsion system is usually delivered as a new vessel propulsion system to shipyards located around the world. Shipyards are responsible for vessel delivery and act as a communication channel between ABB Marine & Ports and the end customer. The end customers can be defined as the owners or operators of the new vessel (Ekelund, 2013, p. 39).

Second, as mentioned in chapter 2.3 the characteristics of project business are quite easy to recognize where the case company operates. It can be stated that at a certain level each delivery project is unique and some sort of discountity exists in the customer relationship, technical solutions, and production process between the deliverable projects. Common factors of the deliverable projects are that orders from a specific customer may take place over a long period, and the quantity of orders for one new vessel is usually small. In addition, the Azipod® propulsion systems can be defined as complex products where many different actors and groups are required to deliver a specific project to the end customer. Project lead times are typically long and every project undergoes an engineering process before the purchasing and production stages. The financial impact of each delivery project is also significant and is an important issue for the case company, both currently and in the future.

However, recent changes in the business environment and strong business growth have shifted ABB Marine & Ports from a single-project management position towards a situation where multiple projects are continuously running side-by-side and sharing resources from a common resource pool. In a multi-project environment the single-project management perspective is no longer sufficient, and because of this remarkable change ABB Marine & Ports is trying to shift its focus towards process-oriented approaches and a management style where projects are viewed as an integrated entity. Some of the delivery projects may, at some level, be customized according to customer needs, as the same processes are running continuously in different stages of the order-delivery process.

4.3 The role of supply management in ABB Marine & Ports

ABB Marine & Ports has a matrix organization structure. It is a combination of permanent functional organizations and temporary project team structures which are formed for each delivery project (Ekelund, 2013, p. 41). Typical stakeholders in the project delivery process are as follows: the customer, project team, engineering, supply management, multiple suppliers, production, and logistics.

The supply management department, which is more closely covered from the purchasing point of view in this master's thesis, is a part of the Propulsion Products organization. It is responsible for purchasing materials for Propulsion Product new delivery projects, Propulsion Product Service modernization projects, and single spare part needs. The department consists of one sourcing team and two purchasing teams, one of which takes care of new delivery project purchases, and the other of service modernization projects and spare part purchases. The purchasing activities of both purchasing teams are divided into different responsibilities among the purchasers. These responsibilities are material-based rather than project-based, meaning that all of the required project materials are purchased by the efforts of several purchasers. The features and complexity of the purchased materials varies significantly, and some of these materials require more advanced planning and coordination activities during the order-delivery process than others. The purchasing activities can be roughly divided into operational and strategic activities.

As mentioned above, a project team is a temporary organization and usually consists of a project manager, lead engineer, engineer(s), and project-responsible purchaser (Ekelund, 2013, p. 42). The project manager is responsible for the project objectives, schedule, cost control, and communication between the customer and ABB Marine & Ports, as well as conveying the information to other internal groups which are involved in the project. Meanwhile, the lead engineer manages the project-engineering process according to project-specific objectives, and forms purchase requisitions to supply management based on the engineering work. Because purchasing is carried out according to certain material responsibilities and the efforts of several purchasers, the role of project-responsible purchaser is more involved in reporting and informing. The most essential tasks are related to communicating project time schedules and specific project needs, and reporting the overall purchasing status to other purchasing team members and project teams.

Production and logistics, as well as supply management as discussed above, represent permanent organizational structures. The aim of production and logistics organizations is to control and maintain the assembly process and coordinate deliveries to ABB Marine & Ports' production facilities and shipyards after the production process. From a wider perspective, supply management can be seen as a connective link between the different stakeholders mentioned above who participate in the order-delivery process. Figure 15 illustrates the role of supply management in a specific order-delivery process.

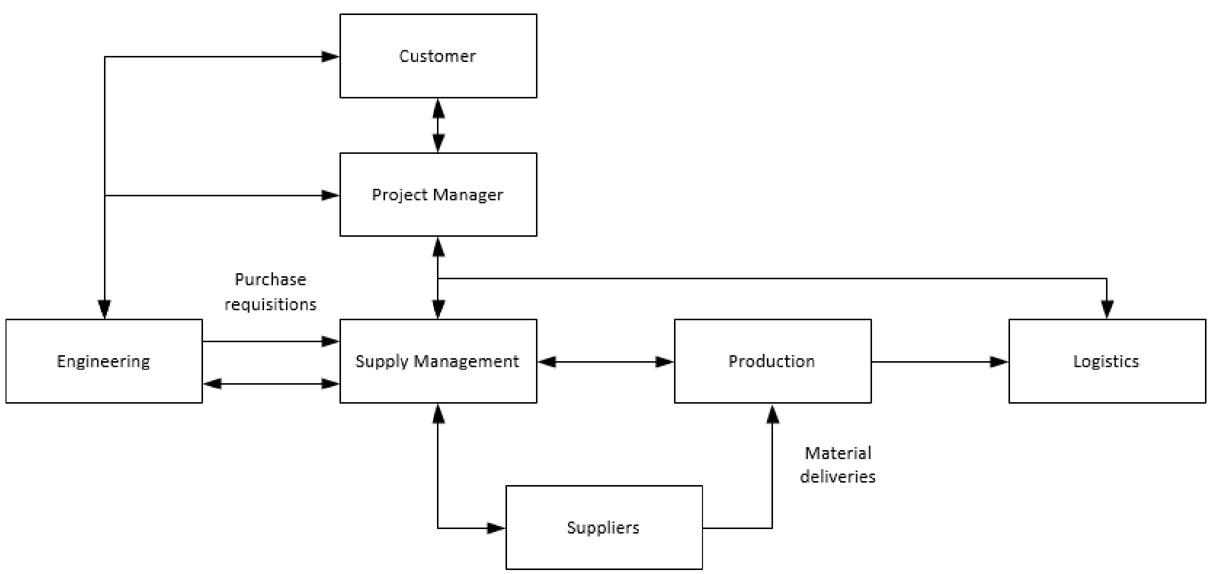

Figure 15. The role of purchasing in a simplified project delivery process. (modified from Ekelund, 2013, p. 42)

4.4 Purchased materials and the supplier network in a typical delivery project

The production of Azipod® propulsion systems is mostly composed of final assembly processes, meaning that all project materials needed for the final assembly stages are outsourced from different suppliers. The production facilities are located in Helsinki, Hamina, and Turku, while final assembly of the new Azipod® X and Azipod® V delivery projects is located in Helsinki and Hamina, and certain service modernization projects in Turku. Because of these major outsourcing activities, supply management has a significant impact on the financial performance of ABB Marine & Ports, since the purchased materials represent a substantial share of the total costs. The total number of suppliers for one delivery project is typically large, and they operate in a wide range of different industry sectors. Some of the supplier relationships can be classified as strategic partnerships, while others are based on single purchase orders.

On a larger scope, ABB Marine & Ports offers complete Azipod® propulsion system delivery solutions for its customers. The typical delivery solution consists of propulsion units, propulsion drives and transformers, an electric power plant, and the propulsion control system. (ABB, 2010a, p. 3). However, in this master's thesis the focus is on the Azipod® propulsor units. The propulsion unit can be divided into three main entities: the Azipod® propulsion module, Azipod® steering module, and Azipod® room. The Azipod® room consists of different individual auxiliaries, and the content of the room varies between the ice-going (VI) and open water (XO) propulsion unit types, as do the propulsion and steering modules. One of the main differences between these two propulsion types is that the Azipod® XO uses an electrical steering unit, whereas the Azipod® VI is delivered with a hydraulic steering unit. In addition, the ice-going propulsors have strengthened hulls with more powerful machineries than the open-water propulsor units. (ABB, 2010c, p. 8-19; ABB, 2012, p. 7-13) When bearing and size class variations of the Azipod® product types (for example, XO2100 and XO2300) are taken into account, it is easy to understand that these differences have their own impacts upon purchasing in terms of complexity.

Most of the purchased project materials can be classified according to ABC analysis and Kraljič classification to C-class or non-critical and leverage materials that have a minor financial impact and relatively short delivery time. It means that there are relatively small groups of materials that form most of a project's total costs, which also have long delivery times and can be considered as critical in terms of the project delivery schedule. These critical materials are usually also project specific and customized according to project-specific needs, and can be classified as A-class or strategic and bottleneck materials, depending on the examined perspective. In addition to these purchased project materials, ABB Marine & Ports have interlinked with its production facilities storage, where both valuable and non-valuable materials are stored and controlled by different inventory management methods. Usually the non-valuable materials are available to all new delivery and modernization projects, whereas valuable materials are critical spare parts that are safety stocked in order to ensure their availability for possible service operations.

The Azipod® X propulsor unit modules and auxiliaries can be further divided into more specific categories, as follows: the propulsion module, steering module, steering drives (SD-1...4), electric steering control unit (ESCU), cooling air unit (CAU), adapting air ducts (AD-In), (AD-Out), slip ring unit (SRU), shaft line support unit (SSU), Azipod® interface unit (AIU), and local backup unit (LBU) (ABB, 2012, p. 7). An example of these modules and auxiliaries can be seen in Figure 16. Notably, these modules and auxiliaries consist of several different sub-assemblies, so that the actual delivery project may consist of thousands of separate materials that are purchased from different vendors. Figure 16 is therefore a highly simplified main-level description of the contents of the actual delivery project.

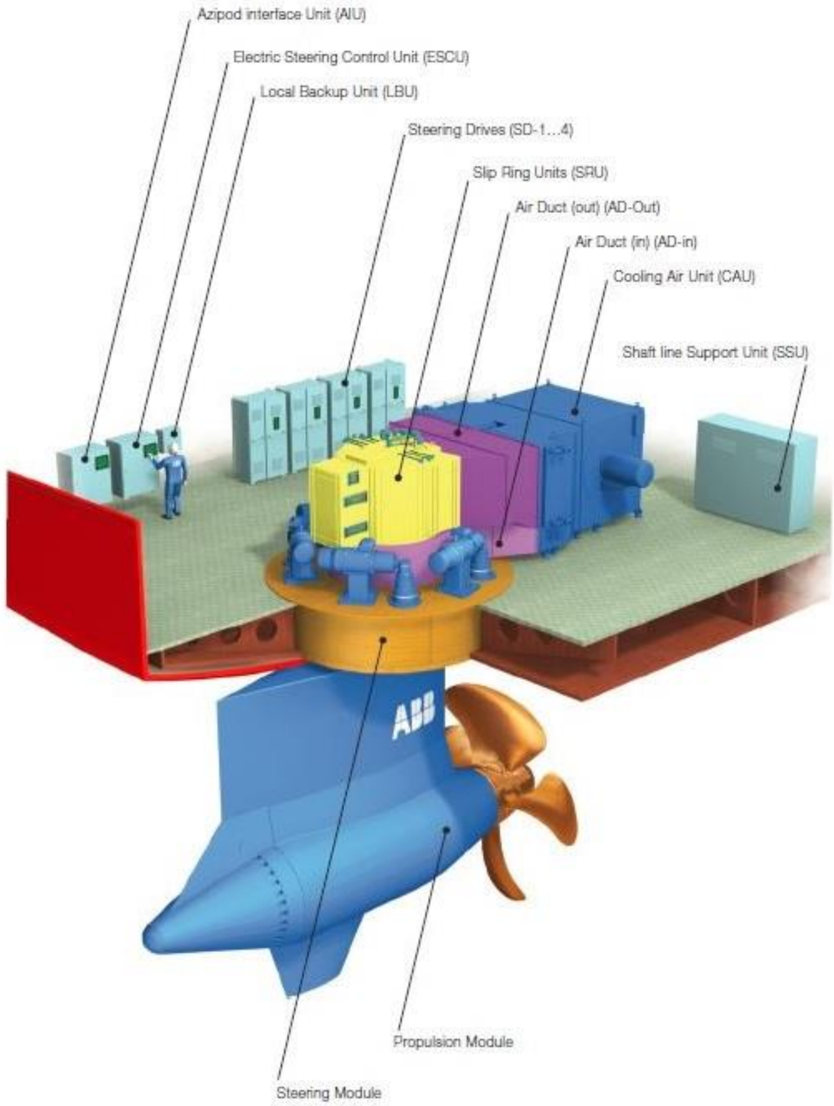

Figure 16. Azipod® X propulsor unit modules and auxiliaries. (modified from ABB, 2012, p. 8)

In order to avoid misunderstandings, it must be mentioned that the layout presented above describes the propulsion unit's final installation assembly at the shipyard. The propulsion and steering modules and room auxiliaries mentioned above are delivered separately to shipyards from the supplier's or ABB Marine & Ports' own production facilities. Thus, in addition to the traditional ordering and order follow-up tasks, the purchasing function requires that purchasers possess the ability to communicate actively between the different actors and coordinate the project deliveries.

4.5 Factors affecting supply management

The marine and offshore industry uses a classification system that impacts supply management and purchasing activities. This classification is a significant element of the manufacture of several new devices or applications for installation on ships or offshore oil and gas units. Classification societies establish, set, and apply technical requirements for the design, construction, and survey of marine-related devices and applications. These requirements are more commonly known as the classification rules. In general, this is a system to safeguard life, preserve the environment, and protect assets. (Bureau Veritas, 2016) The classification is always part of the delivery process of a new propulsor unit or modernization project, and as such it is not a problem. However, the classification society usually varies between projects, which sets certain challenges for supply management and purchasing activities. As each society has its own specific rules for classifying materials, in principle they must be purchased on a project basis.

