Master Thesis

Supply Chain Promise of Spare Parts

Student: Stefan A. Veldhuis
Master Business Administration at the University of Twente
Student number: S1132989
Student mail: s.a.veldhuis@student.utwente.nl

1st supervisor UT: Dr. Niels Pulles
2nd supervisor UT: Dr. Matthieu van der Heijden

Supervisor Thales NL: Berend Jongebloed

A standard template of Thales is used for this master thesis.

Supply Chain Promise of Spare Parts

What to promise the customer regarding different categories of customer demand?

Master Thesis Business Administration

Enschede, 24-07-2015

Author:

Stefan A. Veldhuis

S1132989

s.a.veldhuis@student.utwente.nl

1st supervisor UT: Dr. Niels Pulles

2nd supervisor UT: Dr. Matthieu van der Heijden

Supervisor Thales NL: Berend Jongebloed

MANAGEMENT SUMMARY

This thesis is the result of a research, conducted within Thales, regarding the replenishment of spare parts. This research is focused outside-in, from the view of the customer. Customer demand is mapped, differentiated, improvements are suggested and the supply chain promise per category of customer demand is formulated.

The main research question is: '*How can the service, with regard to the replenishment of spare parts, be improved and priced by means of a differentiation of customer demand?'* In order to answer the main research question it is investigated how customer demand should be differentiated, how the service can be improved with regard to these different categories of customer demand, which pricing strategies should be used to price spare parts within different groups of customer demand and how to implement the differentiation within Thales as well as within the supply chain promise to the customer.

Methods

To investigate how customer demand should be differentiated, interviews are held at the Royal Netherlands Navy to investigate the different categories of customer demand. Furthermore, internal interviews are held to validate the results of the interviews at the Royal Netherlands Navy with respect to customers worldwide. Subsequently, the customer demand categories are quantified by an analysis of a Logistic Engineer of Thales. Based on the customer demand categories, a theoretical maintenance model and literature about the urgency of demand, customer demand is differentiated.

Based on literature about the criticality of spare parts and information sharing and communication suggestions are made for improvement. Besides, an interview is held at Transportation Systems, to investigate what can be learned from their replenishment process. Thereby, more suggestions for improvement are made. Subsequently, input from the internal interviews is used to propose several improvements.

To investigate how the spare parts should be priced, pricing strategies are discussed which are described within literature. Thereafter, input from the internal and external interviews is used to investigate which pricing strategies are appropriate for different categories of customer demand.

The implementation of the differentiation model with improvements is investigated by internal interviews. Thereby, it is proposed how to implement the differentiation model with improvements within Thales and how to communicate the supply chain promise to the customer.

Results

Demand for Line Replaceable Units, Shop Replaceable Units, Preventive Spare Parts and Overhaul Spare Parts can be anticipated on, because it is expected or even plannable that these spare parts are needed during the lifetime of a system. Demand for Components, Specials and Emergency Requests cannot be anticipated on, because it is not expected that these spare parts are needed during the lifetime of a system. It showed that unanticipated demand is more urgent to the Navy, because the Navy has already anticipated on most anticipated demand. The Differentiation Model shall be validated at the Royal Netherlands Navy and the employee of the Navy which sends the request shall already indicate in which category the request fits. The Sales Support Employee of Thales should recognize and validate in which category the request fits.

Improvement can be made regarding information sharing and communication. Spares lists including Price, Lead Time, MTBF, Where Used, Criticality, Export Regulations, Tendering Regulations and Influence of Partners Involved can be communicated to the customers. Subsequently, the Material Manager of the Navy can include this information in their ERP system. After Sales Managers shall also keep communicating with Navies about their maintenance model and maintenance planning and share this information proactive within Thales. Thereby, it can be better anticipated on Preventive Spare Parts and Overhaul Spare Parts.

Within the Navy as well as within Thales, per order, one person should be responsible and posses information regarding the order. Therefore, within the Navy as well as within Thales, information should be shared proactively. For example, regarding the need for spare parts, maintenance planning and order status. Sensitive information, like the usage of systems and actual failures of spare parts, can be shared under a Non Disclosure Agreement.

Common *Components* can be delivered out of stock and included in the Spares List. When the Repair Planner of the Navy has a need for a Non-Common Component, the Repair Planner should call the Service Desk for the best and fastest solution. When the Installation Manager of the Navy has a need for a Special, the Installation Manager should call the Service Desk for the best and fastest solution.

Emergency Requests should be minimized by investigating the causes of Emergency Requests and cooperation between the Navy and Thales to eliminate these causes.

Pricing

This research showed that it is hard to introduce customer value based pricing, priority pricing or dynamic pricing in a business to government context. Therefore, prices of spare parts can differ, based on the cost of the improvement for the specific spare part. Further research is needed regarding the implementation of customer value based pricing.

Recommendations to the Navy

Material Managers and Installation Managers should share information regarding actual failures of spare parts and usage of systems. Installation Managers should share information regarding maintenance planning and overhaul spare parts needed. When there is a need for a Non-Common Component of Special, the Installation Managers and Repair Planners should call the Service Desk. Organize weekly meetings with Installation Managers, Material Manager, Finance Department and Project Procurement Officer/Senior Purchaser to share information.

Recommendations to Thales

Sales Support provide timely confirmation of orders. Criticality, Export Regulation, Tendering Regulation, Influence of Partners should be included in spares lists as well as common Components. Sales Support and Logistic Engineering should investigate demand patterns of common Components. Sales Support should mark Emergency Requests, investigate and report the causes. Organize weekly meetings with Sales Support, Service Delivery, Service Desk, Purchase/Production to share information. Further investigate pricing of spare parts and start a pilot with the Royal Netherlands Navy regarding the abovementioned improvements.

PREFACE

In order to earn my master degree in Business Administration, I executed this research. However, I learned a lot more than only executing a research. During this research, I learned a lot about working, presenting and communicating in a large, technical and innovative company like Thales. This has made a great contribution with regard to my personal development. Therefore, I would like to thank my supervisor, Berend Jongebloed, as well as Jan van Rijn and John Jansen.

This research was conducted within Thales NL, location Hengelo, and commissioned by Service Development within the business unit Customer Services and Support. I had a great and interesting time during half a year. Therefore, I would like to thank all my colleagues within Service Development, but also the colleagues of the other sub-units within Customer Services and Support. I interviewed and talked to a lot of people, during the execution of this research, and would like to thank all these people for their time, knowledge and interesting talks.

I also would like to thank the employees who made time for my interviews at the Royal Netherlands Navy and Thales Transportation Systems. Furthermore, I would like to thank my supervisors at the University of Twente, Niels Pulles and Matthieu van der Heijden, for their support, advice and comments. Personally, I would like to thank my parents, brother, sister, girlfriend, family and friends for their support and advice.

Table of Contents

1. INTRODUCTION

1.1. Context of the research

This research is conducted within Thales NL. The customers of Thales NL are not satisfied, with regard to the replenishment of spare parts. Thales NL expects that, by increasing the customer satisfaction, the sales and after sales can grow. Therefore, the service to the customer regarding the replenishment of spare parts needs to be improved. Within Thales, a dedicated project team is working on this improvement. In parallel the “Supply Chain Promise of Spare Parts” towards the customer shall be defined. In other words, what can the customer expect from Thales regarding the replenishment of spare parts. Therefore, improvements of the service are proposed and the ‘Supply Chain Promise of Spare Parts’ is based on these improvements. The internal project team is using an “inside-out” approach. Therefore, this research shall be based on an “outside-in” approach. Hence, it is investigated from the view of the customer. Before the research is addressed in section 1.3, a short introduction of Thales, their products, market and the business unit Customer Services and Support is given.

1.2. Thales

The Thales Group is a key player in the aerospace, space, ground transportation, defence and security industry. The main statement is that wherever safety and security are critical, Thales delivers. By innovating together with customers, smarter solutions are build.

The Thales Group has around 65.000 employees and is present in 56 countries, an impression of that is shown in Figure 1. Appendix 1 shows that the Thales Group is most active in France, United Kingdom and Germany. In the recent years, Thales is growing and their revenues have increased. Figures and numbers are shown in Appendix 1.

Figure 1: Global Presence

In the Netherlands, Thales has a workforce of approximately 2.030 employees and is located in Hengelo (headquarter), Huizen, Delft and Eindhoven. The main markets of Thales NL are naval systems, land defence, transportation systems in the civil market, cryogenics and cyber security markets. The headquarter in Hengelo is mainly focused on the naval systems market and it is a Business to Government (B2G) business. Approximately 1600 employees are working in Hengelo.

This research is conducted within Thales NL-location Hengelo and this is referred to in this thesis as Thales. Besides, the experiences of Thales Transportation Systems-location Huizen are used with regard to improving the service. This is referred to in this thesis as Transportation Systems, to make a clear distinction between the two different sectors.

1.2.1. Products

Thales produces several products and services. Table 1 shows the key products and services and where the products are produced.

Table 1: Product examples per industry and location

Location	Markets	Products and services
Hengelo	Naval Systems	Combat Management Systems
		Program Management and System Integration
		Customer Services and Support
	Sensors	Integrated Mast
		Surveillance Equipment
Huizen	Land defence	Communication systems
	Cyber security	Security software
	Transportation Systems	Smart-card
Eindhoven	Cryogenics	Cryocoolers
Delft	Sensors	R&D

Figure 2 shows the TACTICOS Combat Management System, which integrates different surveillance and warfare equipment into one combat management system. The TACTICOS Combat Management System is one of the main products of Thales and is produced in Hengelo.

Figure 2: TACTICOS Combat Management System (source: www.naval-technology.com)

Figure 3 and 4 show examples of surveillance equipment and an integrated mast, also main products of Thales which are produced in Hengelo. The Smart L Volume Search Radar and the Integrated Mast (IM-400).

Figure 3: Smart L Volume Search Radar (source: www.marineschepen.nl)

Figure 4: Integrated Mast (IM-400) on a navy ship (source: www.navaltoday.com)

1.2.2. Market

1.2.2.1. Competitors

Thales has several competitors. Table 2 shows the main competitors, ranked by total annual sales. Thales is also added to the Table, to show their position amongst competitors.
All these competitors have their own home-market. Within this industry, there is generally little competition within the home-markets. Thus, the main competition is within markets which are not home markets of one of the competitors. The main markets of Thales are UK, France and the Netherlands.