The second factor that affects the purchasing process is the engineer to order (ETO) production approach. All new delivery projects undergo an engineering process before purchasing and production activities. Simply described, the standard structure design of Azipod® X or the previous project structure of Azipod® V functions as a basis for the engineering work, and is modified according to customer-specific needs. Because features and dimensions of the ordered devices can vary in size between the same types of delivery projects, this creates some uncertainties for the forecasting process in terms of their exact needs. In this way, the ETO production approach complicates and challenges the traditional proactive and systematic operation models, which are quite common and applied practices in other production techniques.

The third factor is the way that purchase requisitions are formed. As a result of project-specific engineering work, the structures of all modules and auxiliaries included within the delivery scope are formed by the company's ERP system. After the formed structures have been accepted and released for purchasing, the current ERP process creates purchase requisitions for all required materials. As engineered modules and auxiliaries are typically identical within the specific delivery project and consist of the same materials, the outcome is a substantial amount of project-specific order rows.

The fourth factor that impacts on purchasing is the multistage supply chains of certain materials. Because some of the required materials are complex, large, and challenging ensembles to manufacture and deliver, their supply chains need more coordination activities than others. Large ensembles comprise a variety of different work phases, which are sometimes purchased from different suppliers. The supply chain may consist of several first- or second-tier suppliers, and the role of purchaser is to oversee and coordinate these different sources in such a way that they ultimately form one supply entity. In these cases, purchasers usually spend more working time on coordination than on traditional purchasing activities; as stated by one interviewee, *"the purchaser can be seen more as a project manager than operational purchaser."* (25.8.2016)

5. RESEARCH METHODS

This chapter presents in more detail the methods used for the collection of research material. This stage was largely carried out during autumn 2016, and several people were involved in. Following the empirical research stage, the findings were gathered and analyzed in order to establish the current state of the purchasing process, so that a development proposal could be created. The research methods used are explained in more detail in the following sections.

5.1 Internal survey

Interviews were chosen as one of the three research methods, because issues related to the current purchasing process were not possible to gather comprehensively and unambiguously using a quantitative research method. With the use of interviews, the researcher was able to form a better overall view of the current purchasing processes, the level of cooperation between sourcing and suppliers for different materials, the current material classification principle, and material control methods in use. In addition, the interviews helped the researcher to understand the special features of certain purchased materials and their impact on the purchasing process.

The interviews were mainly conducted during August 2016. From the total of 16 people interviewed, 14 were from the supply management organization (the main focus of the interviews), 8 were purchasers, 3 were sourcing managers, 2 were purchasing team managers, and 1 was the supply chain manager. The remaining two interviewees were the logistics and warehouse manager, and the manager of the product engineering and updates team. The decision of which people to select for interviewing was made carefully, and on the basis that these interviews could enable an accurate representation of the current operation of the supply management department as well as other stakeholders in the order-delivery process, and to form a realistic solution within the context.

The interviews were semi-structured theme interviews, whereby a list of questions was sent in advance to preselected interviewees so that they were able to answer questions and freely state their opinions about the current problems and any possible development ideas. According to their answers, the interviewer made consistent follow-up questions as required. A list of topic-relevant questions was formulated, with varying content according to the positions of interviewees. During purchaser interviews the focus was on an operational level, whereas during managerial interviews the focus was on a tactical and strategic level. The interview with the logistics and warehouse manager focused on current inventory management and control principles, and the interview with the product engineering manager on material administration issues – in particular, how this should be taken into account in the development proposal.

The contents of the interviews were recorded, but due to confidentiality they are not presented in more detail here. A list of people involved in interviews and interview questionnaires can be found in Appendices A, B, C, D, and E.

5.2 Statistical data analysis

Because the main aim of this research was to explore the uniqueness of delivered projects and compare the findings with current operation methods, numeric data were also required. At this stage of the research, numerical data from the case company's ERP system was obtained and analyzed statistically with Microsoft Excel. The aim of statistical data analysis was to examine:

- How equal are two specific product series Azipod® propulsion units at the structural level?
- In reality, how unique delivery solutions the Azipod® propulsor units have been?

The analysis was carried out in two stages. First, the product structures of two specific product series Azipod® propulsion units were analyzed. The aim of structural level analysis was to investigate similarities between the product series on a structural level and to form an overall picture of their equation. Based on the results of the structural level analysis, the analysis was decided whether to continue on to the second stage, where the contents of actual delivery projects were analyzed. The aim was to find out, in reality, the uniqueness of the actual Azipod® propulsor units as delivery solutions.

5.3 Benchmarking

The purpose of benchmarking was to find out what kind of material classification principles other organizations apply, what material control methods and implementation techniques they use for purchased materials, and how they have developed their purchasing process. The benchmarked organizations were ABB Drives, and ABB Motors and Generators. The benchmarking was carried out with the same principles as the internal interviews; a list of questions was formulated beforehand and sent to the benchmarking participants. The questions and topic were discussed at length during whole benchmarking days, which were held at the ABB Drives and ABB Motors and Generators offices in Helsinki.

These organizations were selected for benchmarking because they are part of the same corporation as the case company, and therefore it was assumed that they could more easily provide open answers and concrete examples related to the topic. It was not expected that the benchmarking would provide direct solutions to the research problem, due to the differences in business operations between the business units. Instead, the aim of benchmarking was to apply both new and radical ideas to current operation methods from quite different business environments, as well as to investigate the possibility of using these different methods in the operation of ABB Marine & Ports.

As for the internal interviews, the contents of the benchmarking days were recorded but are not presented in more detail here due to confidentiality. The questionnaire for benchmarked organizations is presented in Appendix F.

6. RESEARCH FINDINGS

This chapter presents the findings from the internal survey, statistical data analysis, and benchmarking. These results are presented individually, and then handled as a whole during the development proposal in the next chapter.

6.1 Findings from the internal survey

The case company's purchasing activities are currently very reactive, despite the properties of the purchased materials. *"Purchases are directed on a project-basis and the purchasing process is handled strictly from the single project perspective,"* stated one interview (08.08.2016). A general observation from the interviews was that none of the interviewees knew about the scale of material recurrence between the product series and product types. This question was challenging, especially for purchasers, who purchase most of the required materials in terms of order rows for a specific project. The improvement of the purchasing process was also considered to be challenging, mainly because of the project-specific engineering work and the uncertainties created by it for the final delivery project solution. In addition, unexpected changes to the product design during the order-delivery process were considered to be challenging from the purchasing process development point of view. However, a general opinion among the interviewees was that purchasing activities should be developed in a more proactive direction, and that not all materials should be handled through the same, standardized purchasing process. This opinion was raised in particular by interviewees whose purchasing responsibilities included non-critical and leverage materials.

The interviews showed that the current material classification principles do not reach the material level in the case company. Materials have previously been classified according to ABC analysis and the Kraljič matrix, but these classification practices are not linked comprehensively to material control methods or operational activities. In other words, most of the materials are treated identically and purchased according to the same standardized process, regardless of their characteristics. (8.8.2016) In general, the development of material classification methods was considered as important, because it was believed to be a starting point for the development of the current purchasing process.

In relation to this finding, a primary theme of the interviews was to find out the special features of different materials, and how they should be taken into account in the development proposal. At this point of the research, it seemed quite clear that the new material classification principle would differ from the traditional ABC or Kraljič classification methods. The interviews revealed that the profit risk, supply risk, and item volatility were not the main parameters used to classify materials into different material groups, or further to manage them under different material control methods and practical implementation techniques. The special features of purchased materials should be taken into account in the development proposal to ensure its relevance. The most significant factors affecting the development proposal, according to interviewees, are presented in Figure 17.

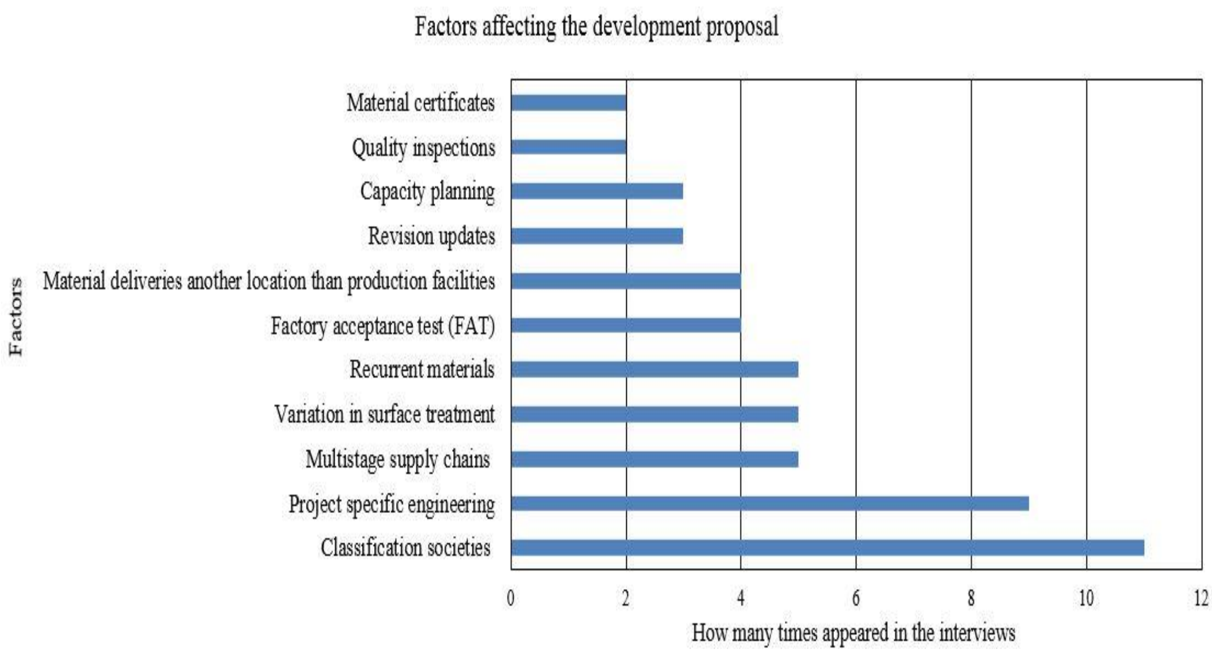

Figure 17. Factors affecting the development proposal.

Figure 17 indicates that the most significant factors to take into consideration during the development proposal are classification societies and project-specific engineering work. Other relevant issues raised by the interviews were multistage supply chains, variations in surface treatment, recurrent materials, factory acceptance tests, material deliveries to other location than the ABB Marine & Ports production facilities, revision updates, capacity planning, quality inspections, and required material certificates. One interviewee also pointed out the importance of ensuring availability of critical and long lead time materials (18.8.2016). Another interviewee mentioned that the new material control models should be developed such a way that the possibility of changes in materials can be taken into account (15.8.2016). In addition, it was raised that political decisions can also impact upon supply management and purchasing activities (8.8.2016).

The interviews showed that the level of strategic planning is more systematic, on an internal and external level, with the materials that have significant financial impacts and the longest lead times. One of the interviewees mentioned that the focus has been more on A-class materials and the main component level, while other materials receive less attention (15.08.2016). Material control of these A-class and main component level materials is proactive in the sense that purchases are directed to pre-decided suppliers, according to the views of the sourcing manager and purchaser. The sourcing manager mainly conducts price negotiations, and the purchaser is responsible for making the purchase orders in accordance with the pre-prepared plan, as well as supervising the purchasing process. Since many of these main components are to some extent project-specific and tailored, project-based purchasing seems to be a necessity according to interviewees (25.8.2016; 18.8.2016).

The opposite situation is true for simple materials, which have relatively short lead times and less significant financial impacts. The level of proactive planning is limited for these materials and usually the purchaser decides on the supplier at the beginning of the purchasing process. The selection of the supplier is based mainly on accepted alternative suppliers, and the purchaser’s own views and experiences. Agreed price lists and delivery times exist for most of these materials, with the intention to simplify the purchasing process, but occasionally materials are also tendered among the suppliers. Despite existing agreements, materials are purchased with a manual purchasing process on a project basis (18.8.2016; 29.8.2016). Do these approaches support the most effective and competitive way of purchasing non-critical and leverage materials in a multi-project environment? How much savings can be achieved through competitive bidding or comparison of price lists for these materials? The answers to these questions depend on the uniqueness of the required material and its characteristics.

The aim of the interviews was also to examine the purchasing process and its various stages for different materials more closely, so that they could be modeled. During the interviews, the purchasing processes were examined in as much detail as possible from the AS-IS perspective. The processes differ depending on the characteristics of the purchased materials, so when looking to new process modeling practices it is necessary to discuss about the level of modeling with instructors. For simple materials, the purchasing process is fairly straightforward and purchasers spend most of their working time on operational activities. However, with complex materials the purchasers make less orders and their working time is spent mostly on supervising and coordination activities between the different parties of delivery projects. The interviews show that the current purchasing process includes a lot of manual activities that could be replaced by IT and automation.

Along with the changes in business environment and business growth, one interesting issue is related to increasing the use of stock-based material control for certain materials in the future. To clarify the present state of inventory management the logistics and warehouse manager was interviewed, and revealed that inventory management is currently problematic because it cannot be effectively monitored. Storage would probably require substantial investments, if the decision were made to control materials more on a stock basis. The interviewee stated that at this point, development efforts should be focused on the current small parts storage system. (6.7.2016) In addition, the possibilities of material revision and the subsequent influences should be taken into account in stock-based material control. According to the manager of the product engineering and updates team, communication and cooperation with supply management, product engineering, and engineering is in a key role if stock-based material control is implemented on a larger scale. The core question was: “How will material revision be handled with these materials?” (12.9.2016)

6.2 Findings from statistical data analysis

In order to clarify the uniqueness of different delivery projects, a comparison was made between their product structures and related materials. Based on these analyses, it was possible to form an overall picture of the uniqueness of projects already delivered, on both a structural and actual delivery project level.

6.2.1 Structural level analysis between the product series at a material level

In the first stage of the statistical data analysis, the structures of two product series Azipod® propulsion units were compared. The structural level comparison was a good starting point for the analysis because it offered a pre-description of how different materials recur between the structures at a general level. The analysis was initiated by downloading the product structures from the case company's product data management (PDM) system to Microsoft Excel. Because of confidentiality, the analyzed propulsor unit structures are presented as "product series 1" and "product series 2" in this master's thesis.

The available data were modified so that all the materials that do not form purchase requisitions were removed from the final analysis data. In practice, these materials were identified from the product structures with reference point tags. The final analysis data were then divided into propulsor and steering modules before detailed analysis, because these two modules are final assembled in different production facilities, and this division enables easier identification of the materials that are already stored in these production facilities. At this point, it is worth mentioning that the Azipod® room auxiliaries are not included in the structural level analysis, because they are usually designed on a project basis and purchased with project-specific material codes.

Figures 18 and 19 show the findings of the structural level analysis, which indicate that there are more consistencies on a structural level between the "product series 1" propulsor and steering modules, than the equivalent "product series 2" modules. In particular, these consistencies can be seen in the "product series 1" steering module, as in principle it seemed to be identical to the other "product series 1" products on a structural level, with the exception of certain project-specific customizations, which could be observed only from the actual project structures.

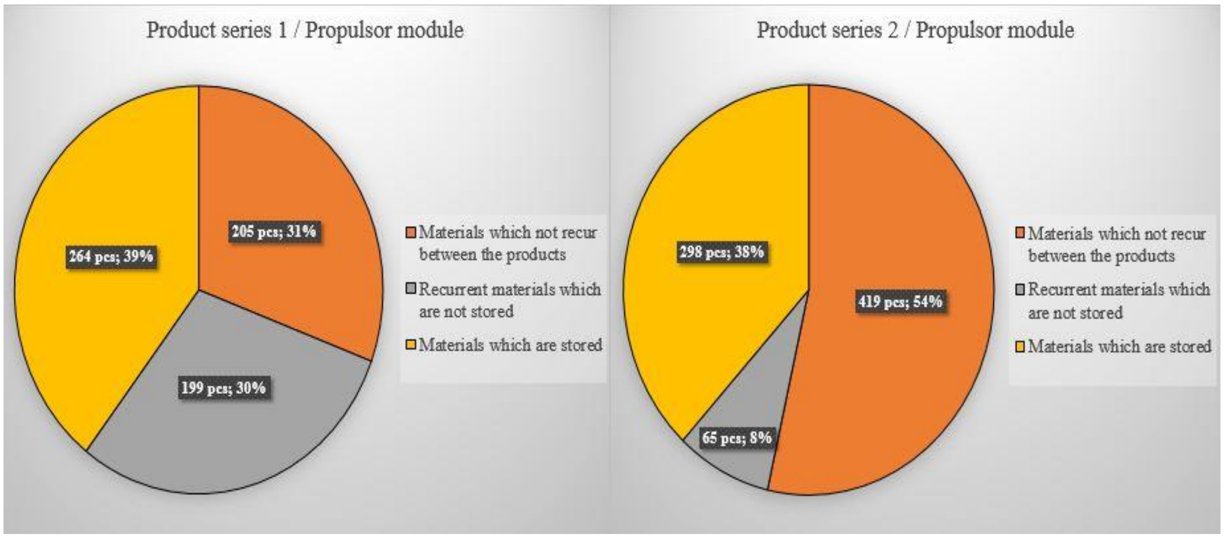

Figure 18. Structural level comparison of propulsor modules.

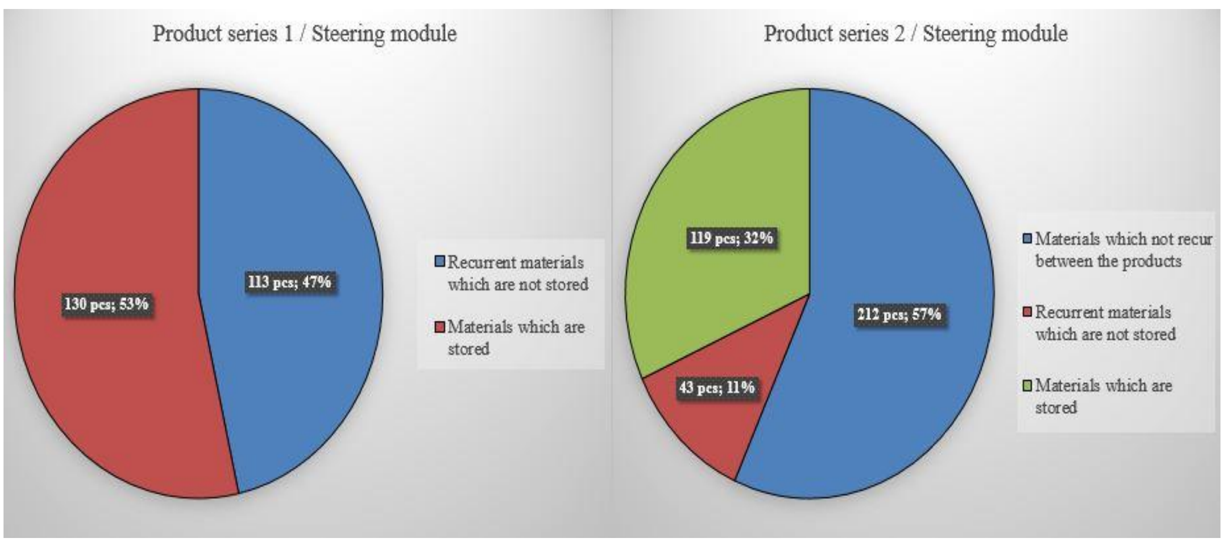

Figure 19. Structural level comparison of steering modules.

Since the actual delivery project structures are formed along with the project-specific engineering work, the actual delivery project structures may differ from the above-presented standard product series structures. Therefore, it was also necessary to examine the actual delivery project structures and establish their recurrence at a material level. Moreover, the first stage of analysis does not reveal how materials can be repeated within different delivery projects of each product type, and so another analysis was needed. However, at this stage the findings from the structural level analysis cautiously supported the idea of developing a substitute material classification principle, in addition to alternative material control methods and implementation techniques, to enhance the purchasing process. The analyzed structures were not found to be completely unique, particularly with the “product series 1” product types.

6.2.2 Actual delivery project structure analysis at a material level

During the second stage of the statistical data analysis, the actual delivery project structures were analyzed. Three different projects from product types of both product series were selected for analysis. From the selected projects, two of the three were already delivered and one of was at the purchasing stage. The surveyed projects were chosen to ensure that they were not sister ship deliveries, because these are likely to contain more recurrences than other projects. The available research material was also reviewed so that the selected project purchases all took place between 2014 and 2016. Two years was considered to be an appropriate time interval for observations, as it should give a sufficient indication of the contents of the actual delivery projects, any recurrences, and how materials may have changed or been revised during the period under review. For confidentiality reasons, any specific identifiers of the surveyed delivery projects or product types are not provided in this master’s thesis. Product types are presented generally as “product 1,” “product 2,” “product 3,” and “product 4.”

During the analysis, the purchased materials of already delivered projects were compared with the most recent project (which was in the purchasing stage). Recurrent materials were identified mainly by their material code and material description text. With the help of this method, it was possible to determine the uniqueness of actual delivery projects, the scale of revised materials during the period under review, and the materials that were designed on a project basis. The results from the second stage of analysis are presented in Figures 18, 19, 20, and 21. Figures labeled A present the uniqueness of the surveyed delivery projects in reality, and figures labeled B the materials that were revised during the period under review. Before a more detailed examination of these figures, it is necessary to note that pre-stored materials are not included in the examination of actual delivery project structures; these materials are already under stock-based material control, and the focus of this master's thesis is on materials that are purchased separately for each project by a manual purchasing process.

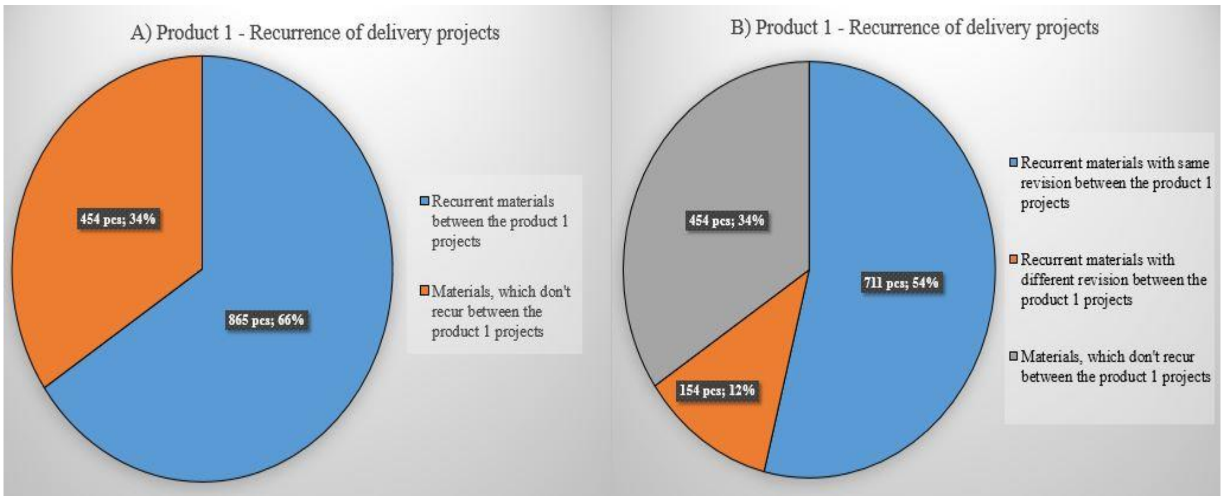

Figure 20a. The uniqueness of product 1 delivery projects during 2014–2016.
Figure 20b. Revised materials in product 1 delivery projects during 2014–2016.

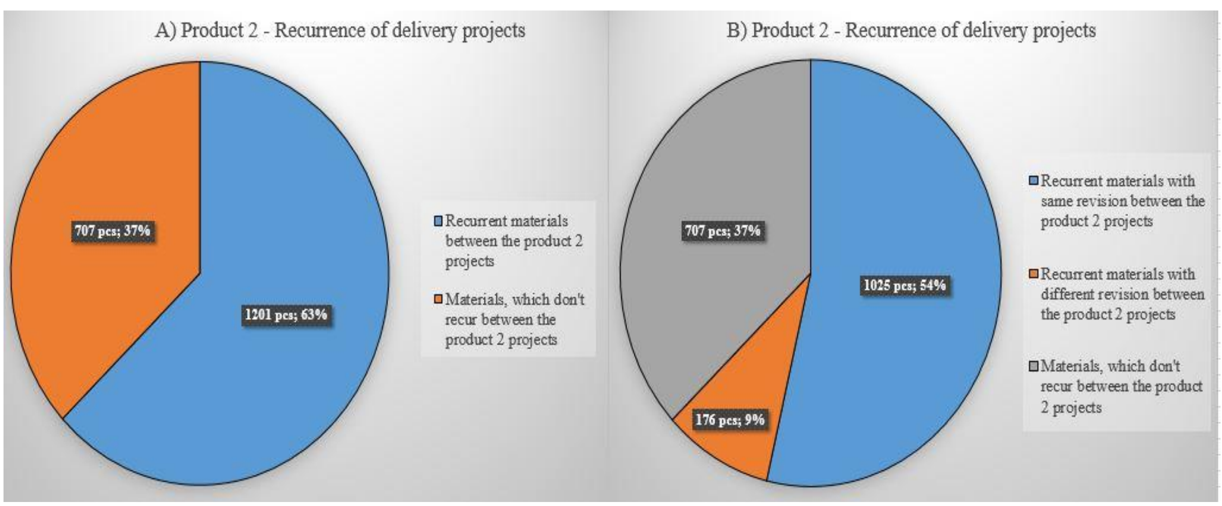

Figure 21a. The uniqueness of product 2 delivery projects during 2014–2016.
Figure 21b. Revised materials in product 2 delivery projects during 2014–2016.