Table 2: Main competitors of Thales

Main competitors	Workforce (#employees)	Annual Sales (in millions, 2013)	Estimated annual Sales/Employee (x1000)	Home Market
LOCKHEED MARTIN	112000	€40300	€360	US
Raytheon	61000	€20200	€331	US
BAE SYSTEMS	88200	€18200	€206	UK
THALES	65000	€14200	€218	UK/FR/NL
AIRBUS DEFENCE & SPACE	40000	€14000	€350	FR
DCNS	13650	€3360	€246	FR
Selex ES A Finmeccanica Company	17000	€3200	€188	IT
SAAB	14140	€2519	€178	SW
ATLAS ELEKTRONIK	1500	€337.6	€225	GER
TERMA	1100	€153	€139	DE

1.2.2.2. Customers Thales Group

Appendix 2 shows that in 2014 most of the sales were from customers in France and UK. After that, most sales were from other European countries and Asia. Therefore, the main customers are governments of these countries.

1.2.2.3. Customers Thales

As stated before, Thales is mainly focused on the naval market. Customers of Thales are mainly navies all over the world and overarching organizations or other organizations which are positioned between Thales and the end-user (navy). One example of this is OCCAR, which is an international organization whose core-business is the through life management of cooperative defence equipment programs. OCCAR facilitates and manages amongst others, collaborative European armament programs through their life cycle. So this also means that OCCAR manages the in-service support of different naval systems, for instance ordering spare parts, repairs and overhaul. Belgium, France, Germany, Italy, Spain and the UK are member states of OCCAR. Next to the member states, there are also states which are participating in one or more OCCAR programs: Finland, Luxembourg, the Netherlands, Poland, Sweden and Turkey. This means that part of the services and deliveries of spare parts are communicated and ordered by OCCAR for navies of those countries. But the navies also have their own systems which are not part of the European armament programs of OCCAR, thus the navies themselves are also direct customers of Thales. This is only one example of many customer-end user relations, because there are also organizations like OCCAR in the rest of the world. (OCCAR, n.d.)
Next to that, also ministries of defence for instance can be positioned between Thales and the end-user.

1.2.2.4. Difference Customers Worldwide

Within this research, a lot of improvement is gathered from the Royal Netherlands Navy. Therefore, the recommendations shall be focused on the Royal Netherlands Navy. However, Thales has customers worldwide and there exist a couple of important differences regarding customers worldwide. Culture and local legislation differs between customers worldwide. Therefore, different customers need different approaches, for instance regarding information sharing. In some countries, an agent is present between the Navy and Thales. For some customers, this brings a massive delay in the information process. For instance, in South America it can take about 5 months before a request is ordered at Thales. In Asia for instance, there are also agents present, but those agents only delay the information process by approximately 2 weeks. Hence, this differs between customers. According to the After Sales Managers, these agents are needed and cannot be eliminated. For instance, to reduce literally and figuratively distance between Thales and the Navy. Therefore, information streams for some customers will always have a delay, because of the agents involved. Besides that, information can be lost by means of multiple interactions. Hereafter the focus will be, mainly, on the Royal Netherlands Navy. Therefore, some recommendations may need some adjustment for other customers.

1.2.3. Customer Services & Support (CSS)

1.2.3.1. Organogram

This study is commissioned by the sub-unit Service Development within the business unit Customer Services and Support. Figure 5 shows the positioning of Service Development within Thales.

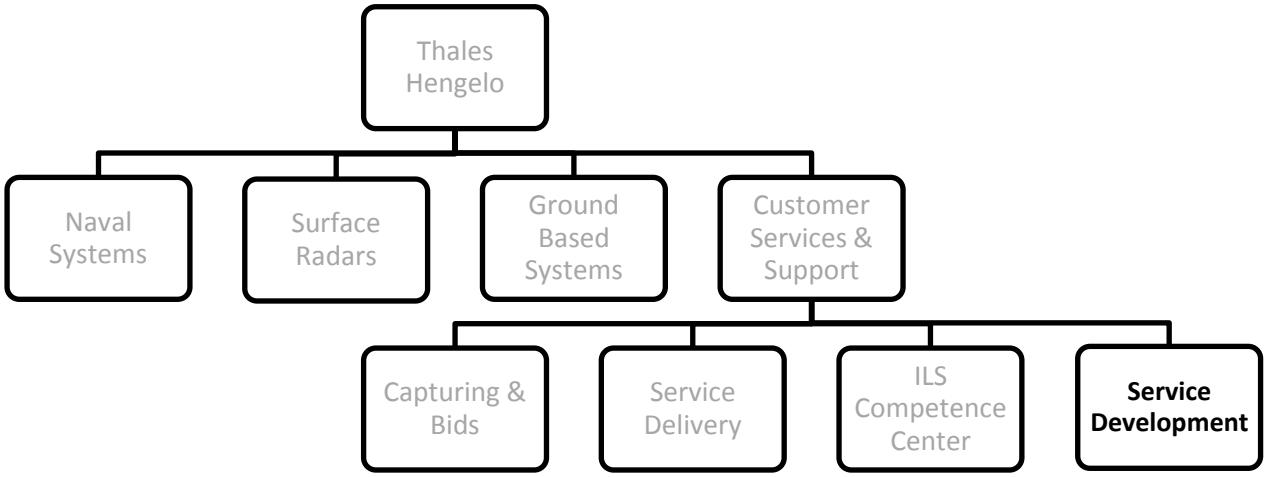


Figure 5: Positioning of sub-unit Service Development

The business unit Customer Services & Support is responsible for the after sales services, training and the replenishment of spare parts. Customer Services & Support operates out of Hengelo and local offices. CSS has more than 85 customers and these customers are spread over 42 countries. The main products and services of Customer Services & Support are spare parts, repairs, overhaul programs, update programs, modifications, documentation and training. This is important because of the long life cycle of the systems that Thales delivers to the customer, on average about 30 years. Within this life cycle there is the demand for training, maintenance, spare parts and repair.

1.3. Aim of research

A system of Thales NL consists of a lot of (different) parts. However, most of these parts are never ordered as spare part by customers. Hence, customers do not have the need for all these parts as spare parts. Therefore, it is investigated which different categories of spare parts are ordered by means of the replenishment service and what demand of the customer belongs to those orders. By means of such a differentiation of customer demand, Thales NL can improve the categories of customer demand which are most important to customers. Therefore, the aim of this research is the development of a differentiation model of customer demand and to investigate how the implementation of this model can help to improve the service with regard to the replenishment of spare parts.

1.3.1. Low Customer Satisfaction

The differentiation model should help to increase the customer satisfaction. Customers are not satisfied with regard to reliability, responsiveness, communication, credibility and the understanding of the customer. One of the main reasons for this low satisfaction is the low percentage of On Time Delivery (OTD) of spare parts. At first, the review of customer satisfaction is discussed and thereafter the on time delivery is discussed.

1.3.1.1. Customer Satisfaction Reviewed

Customer Services & Support has reviewed customer satisfaction with regard to the services they deliver. CSS reviewed customer satisfaction by means of the conceptual model of service quality of Parasuraman, Ziethaml and Berry (1985). This model contains 10 dimensions which 'consumers use in forming expectations about and perceptions of services, and dimensions that transcend different types of services' (Parasuraman, Ziethaml & Berry, 1985, p. 49). These 10 dimensions are: Reliability, Responsiveness, Competence, Access, Courtesy, Communications, Credibility, Security, Understanding the customer and Tangibles. Thales rated this model from the perspective of multiple customers. Next to that, one customer also rated the 10 dimensions by itself. Appendix 3 shows the rating of the 10 dimensions (for privacy reasons not available in the public version).

Security was not included in the review and Thales scores high on Competence, Access, Courtesy and Tangibles. However, Thales scores low on reliability, responsiveness, communication, credibility and understanding of the customer. Reliability, responsiveness, communication and credibility are mainly focused on delivering on the agreed delivery date and the ease of communication. When it is not possible to meet the required demand, which is proposed earlier, this is not clearly communicated to the customer with a proper justification. This is related to the lack of information and delays in delivering the quotations, which is experienced by the customers. Another point is the high delivery time of spare parts and repairs, which is a big problem to customers and has a negative influence on the customer satisfaction.

1.3.1.2. On Time Delivery (OTD)

As described above, the low OTD of spare parts is one of the main reasons for the low customer satisfaction. Because the spare parts are not always delivered on the promised date, customers can not use their systems when they planned to. Hence, customers also can not use their ships on a mission and the mission has to be postponed. The OTD figures of previous year are shown in Appendix 4 (for privacy reasons not available in the public version).

Thales is aware of the problem of low customer satisfaction and low OTD of spare parts. Therefore, projects are started trying to increase the OTD and decrease the long lead times of spare parts. These projects focus on processes within Thales and the relationship with suppliers of Thales, to decrease the lead times and speed up the delivery of spare parts. The improvements of the main project, regarding this subject, will be matched to the differentiation model.

1.4. Focus of this study

Within improvement projects of Thales, little attention is given to the demand of customers, which categories of spare parts are ordered and which demand is most important to customers. Therefore, it is not known whether the improvements of the internal project will affiliate with the needs of the customer. Hence, the focus of this study is on the demand of the customer and the needs associated with this demand.

By smarter responding to different types of customer demand, in order to satisfy the needs of customers, it is expected that customer satisfaction can be increased. Therefore, customer demand is differentiated and the implementation of this differentiation within Thales is proposed. Based on that, it is proposed what can be improved and what the supply chain promise to the customer should be. In other words, what Thales should and can promise the customer, regarding the replenishment of different categories of customer demand.

1.5. Contribution

The theoretical contribution of this study is the development of a differentiation model of customer demand, with regard to the replenishment of spare parts, from the perspective of the customer. Some literature is written about differentiation factors with regard to spare parts. However, most of the literature is focused on inventory management or the suppliers' perspective. Besides that, literature which focuses on a differentiation from the perspective of the customer identifies some differentiation factors, but is not complete for practical use. Therefore, the practical contribution is the development of a differentiation model for practical use and the implementation of this model within Thales. By means of this differentiation model, Thales can improve the service with regard to different categories of customer demand and fulfil the needs of the customer. Thereby, it is expected that the customer satisfaction can be increased.

1.6. Research Questions

The purpose of this study is to develop a differentiation model of customer demand and to investigate the implementation of this model within Thales. Besides that, suggestions should be made how to improve the service and price the spare parts, based on the differentiation model. Therefore, the main research question is:

How can the service, with regard to the replenishment of spare parts, be improved and priced by means of a differentiation of customer demand?

To answer this question, the following sub-questions are formulated:

1. How should customer demand be differentiated?
    a. Which different categories of customer demand exist?
    b. What are major differences with regard to customer demand?
2. How can the service be improved with regard to these different categories of customer demand?
3. Which pricing strategies should be used to price spare parts within different groups of customer demand?
    a. Which pricing strategies are described within literature, which consider differentiation?
    b. Which pricing strategies are appropriate for the different categories of customer demand?
4. How should this differentiation be implemented?
    a. How to implement the differentiation, with improvements, within Thales?
    b. How to communicate the supply chain promise to the customer?