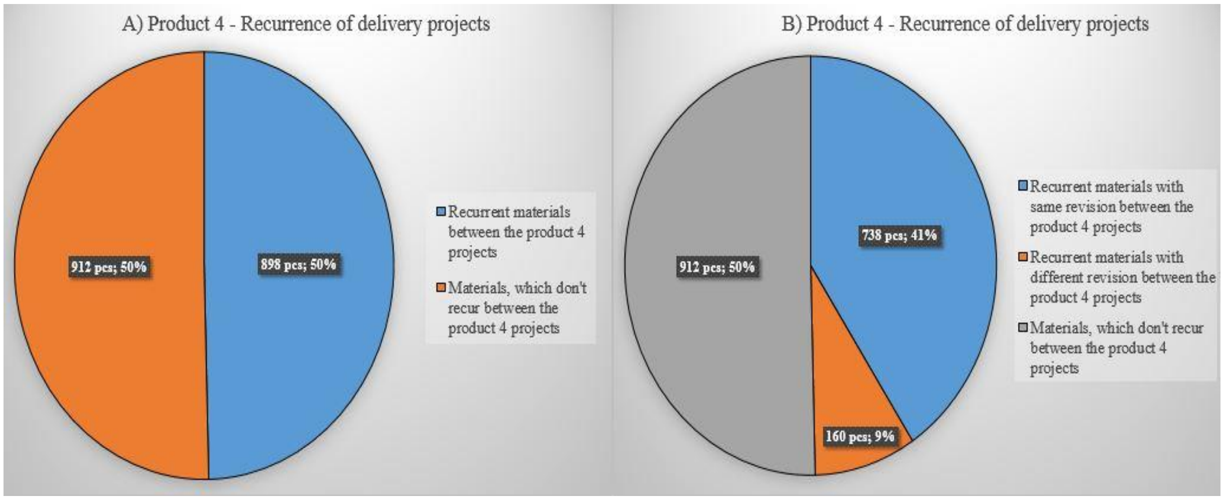

Figure 22a. The uniqueness of product 3 delivery projects during 2014–2016.

Figure 22b. Revised materials in product 3 delivery projects during 2014–2016.

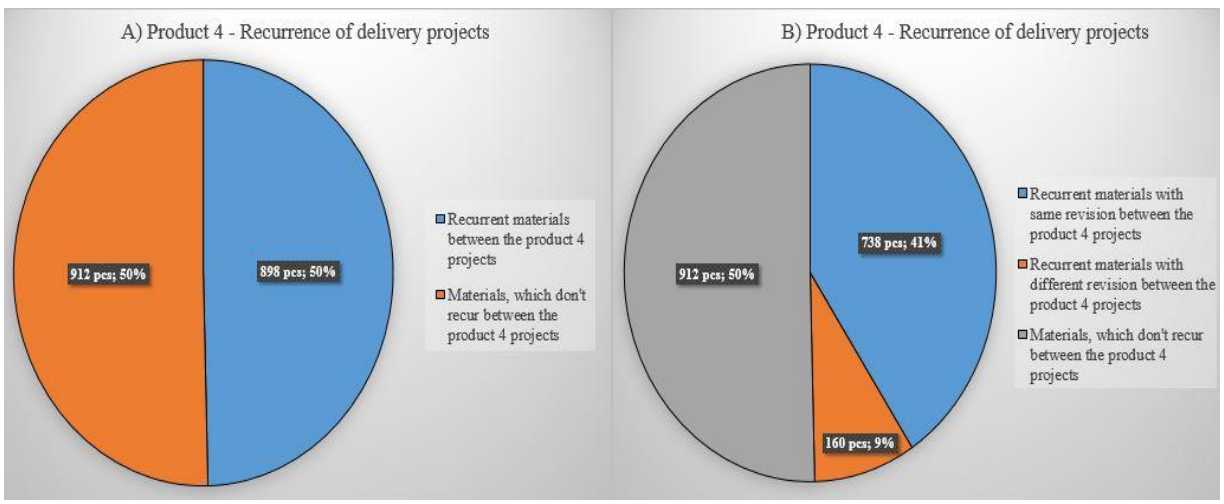

Figure 23a. The uniqueness of product 4 delivery projects during 2014–2016.

Figure 23b. Revised materials in product 4 delivery projects during 2014–2016.

The findings of the second analysis strongly indicate that the delivered propulsor units were more recurrent than the unique delivery solutions. In a larger context, most of the purchasing activities seem to be ongoing and repetitive, and in terms of efficiency, the purchasing process of these recurrent materials should be planned on a continual basis rather than separately for each project. The diagrams also showed that the majority of the recurrent materials have remained unchanged over the past two years. This observation is particularly valid for the "product 1", "product 2", and "product 4" delivery projects.

The findings from the second stage of analysis raised additional questions, such as:

- Is it reasonable to classify and treat all materials according to the same practices in the future?
- Why are most of the required materials purchased on a project basis?
- Should certain acquisitions be centralized to specific suppliers?
- Would it be beneficial to use a stock-based material control method for the recurrent materials?

6.3 Findings from benchmarking

A number of clear differences in material classification principles and material control methods were observed between the case company and benchmarked business units during the benchmarking days. These observed differences are covered more specifically in this section.

The first significant difference between the organizations is that both of the benchmarked organizations define most of their material needs by using the material requirements planning (MRP) calculation system, whereby material needs are calculated and scheduled in accordance with the production plan. The impulse for the required materials comes from production, after the system has matched information from different inputs (master production schedule, bills of materials, and inventory records). However, in the case company MRP is not in systematic use, and the impulse for the required materials typically comes from engineering as a result of project-based engineering work. Material control is not based only on an MRP system in the benchmarked organizations, but is used as a supportive system for stock-based material control in the form of forecasts. The benchmarked organizations use different inventory management methods, such as vendor-managed inventory (VMI), a two-bin system, and the reorder point method, for stored materials. (7.3.2016; 7.9.2016) Second, differences in material classification principles were also observed between the benchmarked organizations and the case company.

ABB Drives uses two-dimensional ABC(D)-XYZ analysis in material classification, where alongside the consumption value (based on the 20/80 principle), XYZ classes are created for item volatility. This could be described as a typical solution for a make to stock production environment, but it is not necessarily the optimal solution for the case company's business environment. Meanwhile, Motors and Generators have developed a slightly different classification principle which seems to be a more interesting solution; the purchased materials are divided on a top level into two entities, for which material control is implemented using different techniques. The only unclear issue in this classification principle is which parameters should be used, and how, when dividing materials and directing them under different material control methods and implementation techniques? (7.3.2016; 7.9.2016) However, this classification principle seemed interesting, and with further development it could be exploited in the case company's business environment.

The third essential observation was that both of the benchmarked organizations had enhanced the purchasing process with a supply chain collaboration portal, and to some extent by using automation in the purchasing process. Organizations are using ABB's own supply chain solution, ASCC, which provides a collaborative commerce network between ABB and its suppliers. The purchasing process was also streamlined by centralizing purchases to certain suppliers, in such a way that mainly the single needs are under competitive bidding activities. (7.3.2016; 7.9.2016) These methods could be also used on a larger scale in the case company, especially with the recurrent materials.

7. DEVELOPMENT PROPOSAL

In this chapter, a concrete development proposal for the case company is presented and thoroughly scrutinized. The proposal is based on the theoretical framework and research findings. It consists of a new material classification principle and a new material control model, with practical implementation techniques, and aims to enhance the efficiency of the current purchasing process. The development proposal also includes process descriptions for purchasing processes, which are modeled based on the new material control implementation techniques.

The development proposal is intended to support both Propulsion Products purchasing teams. Although the purchasing teams purchase materials for different business segment needs and on different scales, the purchased materials and the purchasing processes are essentially similar. These common approaches are considered to support both teams' activities and facilitate their management. The development proposition is first reviewed, followed by an example calculation that demonstrates the impact of the development proposal on the current situation.

7.1 Material classification and control methods

Based on the research findings, it was possible to challenge the current material classification principle whereby almost all materials in terms of material control are classified as identical, despite their characteristics. This classification principle is more suitable for a single-project than a multi-project environment. The above-mentioned classification principle does not support continuous and repetitive processes between different projects, and so prevents the most effective operation methods. As evidenced by the findings from statistical data analysis, during the past two years the delivered propulsion units have mostly consisted of recurrent materials. Product 3 can be considered as the only exception of this conclusion, as it has included significantly more project-specific materials. Even though each delivery project contains project-specific ensembles, they do not make the projects completely unique solutions. These project-specific materials should be possible to identify, classify, and control in a different way than materials that recur between the product series and product types.

According to the above viewpoints, a new material classification principle and material control model, with practical implementation techniques, is developed for the case company. With the help of this development proposal, the supply management organization is able to systematically control future project purchases, and further develop its operations. The new material control model and practical implementation techniques are presented first, followed by an explanation of how to direct different materials using the new material classification principle. A new material control model with practical implementation techniques is presented in Figure 24.

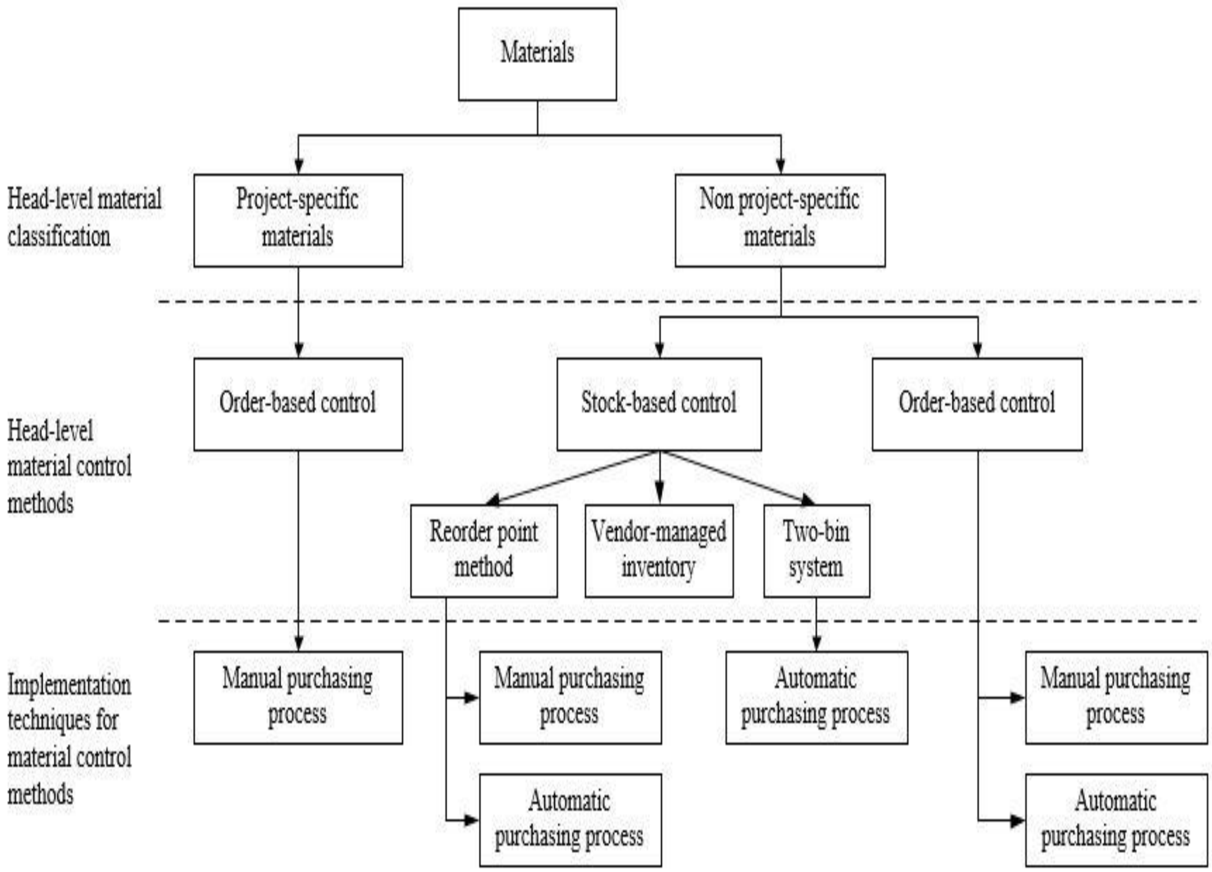

Figure 24. New material control model with practical implementation techniques.

In order to create the model in Figure 24, both the findings from statistical data analysis and issues identified from the interviews were taken into account. The material classification and material control principles surveyed during benchmarking also furthered in the creation of this development proposal. As before two basic strategies, order- and stock-based material control methods, are utilized in this development proposal. Three different inventory management techniques (the reorder point method, vendor-managed inventory, and two-bin method) are used in the stock-based material control method, and the relevant purchasing process is implemented and enhanced by manual and automatic purchasing processes. In turn, materials that are controlled on an order basis are purchased according to specific needs by utilizing tactical purchasing activities, and the purchasing process is implemented and enhanced in the same way as stock-controlled materials. Concerning the implementation of an automatic purchasing process, ABB's own supply chain collaboration portal ASCC is exploited in this development proposal.

7.2 Head-level material classification

In the developed material control method, head-level material classification parameters were first generated for different materials and then used to classify them into two head-level material groups: "project-specific materials" and "non project-specific materials". The head-level classification parameters for project-specific materials were selected from the most significant factors raised in the interviews, which are presented in Figure 17; classification societies and project-specific engineering work. The reason for the selection of these two factors was that they were considered to have a significant impact on both the purchasing process and the usability of materials in other product types.

Materials were classified into project-specific materials and non project-specific materials in the following way:

- Materials that are engineered on a project basis or need the approval of classification societies were classified as project-specific materials.
- Materials that are not engineered on a project basis and do not need the approval of classification societies were classified as non project-specific materials.