1.7. Outline of the Report

In chapter 2, the methodology is described per sub-question and it is explained why this methodology is chosen. Subsequently, sub-question 1 is answered in chapter 3 by means of a Differentiation Model. Thereafter, in chapter 4, improvements based on this Differentiation Model are proposed along with the pricing strategies. Hence, sub-questions 2 and 3 are answered in chapter 4. Furthermore, the implementation is described in chapter 5, before the conclusions and recommendations are proposed in chapter 6. Thereafter, the discussion with limitations and suggestions for future research is described in chapter 7.

2. METHODOLOGY

Different methods are used to investigate how the service, with regard to the replenishment of spare parts, can be improved and priced by means of a differentiation of customer demand. These methods and the research outline are described within this methodology. Per research question the selected method is described and it is explained why this method is chosen.

Figure 6 shows the research overview of this study.

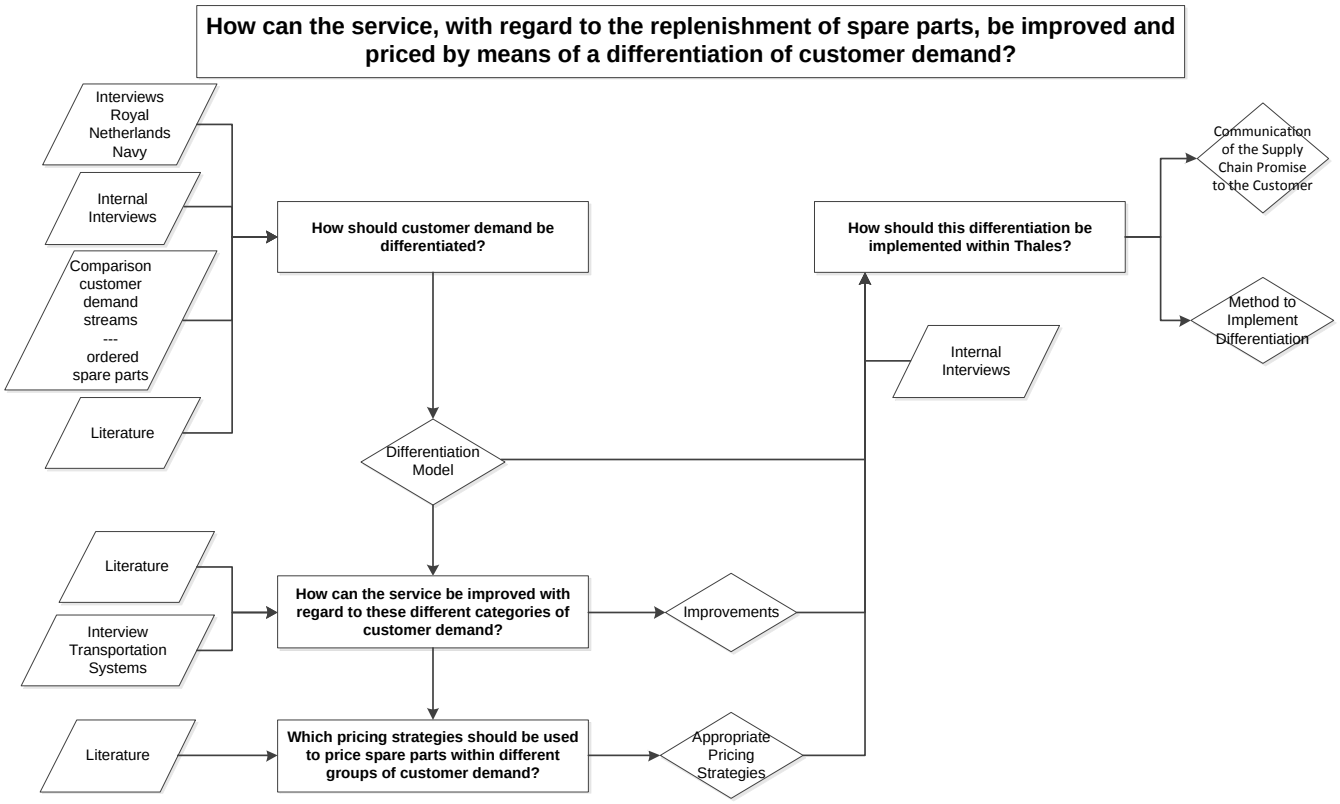


Figure 6: Research Overview

2.1.1. RQ1: How should customer demand be differentiated?

2.1.1.1. RQ 1a: Which different categories of customer demand exist?

This research is focused outside-in, from the view of the customer. Therefore, it is chosen to start with mapping the customer demand which is coming from customers. For this research, it was not possible to interview all customers worldwide. Therefore, a qualitative approach is chosen by interviewing the relevant employees at the Royal Netherlands Navy. After that, the results of the Royal Netherlands Navy are validated with regard to all customers by internal interviews. Subsequently, the results are quantified by comparing the customer demand categories with the ordered spare parts of the last three years. Hence, no literature is used regarding question 1a. Literature is introduced later in this research and used regarding questions 1b, 2, and 3.

2.1.1.1.1. Interviews Royal Netherlands Navy

To investigate which different categories of customer demand exist, interviews are held at the Royal Netherlands Navy. It is very important to understand the customers' customer, and the needs which arise from customers of the customer. (Cohen et al., 2006; Gallagher et al., 2005; Sundin et al., 2009) As described more elaborate in Appendix 5. Therefore, to get a complete overview of the customers' perspective, the supply chain of spare parts of the Royal Netherlands Navy is investigated. The supply chain of spare parts of the Royal Netherlands Navy means: The whole flow, from the need on the ship, till the request for a spare part towards Thales and the delivery of the spare part from Thales until the ship.

It showed that this information is not documented and tangible, so intangible and part of the knowledge of the responsible employees. Therefore, interviews are held at the Royal Netherlands Navy with employees related to this supply chain.

The following employees are selected:

- Installation Managers
- The Material Planner
- The Project Procurement Officer

The Installation Managers have the final responsibility for the spare parts for their installation. The Material Planner is responsible for the inventory and the Project Procurement Officer is responsible for the purchasing process of spare parts. Questions are asked about the supply chain of spare parts and related processes at the Royal Netherlands Navy. Based on the answers, questions are asked about the needs and demand which emanates from this supply chain. In order to keep the interviews spontaneously and at the same time obtain the required information, there is chosen for semi-structured interviews.

2.1.1.1.2. Internal Interviews

The interviews at the Royal Netherlands Navy only describe customer demand from the perspective of the Royal Netherlands Navy. However, Thales serves navies all over the world. Therefore, the results of the interviews at the Royal Netherlands Navy are validated with respect to customers worldwide. Hence, information is gathered about customers within different countries. It showed that this information is also not documented and tangible, but intangible and part of the knowledge of Thales employees. Therefore, interviews are held with employees who have knowledge about customers within different countries.

The following employees are selected:

- After Sales Managers
- Project Managers
- Sales Support Employees

After Sales Managers are responsible for all after sales services towards customers, Project Managers are responsible for different after sales projects towards customers. Sales Support Employees are responsible for acquiring, creating and delivering quotations and acquiring orders from different customers. To keep the interviews spontaneously and at the same time obtain the right information, there is chosen for semi-structured interviews.

2.1.1.1.3. Comparing customer demand streams with orders last three years

To quantify the qualitative results from the interviews, the ordered spare parts of the last three years are analyzed. To keep the data workable and representative for the current and future orders, a time frame of three years is chosen. At first, the logistics database is compared to the ordered spare parts to check the amount of ordered spare parts which are recognized in the logistics database. However, it became clear that the logistics database is not complete. Therefore, this did not result in a complete overview of the portion of the different customer demand streams. Therefore, a Logistic Engineer has analyzed the ordered spare parts and assigned them individually to the customer demand streams. Thereby, it is investigated what customer demand is most common and what customer demand is not. Hence, it is investigated what portion of the ordered spare parts is improved by improving the service with regard to one stream of customer demand.

2.1.1.2. RQ 1b: What are major differences with regard to customer demand?

2.1.1.2.1. Literature

To investigate the major differences with regard to the customer demand streams, a theoretical maintenance model is described. This theoretical maintenance model, known within Thales and validated by several customers, explains how customer demand can differ. Besides that, literature is described which also explains how customer demand can differ. The differences, described within the theoretical model and literature, are used to develop a differentiation model of customer demand.

2.1.2. RQ 2: How can the service be improved with regard to these different categories of customer demand?

To investigate how the service regarding the different categories of customer demand can be improved, information from prior interviews at the Royal Netherlands Navy and internal interviews is considered. Besides that, new information is gathered out of literature and an interview at Transportation Systems.

2.1.2.1. Literature

To investigate how the service, with regard to different customer demand streams, can be improved, literature is described which suggests room for improvement.

2.1.2.2. Interview at Transportation Systems

Transportation Systems at Huizen is responsible for the maintenance of the systems in the Netherlands, sold by Transportation Systems in France. These systems are less complicated and large as the radar systems, sold by Thales. However, the supply chain of spare parts has the same dynamic and the replenishment process is better organized. Therefore, an interview is held at Transportation System with the Material Manager, to investigate how Transportation Systems organizes the supply chain of spare parts. Thereby, it can be investigated what

differences exist between the supply chain of spare parts at Transportation Systems and at the Royal Netherlands Navy. Hence, it is investigated what can be learned from the organization of the replenishment process at Transportation Systems. To keep the interview spontaneously and at the same time obtain the right information, there is chosen for a semi-structured interview.

2.1.3. RQ 3: Which pricing strategies should be used to price spare parts within different groups of customer demand?

2.1.3.1. RQ 3a: Which pricing strategies are described within literature, which consider differentiation?

To investigate how spare parts should be priced, different pricing strategies are discussed, which are described within literature.

2.1.3.2. RQ 3b: Which pricing strategies are appropriate for the different categories of customer demand?

Based on the interviews within the Royal Netherlands Navy and internal interviews, it is argued which pricing strategies are appropriate for the different categories of customer demand. Therefore, during these interviews, different questions are asked about the pricing of spare parts.

2.1.4. RQ 4: How should this differentiation be implemented?

2.1.4.1. RQ 4a: How to implement the differentiation, with improvements, within Thales?

2.1.4.1.1. Internal Interviews

The suggested improvements should also be implemented within Thales. Therefore, interviews are held with the persons who influence, or are influenced, by the improvements. The following employees are selected:

- Sales Support Manager
- Product Service Manager
- Project Manager of internal replenishment improvement project

Sales Support is responsible for acquiring, creating and delivering the quotations. Besides that, Sales Support is responsible for acquiring the orders. The Product Service Manager is amongst others responsible for the service: Replenishment of Spare Parts. The Project Manager of the internal replenishment improvement project is responsible for the improvement of the replenishment of spare parts. To gather the right information and maximize the input, these interviews are also semi-structured and the results of this study are discussed.