Figure 25 presents the result of a head-level material classification for a certain project. It shows that most of the purchased materials in this project were classified as non project-specific, according to the above classification principle.

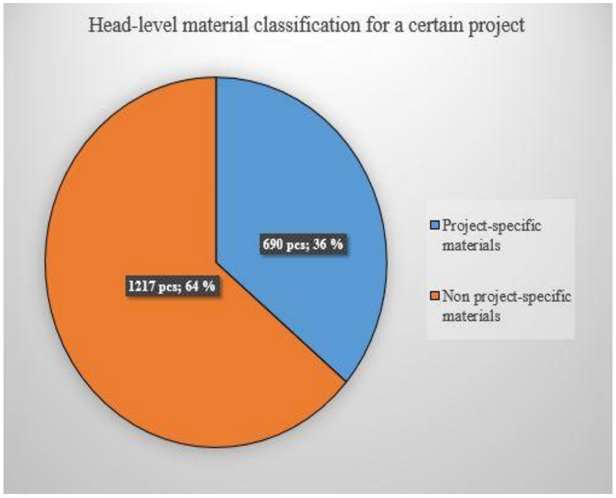

Figure 25. Head-level material classification for a certain project.

However, this principle was not considered to be precise enough to direct materials under the above-presented material control methods and implementation techniques. It was decided to use ABC analysis, which is based on the 20/80 principle from the purchase cost point of view, to specify the head-level material classification in more detail. With this method, it was possible to obtain a more accurate picture of how the purchased materials were divided into project-specific and non project-specific materials, according to the ABC classification principle. This method also helped to develop a more detailed classification principle, where project-specific and non project-specific materials were classified under the order- and stock-based material control methods and their implementation techniques. Figure 26 presents the result of a head-level material classification with the ABC analysis principle for a certain project.

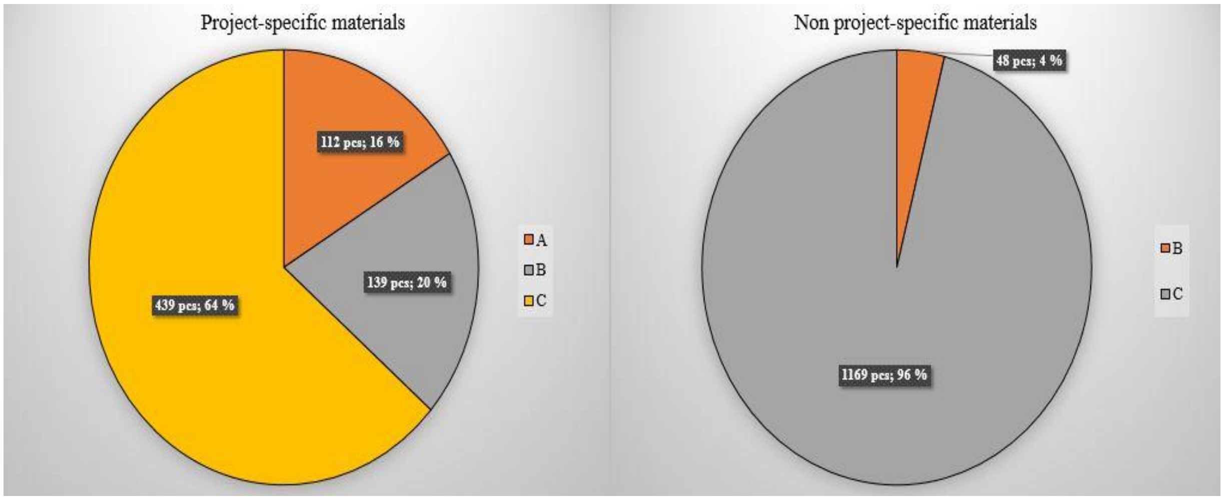

Figure 26. Head-level material classification with ABC analysis principle for a certain project.

7.2.1 Head-level material control methods

This development proposal suggests that project-specific materials are purchased for a specific need using the same operation methods as before. The order-based material control method for project-specific materials is implemented with a manual purchasing process. In particular, project-specific engineering work and its uncertainties around the required materials impact this suggestion, preventing the possibility of using stock-based material control methods for these materials. In addition to project-specific engineering work, project-specific materials also form a substantial share of certain projects' total costs, as shown in Figure 27, meaning that these materials can also tie up a substantial amount of capital in inventories. Even if recurrences do exist among project-specific materials, how should the different classification rules and their imposed limits for using these recurring materials in other similar delivery projects be taken into account in stock-based material control? As most of the project-specific materials are also complex, large, and challenging ensembles to manufacture and deliver, they require more manual coordination and supervising activities during the purchasing process than non project-specific materials. Consequently, the order-based material control method was considered to be the best solution for project-specific materials.

In contrast, use of the order-based material control method for non project-specific materials was challenged, and the possibility of increasing the use of stock-based material control was examined in more detail with one product type (the product types examined during the second stage of statistical data analysis were assumed to behave identically at this point of the survey, and thus only one product type was examined in more detail). As presented in Figure 27, 81% of the non project-specific materials recurred between the three studied delivery projects of particular product type. On the strength of this observation, it was necessary to determine the extent to which these actual delivery project materials recur between other product types. With the help of this further investigation, it was possible to obtain an answer to the question raised above: “Should the material control of non project-specific materials be implemented more on a stock basis in the future?”

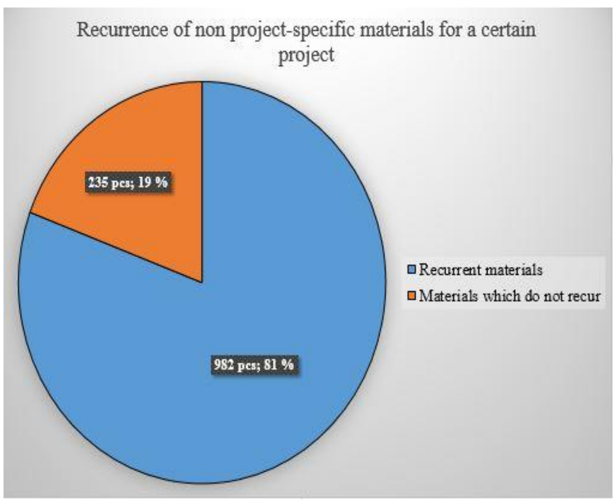

Figure 27. Recurrence of non project-specific materials for a certain project.

In order to determine the possibility of using stock-based material control on a larger scale for non project-specific materials, purchasing data from the period of 1.1.2015 to 26.9.2016 were applied from the case company’s ERP system. Purchased materials were compared between product 1, product 2, product 3, and product 4 in order to obtain an accurate picture of the extent of recurrence of actual delivery project materials between these products. Already stored materials were removed from the comparison data, because the aim was to find out how much recurring materials between different products are purchased on a project basis, and with the manual purchasing process. Figure 28 shows the extent to which different materials recur in at least three-quarters of the above-mentioned product types; this approach was chosen for the comparison analysis because most of the delivered propulsion units will center on three product types in the future. For reasons of confidentiality, the work does not provide any accurate details about these product types.

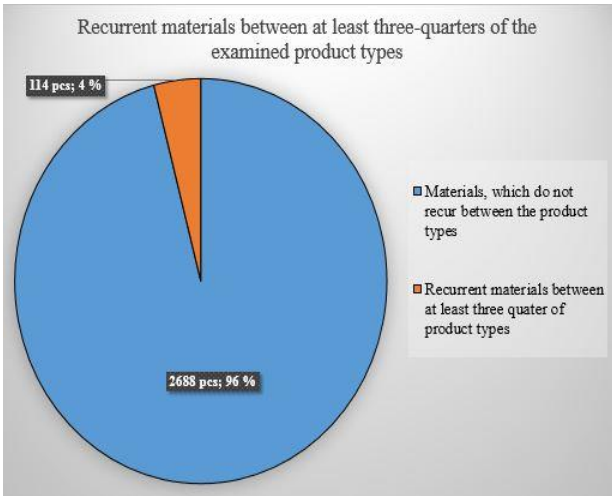

Figure 28. Recurrent materials between at least three-quarters of the examined product types.

As illustrated by Figure 28, most of the purchased materials during the studied period do not recur in at least three-quarters of the examined product types. Since the case company's production resembles one-off production more closely than serial production, the production volumes are small compared to serial- or mass-production, and active delivery project scopes vary smoothly with the production plan, it is not reasonable to significantly extend the current stock-based material control to non project-specific materials. Stock-based material control would tie up unnecessary capital in inventories and the inventory turnover time would be weak with this type of product portfolio. When the lack of effective inventory management is taken into account, it is rather worth concentrating on alternative development actions to enhance the purchasing process of non project-specific materials. According to the research findings, the current model – where C-class and non-critical materials are stored to eliminate bottlenecks – seems to be reasonable for the stock-based material control method for new delivery and modernization project materials. Most of the recurring non project-specific materials should be purchased on an order basis and according to specific needs.

7.2.2 Head-level material classification matrix

Based on the findings and viewpoints presented in the previous section, a head-level material classification matrix was generated. The purpose of this matrix is to assist the generation of a final material classification matrix for project-specific and non project-specific materials, which also includes practical implementation techniques for the previously presented material control methods.

A new two-dimensional head-level material classification matrix is presented in Table 1. The main row of the matrix describes the material classification according to ABC analysis, and the first column describes which material control method (order-based or stock-based) is used for head-level materials. For example, if a material is engineered on a project basis, requires the approval of classification societies, and is classified as a B-class material according to ABC analysis, it is denoted by “x” in the matrix and receives the head-level identifier “B1”. However, if a material is not engineered on a project basis, does not require the approval of classification societies, is already stored, and is classified as a C-class material according to ABC analysis, it is denoted by “y” in the matrix and receives the head-level identifier “C3”.

Table 3. Head-level classification matrix.

Head-level level classification matrix.			
	A	**B**	**C**
Project-specific materials, order-based control (1)		“x”	
Non project-specific materials, order-based control (2)			
Non project-specific materials, stock-based control (3)			“y”

7.3 Material classification principle for non project-specific materials

The classification parameters for non project-specific materials are presented in the following chapters, which explain how these materials are directed under two main material control methods and implementation techniques. Because the objective of this master's thesis is to examine suitable alternative policies for the current material control and implementation techniques, and guidance is not intended to lead fully on a material level, at this point general classification parameters are created for non project-specific materials. Finally, the developed material classification principle, in addition to material control methods and implementation techniques, are piloted with actual project materials to illustrate their impacts on the current situation.

7.3.1 Stock-based material control for non project-specific materials

As mentioned earlier, the current inventories are maintained and managed with different inventory management techniques. To some extent, for example, both non-valuable and valuable materials may be managed with the same techniques, or non-valuable materials may have different management methods. In this development proposal, three different inventory management techniques are proposed for materials that are controlled on a stock basis. The two-bin system and reorder point method are intended as current inventory management techniques, and VMI should be examined in more detail by further research. The development proposal proposes particular inventory management techniques for different materials, in order to facilitate and enhance the current inventory management policy. The two-bin system relies on visual cues to notice when the inventory of certain materials is running low, and its use is suggested for non-valuable and non-critical materials. Meanwhile, the reorder point method is suggested for critical materials whose shortage or unexpected breakage may have a significant impact on project delivery schedules.

First, the classification parameters for materials suggested to use the two-bin system are presented. With the help of these general classification parameters, the case company is able to further develop its stock-based controlled material policy, and identify some new materials that could be controlled on a stock basis in the future. General classification parameters for two-bin system-controlled materials are as follows:

- materials for which the total purchasing cost per one order line is less than unit price;
- materials that are purchased periodically with separate order lines during the year;
- materials that recur in at least three-quarters of all product types; and
- materials that are delivered directly to ABB Marine & Ports' production facilities.

If the above-presented conditions are not met, materials will be controlled on an order basis and purchased with a manual or automatic purchasing process. The purchasing of two-bin system materials is implemented with an automatic purchasing process.

As previously mentioned, the reorder point inventory management technique is designed to ensure the availability of critical materials by safety stocking them, for both new delivery and modernization projects. General classification parameters for materials that could be managed with a reorder point method are presented as follows:

- materials whose shortage significantly affects the continuous final assembly process and final project delivery schedule; and
- materials with relatively long delivery time and high supply risk.

As an area for further development, a more detailed classification of these materials could be based on a specific critical material analysis, but this issue is not covered in more detail in this master's thesis. The reorder point technique is a new material control method for new delivery projects. It is already being used, mainly to ensure the availability of certain materials for service operations, but also to control some materials for new modernization projects. Inventory management for service operations is not dealt with at a more specific level, as it would require different approaches than the traditional material management approaches and because it is not included within the scope of this master's thesis. The reorder point inventory management technique is carried out with the case company's ERP system and its MRP function, and the purchase of reorder point materials is implemented with manual and automatic purchasing processes. The classification parameters for materials that are suggested for purchase by an automatic purchasing process are explained in section 7.3.2.

The possibility of using a VMI as one of the three inventory management techniques should be examined further for the case company. In this context, VMI is defined as a collaborative strategy between a customer and supplier to optimize the availability of materials at a minimal cost to both companies. The supplier takes responsibility for the operational management of the inventory within a mutually agreed framework, and performance targets are constantly monitored and updated to create continuous improvement. Based on the theoretical background it could be a suitable option for the inventory management of C-class and non-critical materials, which are controlled for example with two-bin system. (Baily et al. 2005, p. 155-156) This inventory management technique could be beneficial for both parties; the case company could benefit from reduced acquisition and administration, inventory holding, and inventory stockout costs, and the supplier from a long-term customer relationship, enhanced operational flexibility, and smoothing of demand.