2.1.4.2. RQ 4b: How to communicate the supply chain promise to the customer?

2.1.4.2.1. Internal Interviews

It is investigated how to communicate the improvements to the customer. Hence, what should be the supply chain promise? Based on the improvements, this supply chain promise can be formulated. In addition to that, interviews are held with After Sales Managers to identify important factors, which need to be considered in making a supply chain promise to the customer.

3. CUSTOMER DEMAND DIFFERENTIATION

In this chapter an answer is given to RQ1: How should customer demand be differentiated?

3.1. Categories of Customer Demand

Based on the supply chain of spare parts of the Royal Netherlands Navy (Appendix 6), the following customer demand streams can be distinguished: Line Replaceable Units (3.1.1.), Shop Replaceable Units (3.1.2.), Components (3.1.3.), Preventive Spare Parts (3.1.4.), Overhaul Spare Parts (3.1.5.), Specials (3.1.6.) and Emergency Requests (3.1.7.). Hence, these are the different categories of customer demand. The spare parts within these categories are mutually exclusive, there are no Line Replaceable Units used for Preventive Maintenance for example. The Royal Netherlands Navy has also demand for Special Tools, Test Equipment and Technical Assistance. However, this demand is not seen as spare parts within this research. Therefore, this is not within the scope of this research.

The categories of customer demand differ, based on the technical aspects or application of spare parts, except Emergency Requests. Emergency Requests is a category, which differs, based on the timing of the order and consequences of not having the spare part available. Therefore, an Emergency Request can be for spare parts out of all other categories.

Figure 7 and 8 show the mapping of the customer demand categories (except Emergency Requests) on the amount of ordered spare parts and the value of ordered spare parts of the last three years. Emergency Requests could not been identified based on the information available in the databases. Therefore, Sales Support Employees are asked about the amount of Emergency Requests which are ordered at Thales. According to the Sales Support Employees this is about 10 till 50 times a year. Relatively, this is about 1% till 5% of all orders.

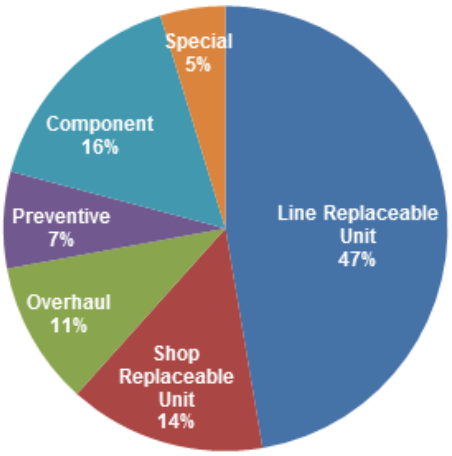


Figure 7: Amount of ordered Spare Parts per Category

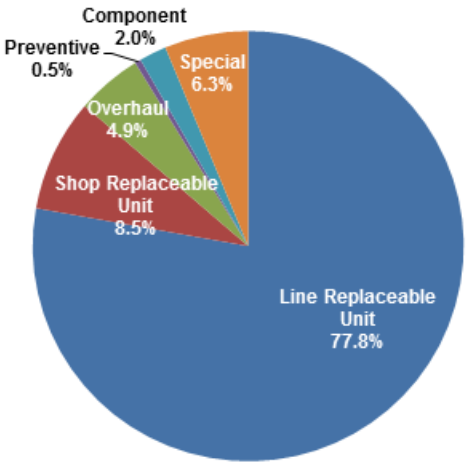


Figure 8: Value of ordered Spare Parts per Category

3.1.1. Line Replaceable Units

Line Replaceable Units (LRU) are spare parts which can be replaced on the ship and are expected to fail during the lifetime of a system (based on MTBF). Therefore, Line Replaceable Units have to fit a couple of requirements. For instance, Line Replaceable Units should be able to be replaced by one maintenance employee and not be fixed by more than four clips or screws. Hence, Line Replaceable Units are easy to replace. Therefore, Line Replaceable Units are seen as the first layer of spare parts. Figure 9 shows this relation.

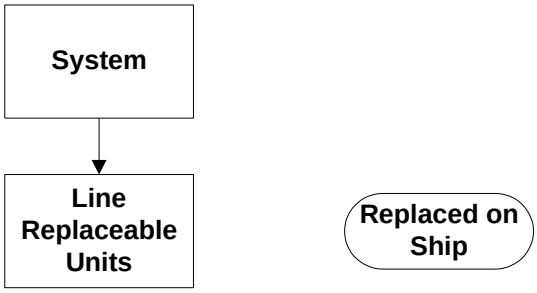


Figure 9: Line Replaceable Units

The supply chain of spare parts of the Royal Netherlands Navy (Appendix 6) shows that the Royal Netherlands Navy has a central warehouse and a common pool (shared warehouse with three countries) where Line Replaceable Units are stocked. According to the After Sales Managers of Thales, most customers do not have a common pool, but do have a central warehouse themselves where Line Replaceable Units are stocked. Therefore, Line Replaceable Units are, generally, ordered to supplement the inventory.

At the Royal Netherlands Navy, the stock which needs to be available in this warehouse is calculated by a METRIC inventory tool, which considers factors as costs, MTBF, criticality and lead time of spare parts. This tool has a system approach, which means that lower fill rates are assigned to more expensive spare parts. According to the After Sales Managers of Thales, most customers do not have a similar inventory tool to calculate the stock needed or do not have the budget to stock all the Line Replaceable Units needed.

Figure 7 shows that, last three years, 47% of all ordered spare parts are Line Replaceable Units. Figure 8 shows that 77,8% of the turnover of all ordered spare parts are Line Replaceable Units. Hence, Line Replaceable Units are most ordered by customers and represent the largest part of the turnover of spare parts.

3.1.2. Shop Replaceable Units

Shop Replaceable Units (SRU) are spare parts which need to be replaced ashore and are expected to fail during the lifetime of a system (based on MTBF). For example, a Line Replaceable Unit can consist of multiple Shop Replaceable Units. Figure 10 shows this relation.

Shop Replaceable Units are still relatively easy to replace. Therefore, a lot of customers can replace Shop Replaceable Units by themselves.

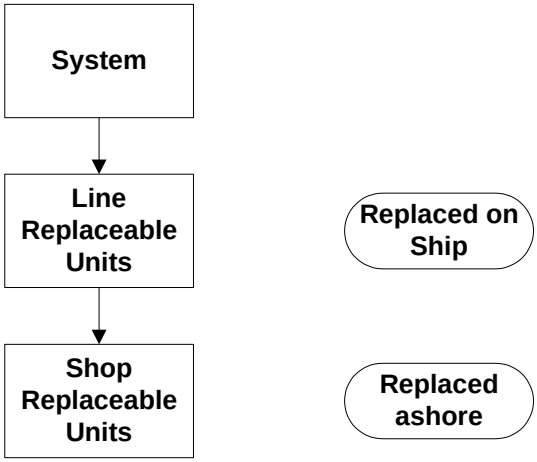


Figure 10: Shop Replaceable Units

The supply chain of spare parts of the Royal Netherlands Navy (Appendix 6) shows that the Royal Netherlands Navy stocks Shop Replaceable Units also in the Central Warehouse. According to the After Sales Managers of Thales, customers who need Shop Replaceable Units will also stock them, but not as much as Line Replaceable Units. However, the demand for Line Replaceable Units and Shop Replaceable Units is similar, because it is expected that these spare parts will fail during the lifetime of a system.

Figure 7 shows that, last three years, 14% of all ordered spare parts are Shop Replaceable Units. Figure 8 shows that 8,5% of the turnover of all ordered spare parts are Shop Replaceable Units. Hence, Shop Replaceable Units are regularly ordered and represent a sufficient amount of the turnover of spare parts.

3.1.3. Components

Components are spare parts which are ordered to repair failed Line Replaceable Units or Shop Replaceable Units. Figure 11 shows this relation. The systems of Thales consist of many different components and it is not known with high certainty which components will fail. Therefore, customers do not hold these components on stock, but order components when they are needed.

The supply chain of spare parts of the Royal Netherlands Navy (Appendix 6) shows that the Royal Netherlands Navy has a Repair Shop, where these components are used to repair failed Shop Replaceable Units. According to the After Sales Managers of Thales, not all customers have the knowledge and resources to replace components by themselves. Therefore, components are not ordered by all customers.

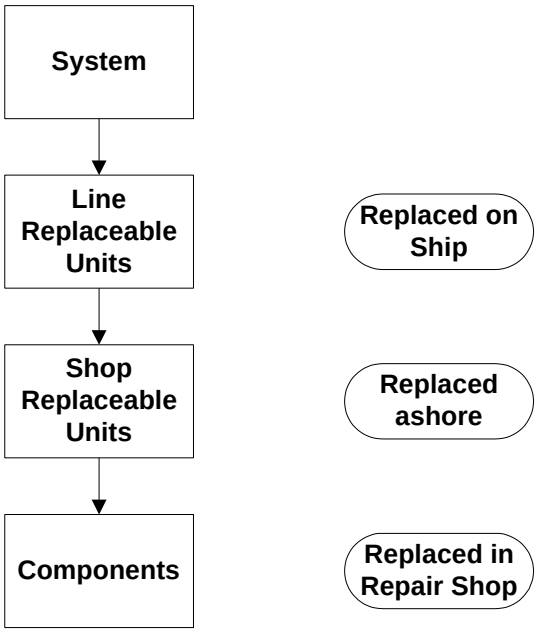


Figure 11: Components

Figure 7 shows that, last three years, 16% of all ordered spare parts are Components. Figure 8 shows that 2,0% of the turnover of all ordered spare parts are Components. Hence, Components are ordered regularly, but are relatively cheap compared to Line Replaceable Units.

3.1.4. Preventive Spare Parts

Preventive spare parts are ordered to perform preventive maintenance. Preventive maintenance is conducted to prevent that (parts within) the system fails, refreshing oil or replacing dust filters for example. Hence, preventive spare parts are mostly consumables, but also parts can be replaced to prevent that these parts will fail during a mission.

The supply chain of spare parts of the Royal Netherlands Navy (Appendix 6) shows that the Royal Netherlands Navy performs this preventive maintenance at a System Maintenance Shop and has a list with items needed for the maintenance tasks. At the System Maintenance Shop, the whole system can be taken off the ship. Small preventive maintenance can be performed at the ship. According to the After Sales Managers of Thales, not all customers perform preventive maintenance. This can, for instance, be explained by the fact that the conceptions of maintenance differ in different countries.

Figure 7 shows that, last three years, 7% of all ordered spare parts are Preventive spare parts. Figure 8 shows that 0,5% of the turnover of all ordered spare parts are Preventive spare parts. Hence, Preventive spare parts are not ordered very often and are relatively cheap compared to Line Replaceable Units.

3.1.5. Overhaul Spare Parts

Overhaul spare parts are ordered to perform overhaul. Overhaul is an extensive form of preventive maintenance. By performing overhaul, the whole system is taken apart and a lot of parts are replaced, especially mechanical parts. These parts are replaced, because they wear over time. After overhaul is performed, the system should meet the total factory requirements again.

The supply chain of spare parts of the Royal Netherlands Navy (Appendix 6) shows that the Royal Netherlands Navy performs this overhaul at the System Maintenance Shop and that there is also a list with needed items for this maintenance task. According to the After Sales Managers, most customers do not have a System Maintenance Shop. Therefore, most customers cannot perform overhaul by themselves. Hence, most customers should not demand for overhaul spare parts.

Figure 7 shows that, last three years, 11% of all ordered spare parts are Overhaul spare parts. Figure 8 shows that 4,9% of the turnover of all ordered spare parts are Overhaul spare parts. Hence, Overhaul spare parts are ordered regularly and are relatively cheap compared to Line Replaceable Units.

3.1.6. Specials

Specials are spare parts which are not expected to fail during the lifetime of a system. However, these parts can fail because of battle damage or human acting. According to the Installation Managers of the Royal Netherlands Navy, these specials are a difficult category of demand. Special parts are, generally, not ordered before by the Navy. Therefore, when a special part fails, the Navy does not recognize this Special as a specific Thales spare part. Within the Navy, parts which are not seen as specific Thales spare parts need to be ordered following an ‘external purchase’ procedure. Therefore, this takes a lot of time within the Navy and Thales. According to the Installation Managers of the Navy, it takes about 2 months on average within the Navy to send the request to Thales. Besides, according to the Installation Managers of the Navy, it takes about 6 months before a quotation is sent back. This takes about 6 months, because Thales needs to find out whether the Special is in stock, needs to be produced by Thales, is in stock by a supplier or needs to be produced by a supplier. The communication between the Navy and Thales, generally, follows the same process as the official purchasing order. Therefore, this takes a lot of unnecessary time.

According to the After Sales Managers of Thales, all customers have demand for specials.

Figure 7 shows that, last three years, 5% of all ordered spare parts are Specials. Figure 8 shows that 6,3% of the turnover of all ordered spare parts are Specials. Hence, Specials are not ordered very often, but represent the highest turnover after Line Replaceable Units and Shop Replaceable Units.

3.1.7. Emergency Requests

Emergency Requests is demand for a spare part when the ship has an urgent need for a spare part and the customer does not have this spare part available. For instance, when the ship needs to go on a mission, the system does not work and there is no spare part available in inventory to repair the system. Hence, Emergency Requests is a different category of customer demand, based on the instant need of the customer and not on the type of spare part which is ordered.

According to the After Sales Managers and Sales Support Employees of Thales, these requests occur sometimes, but not often. Approximately, 10 till 50 times a year (1% till 5% of the total amount of requests). When a request is an Emergency Request, this is communicated to Thales by means of a phone call or email.

3.2. Major Differences of Customer Demand

3.2.1. Maintenance Model

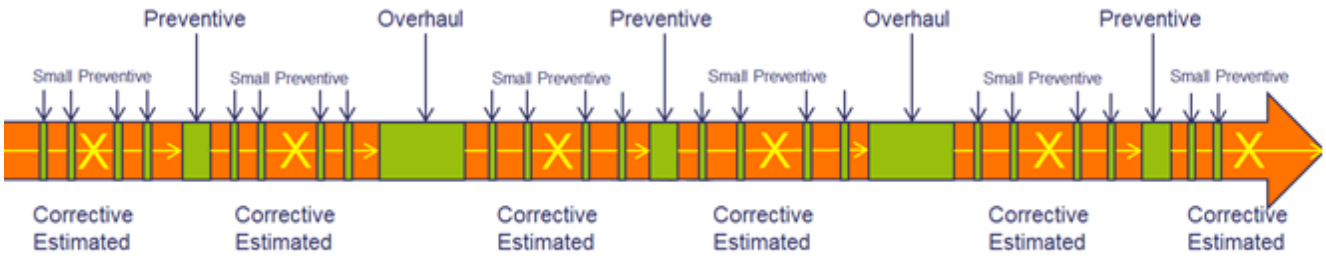


Figure 12: Regular Maintenance Model of navies.

Figure 12 shows the regular maintenance model of navies. This maintenance model shows that a ship (including Thales system) is operable for X years. During these operable years, small preventive maintenance is performed on the ship. After that period, the ship is in dock for preventive maintenance. Subsequently, the ship is again operable for X years and after that, the ship is in dock for overhaul. This dynamic remains the whole life time of a ship. When the ship is in dock for maintenance, the systems on the ship are also available for maintenance. Therefore, it can be planned when spare parts are needed for preventive maintenance and overhaul. For example, the ship needs to be operable for 4 years. Within these operable years, spare parts are needed for small preventive maintenance. Spare parts for the first preventive maintenance task in dock should be delivered and available at the beginning of year 5. Assuming that the ship is half a year in dock, spare parts for overhaul should be delivered and available at 8,5 years. Assuming that the overhaul period is one year,

spare parts for the second preventive maintenance task in dock should be delivered and available at 13,5 years. Again, these dynamics remains the whole life time of a ship. Hence, also the whole life time of a system, this can be 30 to 50 years.

There is always a chance that some parts of a system will fail during operations. Therefore, within the operable years of a ship and system, corrective maintenance is needed. The chance that a part will fail is estimated, based on the Mean Time Between Failures (MTBF). Hence, it can be estimated which spare parts will probably be needed for corrective maintenance during the life time of a system.

According to the interviews with Thales employees, the Navy can anticipate on this by ordering the spare parts which are probably needed before they are actually needed. On the other hand, Thales can anticipate on this by putting the spare parts which are probably needed on stock, before they are actually needed. Besides, there are spare parts which are not expected to fail during the life time of a system, but there is a very small chance that they will. Furthermore, there are spare parts of which there exist too many different spare parts in a system. This can be defined as unanticipated demand. According to the interviews with Thales employees, the difference in the possibility to anticipate on demand is an important factor with regard to the replenishment of spare parts. Related to the Maintenance Model, several customer demand streams can be planned.

For Line Replaceable Units and Shop Replaceable Units it can be estimated which parts will probably fail during the life time of a system. Hence, it can be anticipated which spare parts are needed. Besides that, a MTBF can give an indication when these spare parts are needed.

It is known when Overhaul and/or Preventive maintenance is planned. Hence, it can be anticipated when spare parts for Overhaul and/or Preventive Maintenance are needed.

There exist too many different Components in the systems of Thales. Therefore, it is hard to anticipate on this. Furthermore, the need for Specials and Emergency Requests cannot be estimated. Therefore, it is not possible to anticipate on this.

3.2.2. Urgency of demand

The urgency of demand for spare parts is not very often discussed within literature. (Pourakbar & Dekker, 2012; Gallagher et al., 2005; Fisher, 1997) However, according to the After Sales Managers, the urgency of demand is an important factor that can differ between demands for spare parts of Thales. Therefore, this factor is described below. Figure 13 shows a graphical summary of the aspects related to the urgency of demand, as proposed by different authors.

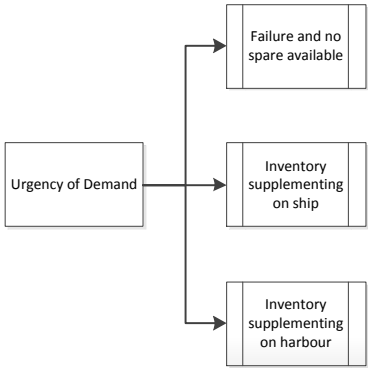


Figure 13: Urgency of demand differentiation.

With regard to the demand of spare parts, distinctions are made between emergency orders and inventory supplement orders (Pourakbar & Dekker, 2012; Gallagher et al., 2005). Emergency orders are orders that emerge from a failure of the system and there is no spare part available in inventory. Inventory supplement orders are orders placed in order to supplement the inventory. It is important for companies to know the nature of the demand of the customer (Fisher, 1997). Therefore, the urgency of demand is linked to the different customer demand streams.

Table 3 shows this division related to the urgency of demand, which is validated by the After Sales Managers of Thales. Hence, this is the Differentiation Model.

Table 3: Differentiation Model

Urgency of Demand ↑	
	Unanticipated Demand
	Emergency requests
	Specials
	Components
	Anticipated Demand
	Line Replaceable Units
	Shop Replaceable Units
	Preventive Spare Parts
	Overhaul Spare Parts

The supply chain of spare parts of the Royal Netherlands Navy (Appendix 6) shows that Line Replaceable Units and Shop Replaceable Units are ordered to supplement the inventory. Hence, the Navy has built a buffer to decrease the urgency of demand. Besides that, spare parts for overhaul and preventive maintenance can be ordered on time, because it is planned when these spare parts are needed. Therefore, this demand is the least urgent to the Navy. However, it is not possible to proactively respond to failures which cannot or is hard to anticipate on. Figure 14 shows the difference between proactive and reactive responding.

Proactive means responding before there is an actual need for a spare part. Reactive means responding after there is an actual need for a spare part. For specials and components it is not possible to put all spare parts on stock, there exists too many spare parts within this categories and it is hard to estimate which spare parts within this categories will fail. Therefore, these failures and demand are more urgent. Besides that, Emergency Requests are placed when there is a failure and no spare part available. Therefore, Emergency Requests is the most urgent category of customer demand.

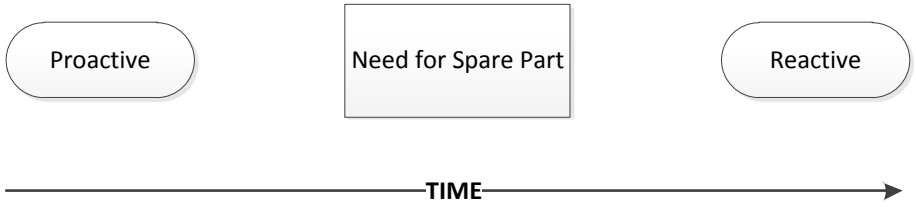


Figure 14: Difference between proactive and reactive responding.