7.3.2 Order-based material control for non project-specific materials

According to the analysis and viewpoints presented in section 7.2.1, it is not reasonable to extend the current stock-based material control for non project-specific materials. Based on this conclusion, most of the non project-specific materials should be controlled on an order basis and purchased for a specific need, with target price negotiations being a mixture of contract and bid-and-order procedures. Because non project-specific materials recur in the same product types on a larger scale than project-specific materials, as demonstrated in Figure 29, and most of these materials are standard and easily manufactured components, tactical purchasing activities for all recurring materials should be performed systematically before purchasing. Instead of purchasing these materials on a project basis with a manual purchasing process from different suppliers, as decided by the purchaser, acquisitions could be centralized beforehand to specific suppliers, utilizing full purchasing power, and the purchasing process could also be enhanced with automation.

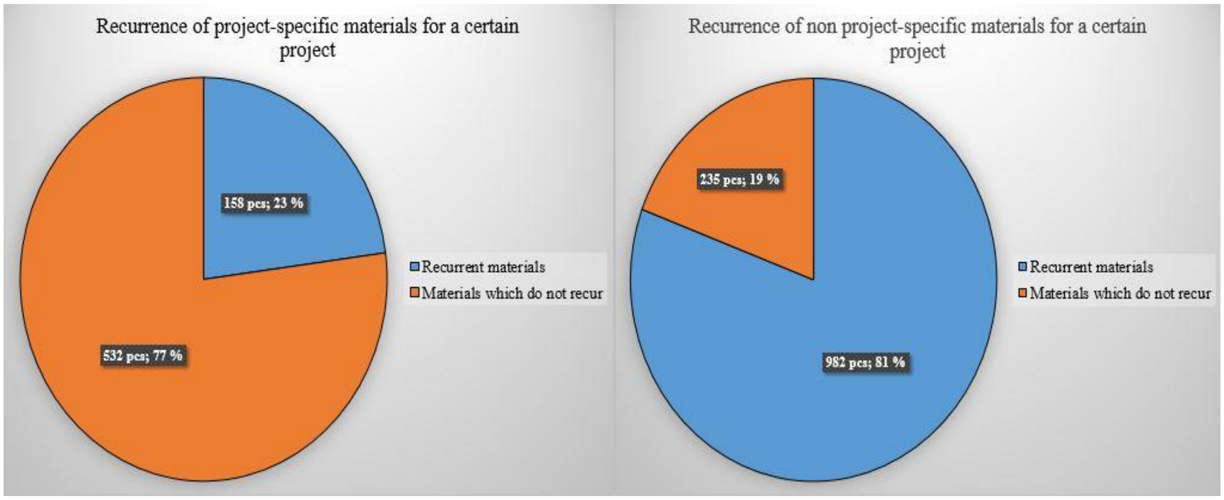

Figure 29. Recurrence of project-specific and non project-specific materials for a certain project.

The current price list principle is not considered to optimally support the acquisition of all non project-specific materials in a multi-project environment. With the help of tactical purchasing activities the purchasing process of recurring materials would become more straightforward, and repetitive negotiations, unnecessary bidding processes, and manual work stages could be reduced. Tactical purchasing activities could also support more a continuous and repetitive purchasing process, save time, and possibly decrease transaction and overall purchasing costs of these materials. Previous research indicates that most of the required non project-specific materials are predictable, and that acquisitions of these materials should be managed in a different way to project-specific materials.

In this development proposal, both manual and automatic purchasing processes are used in the implementation of order-based material controls for non project-specific materials. Automatic purchasing processes are based on tactical contract procedures, whereby ABB's own supply chain collaboration portal ASCC is exploited to enhance the efficiency of current purchasing processes. This approach is intended for materials that recur between the product types and that are purchased many times during one year. In addition, the automatic purchasing process is proposed for materials that are excluded from stock-based material control due to a high purchasing price. Meanwhile, the manual purchasing process is intended for single material needs, and materials that recur but are purchased on a smaller scale than materials in the circuit of the automatic purchasing process. The manual purchasing process is based on bid-and-order purchasing activities for single material needs and tactical target price negotiations for recurring materials, where entities and full purchasing power are utilized.

In order to recognize the materials that are suggested for purchase manually or automatically, general level material classification parameters are created for these materials. The parameters for materials purchased with an automatic purchasing process are as follows:

- reasonably priced materials;
- materials that are purchased often with separate order lines during one year; and
- materials that are delivered directly to ABB Marine & Ports' production facilities.

If the above-mentioned conditions are not met, materials should be purchased with a manual purchasing process.

7.3.3 Final material classification matrix for project-specific and non project-specific materials

According to the above-presented viewpoints, a final material classification matrix for project-specific and non project-specific materials has been generated. With the help of previously presented classification parameters and this classification matrix, materials classified as either order- or stock-based head-level materials can be exported under practical material control implementation techniques.

The final material classification matrix for project-specific and non project-specific materials is presented in Table 2. The first three columns describe how the order-based material control method ("Manual" or "Automatic") and the inventory management techniques of stock-based material control (the two-bin system, reorder point method, and VMI) are defined generally, in the ERP system (Man, Auto, Bulk, MRP, and VMI) and how the purchasing processes of these control methods are implemented in practice (manual purchasing process or automatic purchasing process). The tags A1, B1, C1, A2, B2, C2, A3, B3, and C3 refer to the head-level identifiers that were explained in chapter 7.2.2. For example, if a material has the head-level identifier “A1” it is denoted by “x” in the matrix and will be purchased for a specific need with a manual purchasing process. Meanwhile, if a material has the head-level identifier “C2” and meets the set parameters for the automatic purchasing process, it is denoted by “y” in the matrix and purchased for a specific need.

Table 4. Final material classification matrix for project-specific and non project-specific materials.

Final material classification matrix for project-specific and non project-specific materials											
Definition	**ERP system control parameter**	**Implementation technique in practice**	**A1**	**B1**	**C1**	**A2**	**B2**	**C2**	**A3**	**B3**	**C3**
Manual	Man	Manual purchasing process	“x”								
Automatic	Auto	Automatic purchasing process						“y”			
Two-bin system	Bulk	Automatic purchasing process									
Reorder point method	MRP	Manual purchasing process									
		Automatic purchasing process									
Vendor-managed inventory	VMI	*Further research subject*									

7.4 Development proposal piloting in practice

In order to determine the impact of the development proposal, the developed material classification principles and material control framework were piloted with actual delivery project materials. The purchased project materials of a certain product type were classified under the order- and stock-based material control methods and their implementation techniques, according to the above-presented classification parameters. Most of these classification parameters are based on actual material characteristics, which were defined with the help of interviews, statistical data analysis, and the findings and viewpoints presented in previous chapters. However, some general classification parameters need to be specified with hypotheses in order to make the calculations.

These hypotheses are related to the above-presented purchasing prices and purchasing frequencies of the two-bin system and automatic purchasing process. In this calculation the total purchasing cost per one order line is assumed to be approximately 100€ for non-critical and non-valuable materials, when all costs of purchasing activities before, during, and after the purchasing process are counted together. In turn, periodic purchasing frequency is defined as over 20 separate order lines in a year. According to these specified parameters, all materials with a purchasing price of under 100€ and which are purchased with separate order lines over 20 times per year, combined with the two other parameters presented above, are directed under stock-based material control and managed through the two-bin system. Meanwhile, the reasonable purchasing price for the automatic purchasing process is defined as the average purchasing price of materials that fulfill the other automatic purchasing process classification parameters. In this case, the purchasing frequency for frequently purchased materials is defined as over 10 separate order lines per year. According to this and the above-presented third parameter, the figure of 483€ is obtained as the reasonably priced level for materials purchased with the automatic purchasing process.

When observing the results of the new classification principle, it notably includes only materials that have been purchased manually according to the formed purchasing requisitions. Materials that have already been stored do not generate purchase requisitions for purchasing, even though they exist in released project structures. This means that in reality, the share of materials controlled on a stock basis is significantly greater than the presented values in this calculation. In addition, materials are directed under the stock- and order-based material control methods and their implementation techniques according to the existing purchasing data from the period of 1.1.2015 to 26.9.2016. Materials that were involved in this calculation have certainly been purchased for new delivery projects after the reference period, so the results of this example calculation may vary slightly compared with current results. Tables 3 and 4 present the results of the new material classification principle for a certain delivery project.

Table 3. Head-level material matrix classification for a certain delivery project.

Head-level material classification matrix for a certain delivery project.			
	A	**B**	**C**
Project-specific materials, order-based control (1)	41	53	85
Non project-specific materials, order-based control (2)	**-**	16	328
Non project-specific materials, stock-based control (3)			22

Table 4. Final material classification matrix for a certain delivery project.

Final material classification matrix for a certain delivery project.											
Definition	**ERP system control parameter**	**Implementation technique in practice**	**A1**	**B1**	**C1**	**A2**	**B2**	**C2**	**A3**	**B3**	**C3**
Manual	Man	Manual purchasing process	41	53	85	-	16	214	-	-	-
Automatic	Auto	Automatic purchasing process	-	-	-	-	-	114	-	-	-
Two-bin system	Bulk	Automatic purchasing process	-	-	-	-	-	-	-	-	22
Reorder point method	MRP	Manual purchasing process	-	-	-	-	-	-	-	-	-
		Automatic purchasing process	-	-	-	-	-	-	-	-	-
Vendor-managed inventory	VMI	*Further research subject*	-	-	-	-	-	-	-	-	-

As Tables 3 and 4 indicate, most of the purchased materials are classified on a head level into non project-specific materials, and these are suggested to be purchased for a specific need with a manual purchasing process. Notably, 67% of the purchased materials could have been classified differently compared to the current classification principle. When the calculation result is examined from the formed purchasing requisitions point of view, Figure 30 shows that another suitable material control method and implementation technique could have been applied for 25% of materials, which were purchased manually in this certain project. More specifically, this share of 25% means 480 separate order lines.

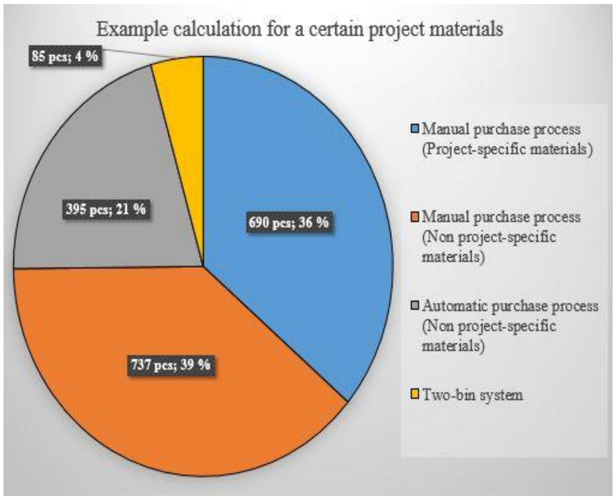

Figure 30. Example calculation for a certain project materials.

To demonstrate the overall impact of this development proposal, the same calculation was carried out for all purchased materials of a particular product type during the same reference period as used above. Tables 5 and 6 present the results of the new material classification principle for all certain product type materials. These tables indicate similar results to those in Tables 3 and 4, where most of the materials were classified as non project-specific and were suggested to be purchased for a specific need with a manual purchasing process. When observing the results below it is noteworthy that the same issues affect to this calculation as for the certain delivery project.

Table 5. Head-level material classification for all certain product type materials.

Head-level material classification matrix for all certain product type materials.			
	A	**B**	**C**
Project-specific materials, order-based control (1)	73	69	103
Non project-specific materials, order-based control (2)	-	32	493
Non project-specific materials, stock-based control (3)	-	-	22

Table 6. Final material classification matrix for all certain product type materials.

Final material classification matrix for all certain product type materials.											
Definition	**ERP system control parameter**	**Implementation technique in practice**	**A1**	**B1**	**C1**	**A2**	**B2**	**C2**	**A3**	**B3**	**C3**
Manual	Man	Manual purchasing process	73	69	103	-	32	373	-	-	-
Automatic	Auto	Automatic purchasing process	-	-	-	-	-	120	-	-	-
Two-bin system	Bulk	Automatic purchasing process	-	-	-	-	-	-	-	-	22
Reorder point method	MRP	Manual purchasing process	-	-	-	-	-	-	-	-	-
		Automatic purchasing process	-	-	-	-	-	-	-	-	-
Vendor-managed inventory	VMI	*Further research subject*	-	-	-	-	-	-	-	-	-

As a result, 69% of certain product type purchased materials could have been classified differently compared to the current classification principle. When the calculation result is examined from the formed purchasing requisitions point of view, Figure 31 indicates that another suitable material control and implementation technique could have been possible for 29% of certain product type materials, which were purchased manually. More specifically, this share of 29% means 2,014 separate order lines during this particular period.

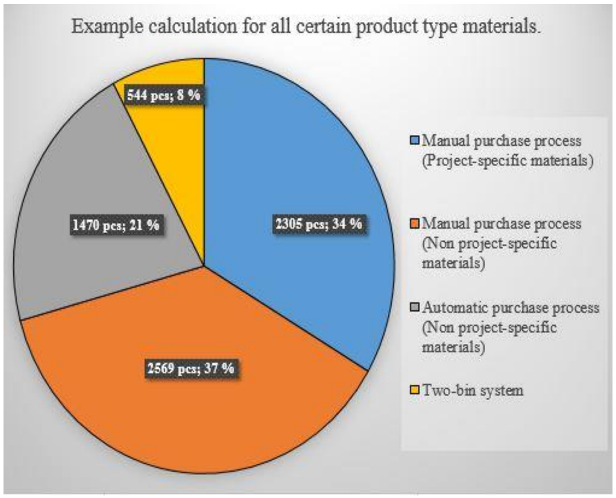

Figure 31. Example calculation for all certain product type materials.

7.5 Purchasing process modeling for the case company

Finally, the generated implementation technique processes of stock- and order-based material control methods were modeled for the use of the case company. Originally, the supply management organization did not have a process description for its existing purchasing process. With the help of the modeled processes, the case company is able to increase understanding of and facilitate communication about the processes between different parties, and to streamline the orientation of new personnel. In addition, the process descriptions were considered to be a first step towards using process-oriented operation methods, which are essential in a multi-project environment, and are useful for constant process development actions in the future.

Since the case company did not have any existing process modeling guidelines, the master's thesis worker modeled the generated implementation technique processes of stock- and order-based material control methods mainly according to the findings from interviews and statistical data analysis. The process modeling phase of this master's thesis consisted of the following main stages:

- Defining the main functions and activities of the current process from the AS-IS perspective.

- Defining the current problems and areas for development of the existing process.
- Defining the main functions and stages of the developed implementation processes from the TO-BE perspective.
- Modeling preliminary process descriptions.
- Refining and improving the process descriptions.
- Approving the process descriptions.

The case company's purchasing process was considered to be a sub process of the order-delivery process, which receives an impulse from engineering or after-sales organizations in the form of purchasing requirements, and produces an output which is a physical product supplied by a vendor. The main functions of the processes consist of internal, external, and supportive actors and their various activities which are required in the implementation of the sub process. The main internal actors of purchasing processes were categorized as engineering and after-sales, supply management, quality control, and warehouse and invoice handling organizations. In turn, the most essential external and supportive actors were classified as the vendor, classification societies, the ERP system, and ASCC. In addition to the common purchasing process activities presented in section 3.3, some special business environment-related activities were identified as affecting purchasing processes. These special activities were the coordination of multistage supply chains, quality inspections, product tests, factory acceptance tests (FAT), and material deliveries to locations other than ABB Marine & Ports' production facilities.

The potential areas for development were identified by comparing the findings from statistical data analysis with current operation methods. New purchasing processes were then modeled from the TO-BE perspective according to the generated development proposal. The final three process modeling phases were performed with the master's thesis instructors. First, the accuracy levels of the process model descriptions were decided. Preliminary process descriptions were then modeled and improved according to feedback from instructors. Finally, the first revisions of the process descriptions were approved.

The traditional cross-functional flowchart, also known as a swim lane flowchart, was selected for the process modeling method. According to general opinions, this modeling principle was considered to be a clear and simple method for processes modeling, and this selection also supported the fact that the benchmarked organizations had modeled their purchasing processes with this method. The Microsoft Visio tool was chosen for process modeling, because the supply management organization did not previously have any specific tool for process modeling. In addition, the company already used Microsoft Office programs for other purposes, Microsoft Visio is a common modeling tool for cross-functional flowcharts, and the program was easily available on the ABB MyIs web portal.

Common recommendations about good process modeling practices were used to model the generated implementation technique processes of stock- and order-based material control methods. The aim of process modeling was to model processes as straightforwardly and logically as possible, so that the reader could understand them and form an overall picture of the purchasing process and its various activities. For further development actions, the case company should create a standardized approach to how process modeling is carried out in practice. The standard process modeling approach could include, for example, a general questionnaire for process modeling, the content of the different stages of modeling practices required for process modeling activities, who is responsible for maintaining and developing processes, how processes are intended to be measured, and where the modeled processes can be found.

The implementation technique processes of stock- and order-based material control methods were modeled with different accuracy levels, because some of the purchased materials included activities that did not recur between all purchased materials. The manual purchasing process for project-specific materials is a good example of the variation of different activities within the purchasing process; this head-level material group includes materials, which either require or do not require the case company's own quality inspection activities before deliveries. Another example is related to non project-specific materials, some of which are purchased by ABB Marine & Ports but delivered to suppliers for final assembly purposes. Because of the variations in activities, the decision was made to model the manual purchasing process for project-specific and non project-specific materials at a general level. If all possible alternative activities were described, this would have resulted in a large number of individual process descriptions, and this approach would not optimally support the objective of this master's thesis. Instead, the automatic purchasing processes of non project-specific materials were modeled as accurately as possible, because these processes are intended to be performed in accordance with standard operation methods.

At this stage the purchasing process of VMI was not modeled, since in this master's thesis it was stated that this process could be used as an alternative inventory management technique for materials that are currently controlled on a stock basis and managed with the two-bin system. The possibility of using this method in practice should be examined in more detail before development work is taken to the process level.

8. CONCLUSION

Based on the results of this study, the case company's purchasing process can be enhanced, to a certain point, by a new material classification principle and a new material control model. The new development proposal aims to clarify and streamline the purchasing process of certain materials, to make savings from the total cost of ownership, and to improve the company's competitive position in an indirect manner through innovations to the purchasing process. The researcher's opinion is that the current principle, where almost all materials are considered as identical and handled in same manner, does not support continuous and recurrent processes of the multi-project environment in best possible way. With the help of the generated material classification, the supply management organization is able to expand its material classification to the material level, and manage materials according to their characteristics on a continual basis rather than separately for each project.

According to the presented results and viewpoints of the development proposal, most of the required materials will be acquired for a specific need in the future. However, the current operation can be enhanced by utilizing an automatic purchasing process for non project-specific materials, as well as adding some recurrently purchased materials under the two-bin inventory management system. With the use of these actions alone rather than the manual purchasing process, 2,014 separate order lines of a particular product type could have been managed otherwise. The outcome for 2017 is predicted to be similar for materials that were included in the development proposal pilot calculation. This forecast is based on the future order backlog and on the strong assumption that the type of project structures will remain the same as over the past two years. Even though the focus of this particular product series will be on another product type in 2017, the comparison of non project-specific materials indicates that 82% are recurring between the different product types of this particular product series. This result is presented in Figure 32.

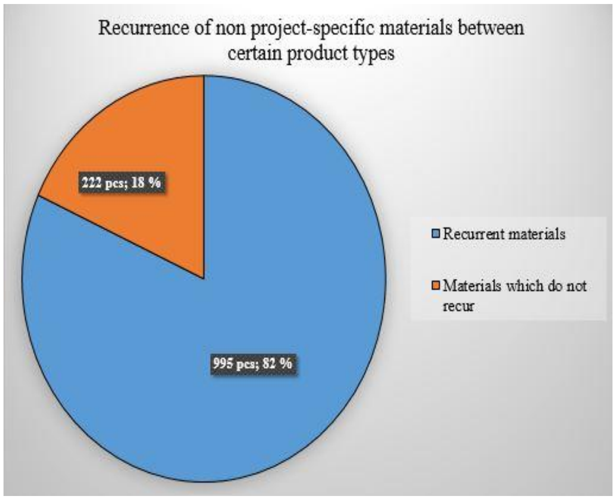

Figure 32. Recurrence of non project-specific materials between certain product types.

The case company's production more closely resembles one-off production, where production volumes are small compared to serial or mass production, the amount of recurrent materials between all product types is minimal, and the active delivery project scopes vary smoothly with the production plan. As a result, increasing the use of stock-based material control is not a sensible strategy in terms of the overall solution. In principle, the number of separate acquisitions could be reduced with larger-scale storing but this would tie up unnecessary capital to inventories and the inventory turnover time would be weak with this type of product portfolio.

Instead, the current small-part storage could be developed into a VMI system, whereby only the administration of materials on an ERP system is the responsibility of the case company. Otherwise, the suppliers would be in charge of ensuring optimal service levels and operational management of the inventory. The materials are located, as before, in the case company's physical warehouses in connection with the production facilities, but they would be in the ownership of suppliers and invoiced according to their consumption. From their point of view, the case company would benefit from a VMI system by reduced acquisition and administration, inventory holding, and inventory stockouts costs. In addition, by safety-stocking critical materials according to a specific critical material analysis, the case company could minimize risks related to project delivery schedules and be better prepared for unforeseen situations.

In the future, the case company's material classification matrix for project-specific and non project-specific materials could resemble Table 7.

Table 7. Prospective material classification matrix for project-specific and non project-specific materials.

Prospective material classification matrix for project-specific and non project-specific materials.											
Definition	**ERP system control parameter**	**Implementation technique in practice**	**A1**	**B1**	**C1**	**A2**	**B2**	**C2**	**A3**	**B3**	**C3**
Manual	Man	Manual purchasing process	x	x	x	-	x	x	-	-	-
Automatic	Auto	Automatic purchasing process	-	-	-	-	-	x	-	-	-
Two-bin system	Bulk	Automatic purchasing process	-	-	-	-	-	-	-	-	x
Reorder point method	MRP	Manual purchasing process	-	-	-	x	x	-	-	-	-
		Automatic purchasing process	-	-	-	-	-	x	-	-	-
Vendor-managed inventory	VMI	*Further research subject*	-	-	-	-	-	-	-	-	x

When thinking about the future, the case company should consider how it could further standardize the current product portfolio on a structural level between different product types. Unified module structures would enable the exploitation of full purchasing power more systemically, and increase the efficiency of the developed purchasing process even further. Another question is related to the ability to systematically use the benefits of module structures: is it possible to use them in an optimal way with a pure ETO production control method, where all project structures go through an engineering process before purchasing activities? This mode of operation, as shown in interviews, creates uncertainties about the final project structures even between the same product types. However, as most of the delivered propulsion units have been more recurrent than unique solutions, should the future material control of recurring materials be based on material requirements planning instead of outputs from project-specific engineering work?

It is noteworthy that the calculation, which was presented in Chapter 7, is completely based on the purchased materials of one specific product type. The development proposal created in this master's thesis was also tested in practice only with the materials of one product type, since the objective of the master's thesis was to examine suitable alternative policies for the current material classification approach, in addition to material control implementation techniques, without expanding the development actions fully on the material level. However, the aim of practical testing was to explore and demonstrate how new material classification principles and a new material control framework could affect the current operation. At this stage, the developed model has great potential to enhance the purchasing process of new delivery projects, but is also suitable for service team purchasing activities. In addition, some assumptions that were not based on unequivocal calculations were used as classification parameters for the two-bin system and automatic purchasing process. Therefore, the presented results of calculations are in a certain way suggestive, and not precise.

In the future, systematic cooperation between sourcing and purchasing with non project-specific materials is also important, so that the purchasing process is efficient from the total cost of ownership viewpoint. In particular, this relates to materials that are recurring between different product types. The purchasing process of these materials should be as straightforward as possible, and should be based on target price negotiations between a mix of contract and bid-and-order procedures, where acquisitions are proactively centralized to specific suppliers. The possible saving potential of these materials is not based on competitive bidding or comparing activities from a single project perspective, but rather on the efficient processing of recurrent purchasing processes and using the possible volume benefits from the multi-project management perspective. This approach would probably require cooperation with other internal organizations, such as engineering, together with product engineering and updates. It is also important to agree common approaches; for example, how possible revision updates are run systematically for materials, and which acquisitions might be based on agreed volume supply contracts in the future.

With the help of the material control implementation techniques modeled in this master's thesis, the supply management organization could increase process-oriented thinking and operation methods within its organization, and facilitate communication and understanding of its processes between other parties. In addition, the modeled processes could ease the orientation of new personnel and help to form an overall picture of the entire process and its various stages. In the future, the supply management organization should develop a performance measurement system for its processes, which would enable continuous analysis and actions for the improvement of processes. Furthermore, automatic purchasing processes should undergo a test period on a smaller scale, and be improved based on the findings, before being extensively implemented.

9. SUMMARY

The objective of this master's thesis was to examine alternative policies for current material classification principles, in addition to material control methods and implementation techniques, in order to develop the case company's purchasing process in a more efficient and flexible direction. The study consisted of a theoretical part, where the relevant literature was examined, and an empirical part, where qualitative research methods were used to compare the current operating methods and the contents of delivered Azipod® propulsor solutions. Based on the findings from these theoretical and empirical frameworks, a development proposal was then created to develop the efficiency of the current purchasing process.

The theoretical framework presented an overview of multi-project business and its environment, characteristics, and challenges and differences compared to single-project and traditional business environments. This part of the thesis also examined how organizations can enhance their operations in a multi-project environment, and what types of changes this requires from current practices. As delivered projects are rarely completely unique solutions, and to an increasing extent consist of recurring operations, process-oriented approaches and the simultaneous management of projects as one large entity are considered to be key factors in improving the efficiency of operations in a multi-project environment.

According to the findings of this master's thesis, the delivered propulsion units were recurrent on a larger scale than completely unique solutions during the last two years. The current operation methods, where almost all materials are seen as identical and handled in the same manner, were thus challenged. Subsequently, a new material classification principle and new material control model with different implementation techniques were created for the use of the case company.