3.3. Summary

Seven different categories of customer demand are identified: Line Replaceable Units, Shop Replaceable Units, Components, Preventive Spare Parts, Overhaul Spare Parts, Specials and Emergency Requests. Line Replaceable Units, Shop Replaceable Units, Preventive Spare Parts and Overhaul Spare Parts can be anticipated on, because it is estimated which spare parts are probably needed during the life time of a system. Specials and Components cannot be anticipated on, because it is hard to estimate which spare parts, within these categories, are probably needed during the life time of a system. Emergency Requests can also not be anticipated on, because it is an emergency.

Therefore, unanticipated demand is more urgent to the navy, which leads to the model as described in Table 3.

4. IMPROVEMENTS

In this chapter an answer is given to RQ2: 'How can the service be improved with regard to these different categories of customer demand?' and RQ3: 'Which pricing strategies should be used to price spare parts within different groups of customer demand?'

Currently, all types of customer demand follow the same replenishment process. However, in Chapter 3 is shown that reality is more fine grained. Therefore, it is investigated how the service can be improved per type of customer demand. At first, literature is discussed with regard to spare parts and the replenishment of spare parts in Section 4.1. This literature describes factors which can be considered in improving the service with regard to the replenishment of spare parts. Subsequently, in Section 4.2 is described what we can learn from the replenishment process at Transportation Systems. Based on those two sections, suggestions for improvement are made in Section 4.3. Furthermore, pricing strategies and the pricing of spare parts are discussed in Section 4.4.

4.1. Literature

4.1.1. Criticality of Spare Parts

Most of the literature about spare parts discusses the criticality of spare parts with regard to customer demand. (Huiskonen, 2001; Molenaers et al., 2012; Cohen et al., 2006; Caggiano et al., 2007; Pourakbar & Dekker, 2012; Deshpande et al., 2003; Buiting et al., 2014) Therefore, the criticality of spare parts is described below. Figure 15 shows a graphical summary of the aspects related to the criticality discussed by different authors.

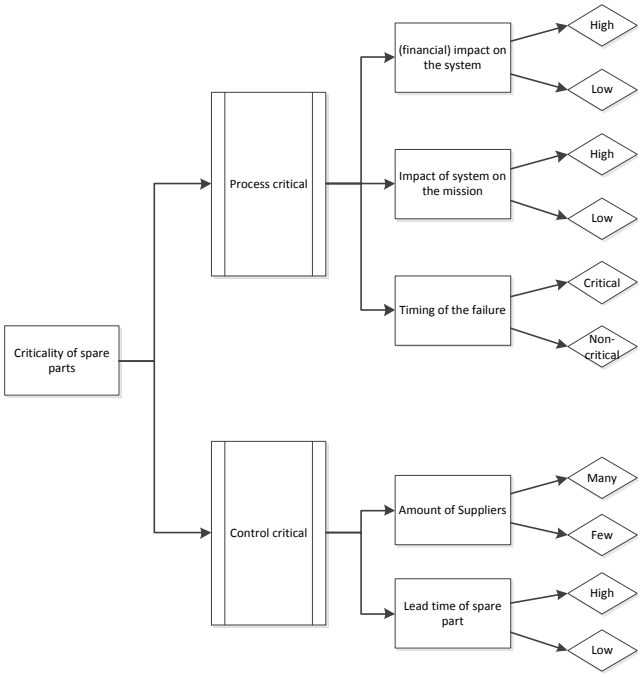


Figure 15: Criticality differentiation of spare parts

The criticality of spare parts can be divided into two aspects: process criticality and control criticality (Huiskonen, 2001). Process criticality refers to, not having a spare part readily available and the impact this has on the production, safety and environment (Huiskonen,

2001; Molenaers et al., 2012). The criticality of spare parts can also differ between customers, based on the impact of the process on the customers business. For instance, the financial impact of the failure of the process and the timing of the failure (Cohen et al., 2006; Caggiano et al., 2007; Pourakbar & Dekker, 2012).

Criticality regarding Mission

For weapon system service parts the demand for spare parts is differentiated, based on the essentiality of the part and the criticality of the mission. Whether a failure of the part renders the weapons system inoperable (very high), affects personnel safety (high), degraded the operational effectiveness of the weapon system (medium) or does not affect the operation of the weapon system (low) (Deshpande et al., 2003). Besides that, the part is assigned whether the application of the system is high, medium or low (Deshpande et al., 2003).

Process Criticality

Related to the process criticality, all the interviewees (within Thales as well as within the Royal Netherlands Navy) state that the most important aspect to customers is the ability to complete the mission. Hence, that customers are able to use their ships and related systems to complete the mission. Therefore, demand for spare parts which are critical to complete the mission, is most important to the customer. Hence, this demand should be fulfilled as soon as possible. To fulfil this demand as soon as possible, customers should have these spare parts in inventory. Therefore, it should be communicated which spare parts are most critical. Thereby, customers can keep these spare parts in stock. This will be further discussed in Section 5.1.1.2.

Control Criticality

Control criticality refers to the possibilities to control the situation, for instance the availability of spare parts from suppliers and lead times of products (Huiskonen, 2001; Buiting et al., 2014). Therefore, spare part criticality can depend on the number of suppliers for a particular spare parts and the lead times of spare parts. Spare parts which are offered by only one supplier, are control critical. Besides that, spare parts which have long lead times are control critical. Therefore, Thales as single supplier can help to reduce control criticality, by reducing lead times of spare parts. This will be further discussed in Section 4.3.1.

Inventory levels

According to the interviewees at the Royal Netherlands Navy, process criticality and control criticality are considered in determining the optimal inventory levels at their own warehouses and ships. The inventory level is determined by a METRIC inventory calculation tool which considers factors as costs, MTBF, criticality and lead times. With regard to control criticality, historical lead times are used. However, lead times may fluctuate. Therefore, the inventory level determined by the Navy can differ from the optimal stock level. Besides that, when the actual lead time is longer than the historical lead time, spare parts are ordered too late. Therefore, customers should consider actual lead times in determining inventory levels and ordering spare parts. Line Replaceable Units and Shop Replaceable Units are expected to fail during the life time of a system and the Navy keeps these spare parts in stock. Therefore, actual lead times should be communicated regarding Line Replaceable Units and Shop Replaceable Units. This will be further discussed in Section 5.1.1.2.

Several criticality differentiations are made within literature. Appendix 7 shows criticality classifications, which are made within existing literature. Besides that, Appendix 8 shows the

Kraljic Matrix, which is considered by the Navy in determining inventory levels of warehouses and ships. Hence, this also includes the process and control criticality of spare parts. This Kraljic Matrix is used by the Navy, because the Navy considers the impact on the mission of a spare part and the supply risk of a spare part within their inventory management. Spare parts with a high impact and high supply risk have a higher stock level. Within the warehouses, as well as at the ship.

Kraljic Matrix

As mentioned in the Introduction, a dedicated project team is working on improvements with regard to the replenishment of spare parts. This project team also uses the Kraljic Matrix to plot the spare parts which should be improved. However, the Kraljic Matrix is used from the perspective of Thales, not from the perspective of the end-user on the ship. Thereby, the focus is only on the processes within Thales and the relations with suppliers. However, the Navy has already decreased the control criticality of process critical spare parts by building inventories. Therefore, to improve the service from the customers' perspective, the Kraljic Matrix should be used from the perspective of the end-user on the ship. Figure 16 shows this difference. By means of plotting spare parts on the Kraljic Matrix, from the customers' perspective, the service should be improved of spare parts which are still control critical for the Navy.

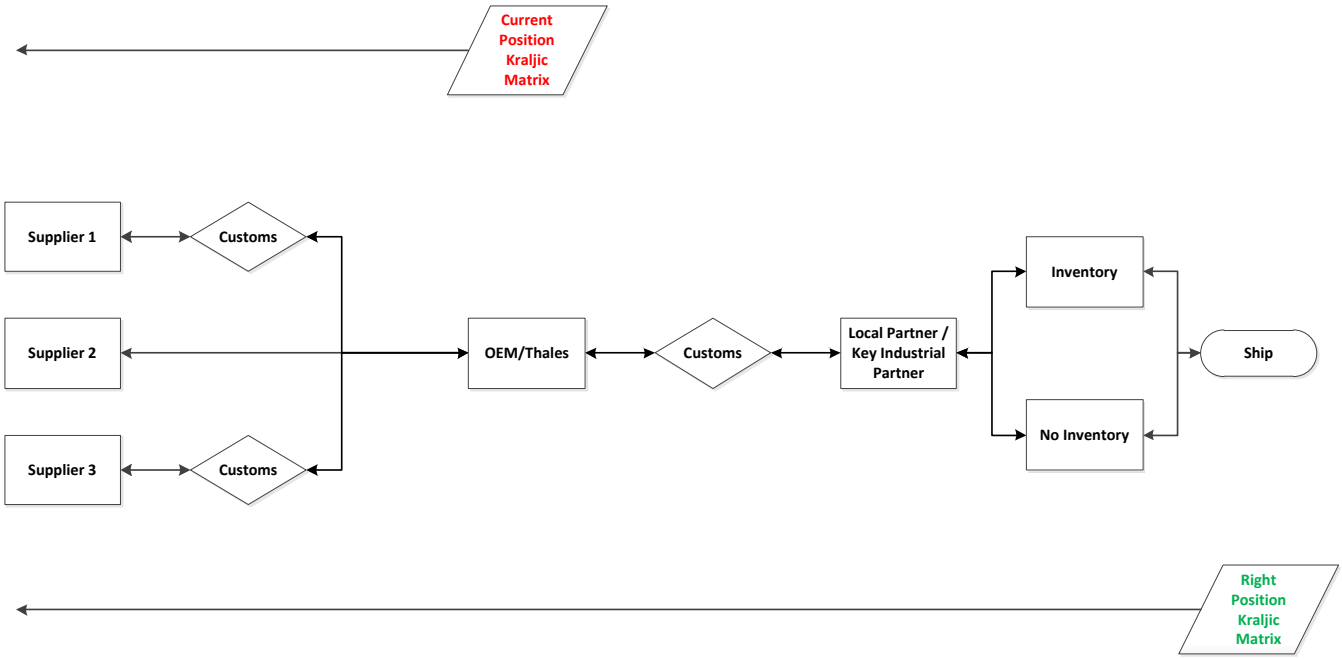


Figure 16: Kraljic Matrix from the customers' perspective.

4.1.2. Information Sharing & Communication

Within literature, the amount of information sharing and communication of OEMs with customers is often addressed as very important within supply chain management. (Pfohl & Ester, 1999; Ulaga, 2003; Töllner et al., 2001; Veenstra et al., 2006) According to all the interviewees (internal as well as external), it is stated that information sharing and communication could be improved and it is suggested that this will help to increase the

customer satisfaction. Therefore, this factor is described below, with regard to the replenishment of spare parts.