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Appendix A, List of interviewed persons

ABB Marine & Ports

Purchasing engineer, (Vuosaari, 23.5.2016)

Purchasing engineer (Vuosaari, 18.8.2016)

Purchasing engineer (Vuosaari, 18.8.2016)

Purchasing engineer (Vuosaari, 18.8.2016)

Purchasing manager (Vuosaari, 25.8.2016)

Purchasing engineer (Vuosaari, 25.8.2016)

Purchasing engineer (Vuosaari, 29.8.2016)

Sourcing manager (Vuosaari, 8.8.2016)

Sourcing manager (Vuosaari, 8.8.2016)

Sourcing manager (Vuosaari, 15.8.2016)

Purchasing manager (Vuosaari, 8.8.2016)

Purchasing manager (Vuosaari, 8.8.2016)

Supply chain manager (Vuosaari, 15.8.2016)

Logistics and warehouse manager (Vuosaari, 6.7.2016)

Product engineering and updates team manager (Vuosaari, 12.9.2016)

Benchmarking

ABB Drives (Pitäjänmäki, 7.3.2016)

ABB Motors and Generators (Pitäjänmäki, 7.9.2016)

Appendix B, Internal interview questionnaire for purchasing engineers/purchasers

Ostoprosessin nykytilan selvitys

Nimi:	Työtehtävä:
Ostotiimi:	Kokemus ostajana:

ABB:n sisäinen haastattelu

Taustaa:
Haastattelu on osa diplomityöni empiirisen tutkimusaineiston hankintaa. Diplomityöni aiheena on nykyisen ostoprosessin analysointi ja kehittäminen. Työssä pyritään selvittämään nykyisen ostoprosessin ongelmat ja miten sitä voidaan kehittää entistä tehokkaampaan ja joustavampaan suuntaan.

Alustavat kysymykset:

Ostettavat komponentit:

1. Mitkä komponentit kuuluvat vastuualueellesi?
2. Mihin kokonaisuuteen/moduuliin komponentit kuuluvat?
3. Millaisia haasteita komponenttien tilaus-toimitusprosessissa on?
4. Kuinka laaja toimittajakenttä näillä komponenteilla on?
5. Eroavatko ostettavat komponentit eri tuotteiden välillä? Entä saman tuoteryhmän projektien kesken?
6. Voiko ostamiisi komponentteihin tulla yllättäviä muutoksia kesken tilaus-toimitusprosessin? Millaisia?
7. Millaisia revisiointimuutoksia komponentteihin yleensä tulee?

Toimittajayhteistyö ja kysynnän jakaminen:

1. Millaista yhteistyötä teet toimittajien kanssa ja miten kuvailisit yhteistyön luonnetta?
2. Jaatko tietoa tulevista projekteista ja tarpeista toimittajakenttään? Mikäli kyllä niin miten ja teetkö yhteistyötä talon sisällä datan luomisessa?
3. Pitäisikö toimittajayhteistyötä kehittää entisestään vastuullasi olevien komponenttien osalta ja miten?
4. Ilmeneekö samoista resursseista kilpailu uudispuolen ja servicen välillä?

Ostoprosessi:

1. Kuinka monta ostoriviä teet keskimäärin a) päivässä b) viikossa c) kuukaudessa tai d) kokonaista projektia ajattelen?
2. Ehditkö hyvin ostaa kaikki projektikohtaiset vastuullasi olevat komponentit?
3. Onko ostotoimintasi enemmän reaktiivista vai proaktiivista?
4. Kumpi on merkittävämpi osa työtäsi a) uusien tilausten tekeminen vai b) toimitusten koordinointi ja seuranta?
5. Teetkö itse päätöksen toimittajasta miltä hankit tarvittavat komponentit vai onko projektikohtainen toimittaja päätetty etukäteen?
6. Täytyykö sinun koskaan varmistaa, että onko jokin hankinta-aloite ajankohtainen vai ei?
7. Miten kuvailisit tämänhetkistä ostoprosessiasi ja sen päävaiheita?
8. Mikä on roolisi ja vastuusi nykyisessä ostoprosessissa?
9. Mitkä ovat mielestäsi nykyisen ostoprosessin suurimmat ongelmat?
10. Miten kehittäisit nykyistä ostoprosessia vastuullasi olevien komponenttien osalta?

Hankintastrategiat:

1. Miten ABB Marinen hankintastrategiat vaikuttavat ostoprosessiisi?
2. Miten kategorisoisit vastuullasi olevat komponentit ABC – luokitusta käyttäen?
3. Jos ajatellaan Kraljičin strategisen hankinta-ajattelun (Liite) pohjalta vastuullasi olevia komponentteja, mihin kategoriaan sijoittaisit komponentit ja miksi?

4. Onko nykyinen pääasiassa projektikohtainen ohjausmenetelmä tehokkain tapa hankkia vastuullasi olevat komponentit? Miten kehittäisit komponenttiesi nykyistä hankintastrategiaa?
5. Sisältävätkö ostamasi komponentit jotain erityispiirteitä mitkä pitää ottaa huomioon hankintastrategioita ja ohjausmenetelmiä kehitettäessä? (esim. luokitus, monivaiheinen toimitusketju jne.)
6. Mitä mieltä olet erilaisten varastointimahdollisuuksien (raaka-aine, puolivalmiste, valmis tuote) käytöstä ostamiesi komponenttien osalta?
7. Kuinka hyvin pääset hyödyntämään volyymietuja ostamiesi komponenttien kanssa?

Liite:


Suuri
Pieni
Hankintojen strateginen merkitys
osuus kokonaiskustannuksista
ja tulosvaikutus
Volyymihankinnat:
Hinta edellä
Kilpailuttaminen
Tiivis toimittajajoukko
Tehokas logistiikka
Strategiset hankinnat:
Pitkäjänteisyys
Jatkuva kehittäminen
Kumppanuus
Ei-kriittiset hankinnat / rutiinituotteet:
Tehokkuus
Tehokkuus
Tehokkuus
Pullonkaulahankinnat:
Saatavuuden varmistaminen
Vaihtoehtoisten toimittajien etsintä
Pitkäaikainen yhteistyö
Pieni
Markkinoiden monimutkaisuus
Suuri
Ostajan markkinat
hankinnan riski
Myyjän markkinat


Hankinnan ostoportfolio Kraljicin mukaan
suuri
pieni
Tarjonnan vaikutukset
Volyymihankinnat
suuri tulosvaikutus
pieni riski tarjontaan
varmista saatavuus
kilpailuta
Strategiset hankinnat
suuri tulosvaikutus
suuri riski tarjontaan
kehitä yhteistyötä
Rutiinihankinnat
pieni riski tulosvaikutukseen
pieni riski tarjontaan
käsittele tehokkaasti
yksinkertaista
Pullonkaulahankinnat
pieni riski tulosvaikutukseen
suuri riski tarjontaan
harkitse ostopolitiikkaa
yritä päästä eroon
suuri
Tarjonnan riskit

Appendix C, Internal interview questionnaire for sourcing managers

Haastattelu

Haastateltava:
Tehtävä:

Taustaa:
Haastattelu on osa diplomityöni empiirisen tutkimusaineiston hankintaa. Diplomityöni aiheena on nykyisen ostoprosessin analysointi ja kehittäminen. Työssä pyritään selvittämään nykyisen ostoprosessin ongelmat ja miten sitä voidaan kehittää entistä tehokkaampaan ja joustavampaan suuntaan.

Kysymykset:

Mitkä komponentit ovat vastuullasi ja mihin kokonaisuuteen komponentit kuuluvat?
Muuttuuko vastuullasi olevin komponenttien design säännöllisesti vai ovatko komponentit standardeja projektista toiseen?
Kuinka laaja toimittajakanta komponenteilla on?
Miten vastuullasi olevia komponentteja ohjataan strategisesta näkökulmasta ajatellen?
Miten vastuullasi olevien komponenttien hankintastrategioita voidaan tehostaa nykyiseen toimintaan verrattuna?
Mitkä ohjausparametrit tulisi ottaa huomioon komponenttien ohjausmenetelmiä uudistaessa?
Miten operatiivista ostoprosessia voidaan tehostaa vastuullasi olevien komponenttien osalta?
Minkälaisia ongelmia komponenttien suhteen ilmenee tai on ilmennyt toimituksen aikana ja sen jälkeen?
Millaisia sopimuksia toimittajien kanssa tehdään?

Appendix D, Internal interview questionnaire for purchasing managers

Haastattelu

Haastateltava:
Tehtävä:

Taustaa:
Haastattelu on osa diplomityöni empiirisen tutkimusaineiston hankintaa. Diplomityöni aiheena on nykyisen ostoprosessin analysointi ja kehittäminen erilaisten materiaalinohjausmenetelmien avulla. Työssä pyritään selvittämään nykyisen ostoprosessin ongelmat ja miten sitä voidaan kehittää entistä tehokkaampaan ja joustavampaan suuntaan.

Kysymykset:

Mitkä ovat nykyisen ostoprosessin suurimmat ongelmat (ennen, aikana ja jälkeen) ja kehityskohteet?
Mihin suuntaan ostoprosessia tulisi mielestäsi kehittää?
Mihin tekijöihin tulisi kiinnittää erityistä huomiota ostoprosessia kehitettäessä?
Minkälaista tietoa haluat tulevaisuudessa ostoprosessin tehokkuudesta?
Mitä toimenpiteitä nykyisen ostoprosessin tehostamiseksi on jo tehty työn aikana?

Appendix E, Internal interview questionnaire for supply chain manager

Haastattelu

Haastateltava:
Tehtävä:

Taustaa:
Haastattelu on osa diplomityöni empiirisen tutkimusaineiston hankintaa. Diplomityöni aiheena on nykyisen ostoprosessin analysointi ja kehittäminen. Työssä pyritään selvittämään nykyisen ostoprosessin ongelmat ja miten sitä voidaan kehittää entistä tehokkaampaan ja joustavampaan suuntaan.

Kysymykset:

Miten ABB Marinen hankintoja tällä hetkellä johdetaan?
Millaisia hankintastrategioita ABB Marinella on tällä hetkellä?
Mihin suuntaan ja miten ABB Marinen ostoprosessia tulisi mielestäsi kehittää?
Mitkä ovat hankinnan ja oston roolit sekä vastuut tulevaisuudessa?
Mitkä ovat hankintatoimen suurimmat haasteet tulevaisuutta ajatellen?
Millaista tietoa haluaisit tulevaisuudessa ostoprosessin suorituskyvystä?

Appendix F, Internal interview questionnaire for benchmarking

Benchmark

Päivämäärä:

Tausta ja tavoitteet:

ABB Marine & Ports Propulsion Products toimittaa aluksiin Azipod-ruoripotkurijärjestelmiä. Toiminta on hyvin projektipohjaista tarkoittaen, että jokainen projektitoimitus suunnitellaan erikseen. Jokaisesta ostettavasta materiaalista muodostuu projektilla lähtökohtaisesti oma hankinta-aloite ja ostorivi, eli yhdelle projektille tehdään toimitusprojektin laajuudesta riippuen huomattava määrä hankintoja projektikohtaisesti vaihtelevilta toimittajilta.

Tilauskannan kasvun myötä meillä on tarve vähentää operatiivisen oston kuormitusta toimintaa tehostamalla. Benchmarkin avulla pyritään löytämään muualta uusia ja parhaita käytäntöjä tätä varten.

Kysymysten tarkoituksena on saada konkreettisia esimerkkejä siitä miten ostotoimintaa on kehitetty muissa toimintaympäristöissä. Tässä kyselylomakkeessa esitettyjen kysymyksien on tarkoitus olla suuntaa-antavia itse benchmark tilaisuudelle, missä asiakokonaisuutta käsitellään tarkemmin läpi. Konkreettisten esimerkkien lisäksi, toivomme, että saisimme nähdä esityksiä prosesseista ja käytännön toimintatavoista.

Paikalla:

Kysymykset:

Materiaalinohjaus:

- Minkä tyyppisiä suoria hankintoja teette?
- Miten hankittavat materiaalit on kategorisoitu ja mitkä parametrit ohjaavat materiaalien kategorisointia?
- Miten materiaalinohjaus eri kategorioiden materiaaleille tapahtuu?

- Miten materiaalinohjaus tapahtuu toiminnanohjausjärjestelmässä?
- Miten mahdolliset materiaalien revisioinnit on otettu huomioon eri materiaalinohjaustavoissa?
- Onko Servicen ostotoiminnalle olemassa erilaiset prosessit ja toimintatavat kuin uusille tuotteille?

Hankinta:

- Millaisia sopimuksia teette toimittajien kanssa?
- Onko ostovolyymit jaettu tiettyjen toimittajien kesken hankinnan toimesta, vai tekeekö ostaja päätöksen toimittajasta aina tilauskohtaisesti?
- Kuinka hyvin saatte hyödynnettyä volyymietuja hankittavien materiaalien osalta?
- Miten ja missä muodossa kysyntätietoa viedään alihankkijoille?

Ostoprosessi:

- Onko teillä prosessikuvausta operatiiviselle ostotoiminnalle? Millä tasolla kuvaus on tehty?
- Miten ostoprosessia on kehitetty aiemmin tai tullaan kehittämään jatkossa?
- Millaisia muita kehityshankkeita teillä on menossa hankinnan ja ostotoiminnan osalta?