The main customer requirements with regard to information sharing, discussed in literature, are that:

- Suppliers need to be available, customers should be able to contact the supplier when the supplier is needed. (Ulaga, 2003)
- Customers need consultation before they place an order, for example consultation about the article number or technical assistance regarding the installation. Therefore, telephone consulting should be offered to the customer and be on duty as long as possible. (Pfohl & Ester, 1999)
- Suppliers need to provide a timely confirmation of the order to the customer. (Pfohl & Ester, 1999) For example by using an official confirmation document.
- Suppliers need to provide information about the status of the order. (Pfohl & Ester, 1999) For instance who is working on the order and whether the spare part is still produced or is already send.
- Suppliers need to provide information in a timely manner about delays in delivery. (Pfohl & Ester, 1999; Ulaga, 2003) This should be communicated to the customer as soon as possible. Thereby, the customer can anticipate on this.
- Information requests of customers can be linked to demand forecasting and repair and maintenance forecasting. (Pfohl & Ester, 1999) For example by analyzing this data and searching for demand patterns.
- It is essential to customers that the number of contact persons is low and that information exchange is handled openly. (Töllner et al., 2001) Therefore, one person should be responsible for the information sharing and this person should posses all information.

Information sharing is an important aspect of the ordering and delivery process of spare parts. In relation to information sharing, there is studied that supply chain collaboration brings benefits for customers, as well as suppliers (Veenstra et al., 2006). Therefore, information sharing will be an important factor to improve the service and customer satisfaction.

Looking at the customer requirements, with regard to information sharing, it is stated that suppliers need to provide a timely confirmation of the order. According to the Project Procurement Officer of the Royal Netherlands Navy, Thales does not provide a (timely) confirmation of orders. Therefore, this needs to be improved by providing a timely confirmation of all orders. The Sales Support Employee who receives the order should also provide a timely confirmation of the order.

4.2. What can we learn from Transportation Systems?

Appendix 9 shows that Transportation Systems has demand for *Line Replaceable Units, Shop Replaceable Units, Components, Preventive Spare Parts, Overhaul Spare Parts and Specials.* Hence, this is comparable to the Royal Netherlands Navy. Transportation Systems had in the past also several Emergency Requests, but Transportation Systems has minimized the Emergency Requests from the field. Subsequently, Transportation Systems has minimized the Emergency Requests towards the OEM. To minimize the Emergency Requests, it was investigated what the causes of the Emergency Requests were. Subsequently, actions are taken to take these causes away. For instance, mechanics who took extra spare parts from stock for their shifts are not able to do this anymore.

Integral view

There are many persons involved with regard to the supply chain of spare parts. At the Navy, those persons look at one part of the supply chain of spare parts.

Within Transportation Systems, there is an integral view on the supply chain. Integral view means that the whole supply chain from OEM until the end-user is overlooked. The Material Manager has information about the prices, lead times, MTBF, criticality, failure rates of spare parts and usage of systems. This information is used to determine the inventory levels at all stock places in the supply chain from OEM until the end-user. Thereby, the right spare parts are in stock and the spare parts are ordered on time. This leads to an increase in the availability of the systems.

To create this integral view, the Material Manager, Technical Managers, Purchaser of Transportation Systems and Purchaser of the OEM (Thales France) are proactively sharing information. Based on this information, it is able to proactively respond to changes regarding the replenishment of spare parts. Table 4 shows a few examples of a change in information which may lead to proactive action. Proactively means that the Material Manager, Installation Managers and Purchasers do not wait until there is a need for spare parts, but take actions before there is a need for spare parts. Thereby, they are able to anticipate on this need for spare parts and know how to fulfil this need. Besides that, they can quickly respond to changes in the environment.

Where Transportation Systems is proactive, at this moment Thales is always responding reactive to the need for a spare part. Therefore, this needs to be changed and Thales should respond proactive as much as possible.

Table 4: Change in information which leads to proactive action.

Change in Information	Proactive Action
Spare Part has become Obsolete	Put obsolete spare parts on stock
Decrease in MTBF	More spare parts ordered for inventory
Increase in price	Less spare parts ordered for inventory
Bounded to Export Regulation	Order spare parts earlier

The information sharing, as mentioned above, is implemented by weekly meetings of the Material Manager, Technical Manager and Purchaser of Transportation Systems with the Purchaser of the OEM (Thales France).

According to the After Sales Managers of Thales, the Royal Netherlands Navy is one of the most mature Navies in the world, but the integral view on the supply chain can be improved. Other customers also do not have an integral view on the supply chain. According to maintenance employees of the Polish Navy, the Polish Navy also does not have an integral view on the supply chain of spare parts. These maintenance employees stated that they do not know what the supply chain looks like and what consequences this has for them. When these maintenance employees need spare parts, they do or do not get these from a logistic employee. How this logistic employee makes sure that there are enough spare parts, is not known to them. The maintenance employees are aware of the fact that they need spare parts,

but not when they need spare parts and which spare parts are needed. Hence, there is no integral view at the supply chain. One reason which is addressed is the bureaucracy of government organizations and the many actors involved in the process. Appendix 10 describes the current information streams regarding requests and order status.

Information sharing and communication can be more effective and proactive. Figure 17 shows the current situation of information sharing between the Navy and Thales. Figure 18 shows the situation of information sharing between Transportation Systems and the OEM (Thales France). The circle shows that information is shared constantly between Material Manager, Technical Manager, Purchaser of Transportation Systems and the Purchaser of the OEM (Thales France).

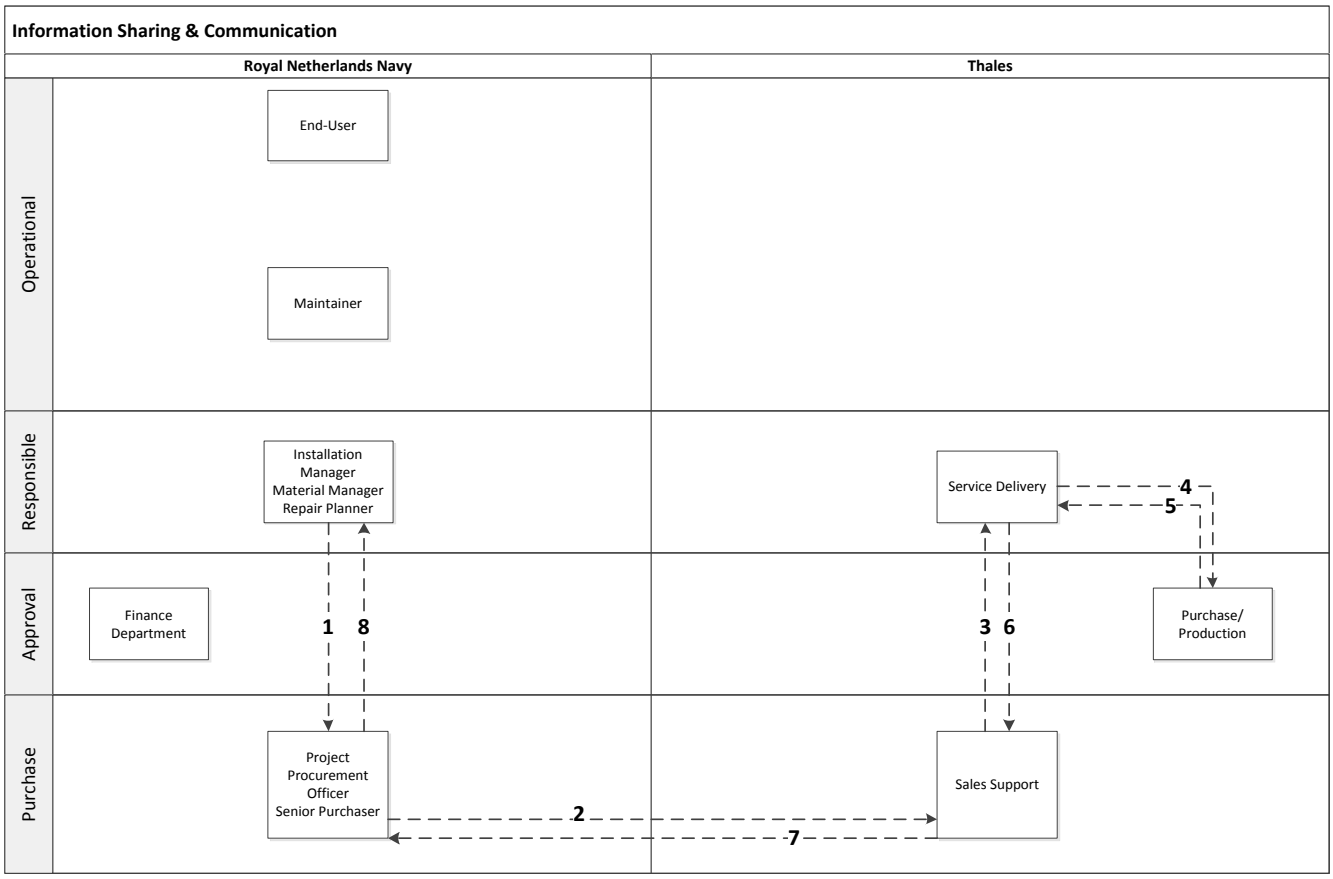


Figure 17: Current information sharing between the Navy and Thales.

Figure 17 shows that the current information process from, for instance, Material Manager of the Navy till Purchaser of Thales takes 4 steps and there are 3 persons in between. An answer has to go the same way. Therefore, this takes 8 steps in total and may lead to distortion of information.

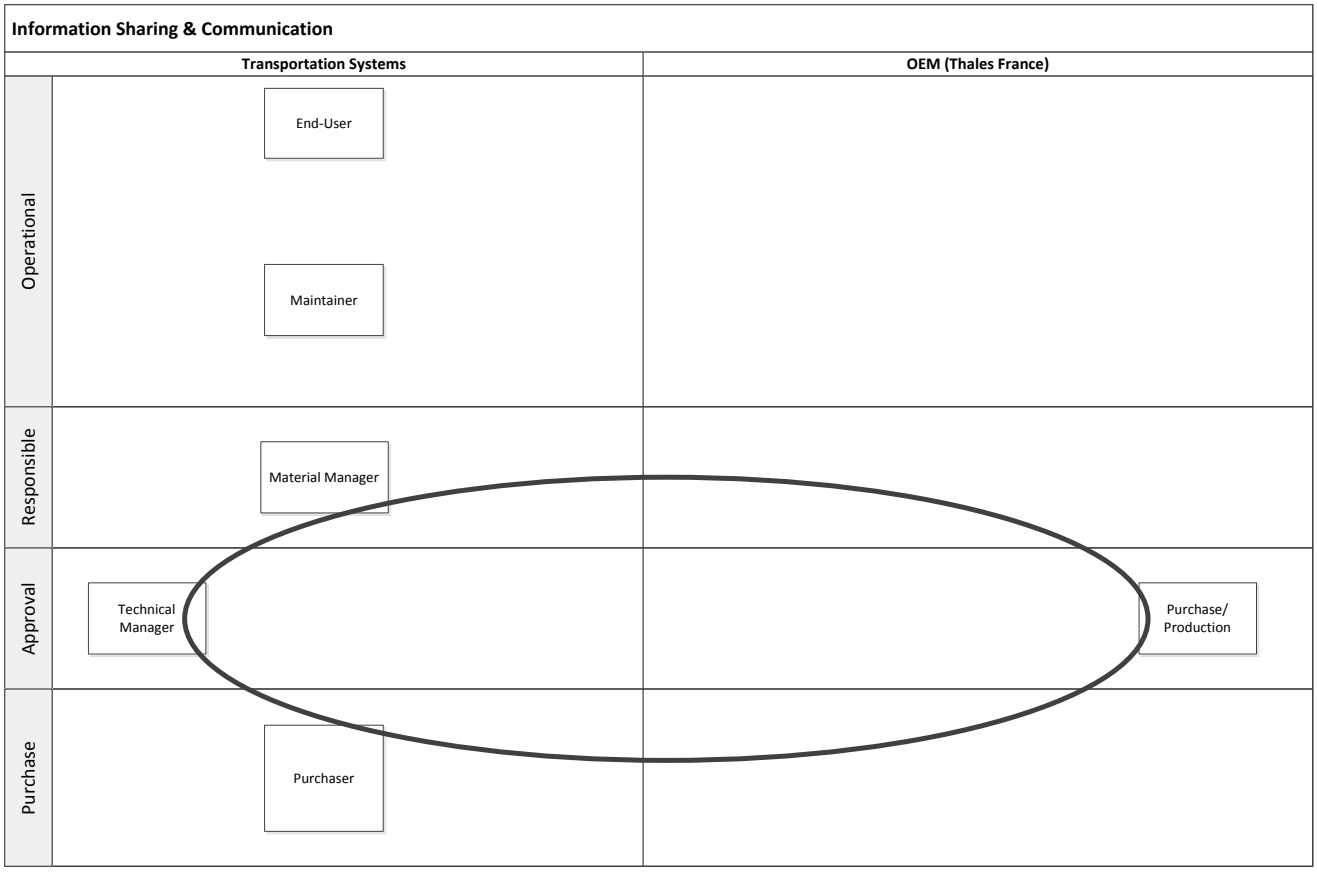


Figure 18: Current information sharing between Transportation Systems and the OEM (Thales France).

Figure 18 shows that information between Transportation Systems and the OEM (Thales France) is shared constantly and that this is more effective and efficient. It is faster and without confounders, because it is direct contact. Hence, this is also the most ideal situation for Thales and their customers. Thales has a lot of customers and it is difficult to go from reactive information sharing to proactive information sharing between customers and Thales. A mind change needs to be made. Therefore, the improvement should be made step by step. The first step can be improving the proactive information sharing within the Navy and within Thales. Per order, one Sales Support Employee should be responsible within Thales and one Project Procurement Officer should be responsible within the Navy. These responsible persons should posses all information regarding the order. Therefore, proactive information sharing is needed within the Navy and within Thales. For example, the Project Procurement Officer should know the need for the spare part and when it is needed. The Sales Support Employee should know who is working on the order, what is the status and possible delay. Thereby, information sharing and communication can be more effective. Figure 19 shows this situation, the Service Desk is added because of the technical knowledge within Thales, this is further described in Section 4.3.3.. When this situation is implemented and working, it can be worked towards a situation similar to Transportation Systems.

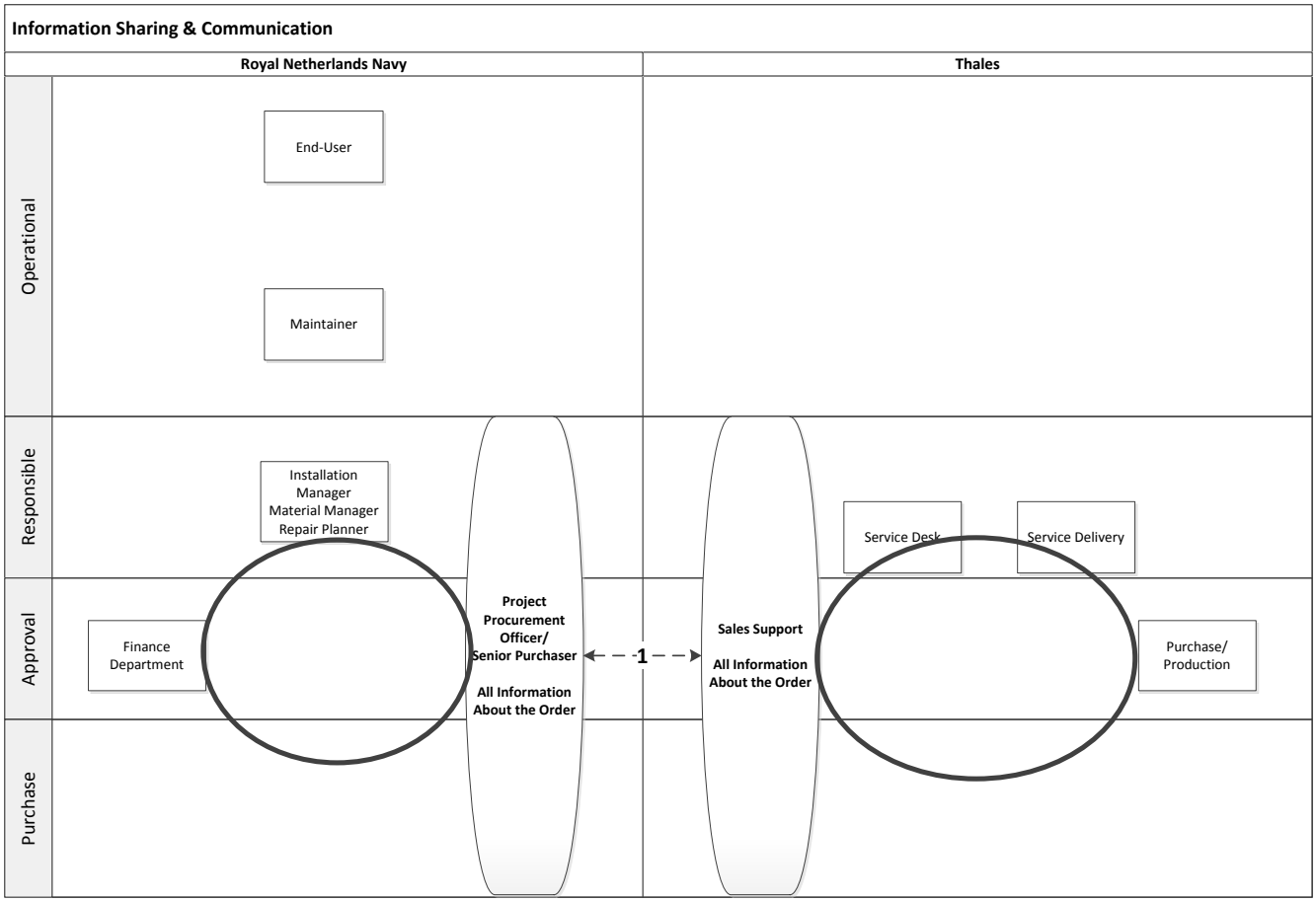


Figure 19: Improved information sharing.

Proactive Information Sharing

As mentioned above, information is proactively shared within Transportation Systems. According to the Material Manager of Transportation Systems, this helps to improve the whole replenishment process. For instance, the interaction of Transportation Systems with their supplier. For some categories of spare parts it should be possible to proactively share information like price and lead time. Subsequently, the Navy can respond to this and take these factors into account within their replenishment process.

Another factor which is very important, according to the Material Manager of Transportation Systems, is information about the usage of systems. Systems which are used very often, need more spare parts than systems which are used less often. Therefore, the Material Manager of Transportation Systems is collecting all information about the usage of systems in the field. Based on this, more accurate forecasts about the failure of parts can be made. Hence, more accurate forecasts can be made about the spare parts which are needed and at which moment. Also for Thales, this would be the ideal situation. However, it is hard to obtain this information from the Navies. Therefore, it is recommended to collect data about the usage of the systems and share the information under a Non Disclosure Agreement.

Within Thales and the Navy, estimations about future failures of spare parts are made based on theoretical calculations. However, Transportation Systems is collecting all the data about actual failures of spare parts. Thereby, Transportation Systems can complement the theoretical calculation with actual information from practice. When Thales has also access to information regarding the actual failures of spare parts and usage of systems, the estimation

of failures of spare parts can be more accurate. Hence, Thales will be able to communicate to the Navy with more certainty which spare parts are needed at which time. Therefore, this information should also be shared by means of a Non Disclosure Agreement.

4.3. Improvements of Customer Demand Categories

Based on sections 4.1 and 4.2, about the criticality of spare parts and information sharing and communication, the service can be improved. In this section, improvements per category of customer demand are proposed. Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts are merged in this section, because the internal project has decided to focus on improving these categories of spare parts. Figures 7 and 8 show that these categories of spare parts are together 68% of the total ordered spare parts and 86,8% of the total turnover of the ordered spare parts. Based on that, the focus on these categories of spare parts can be justified. However, according to the Differentiation Model (p. 30, Table 3) and the criticality (4.1.1), the Royal Netherlands Navy has already built buffers, in the form of inventory, with regard to these categories of spare parts. Thereby, the urgency of demand is decreased for these categories of spare parts. Hence, demand for Components, Specials and Emergency Requests are most urgent to the Navy. Therefore, improvements should be suggested with regard to these categories.

The improvements with regard to Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts are shortly described as well as how these improvements fit to this research. Besides that, it is suggested that Overhaul spare parts can be improved quite similar to the Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts. Subsequently, improvements are suggested, with regard to Components, Specials and Emergency Requests.

4.3.1. Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts

According to the Internal Project Manager of Thales: Thales is optimizing the logistics supply chain to decrease the lead time of Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts and increase the On Time Delivery. With logistics supply chain is meant: the supply chain from placing an order for a spare part at production or purchase until the spare part is ready to be delivered to the customer. The Differentiation Model (p. 28, Table 3) shows that it is able to anticipate on demand for Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts. Based on the improvement, described above, it is anticipated on demand for Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts. Therefore, the improvement of the internal project fits to the Differentiation Model presented in this research.

A key part of optimizing the logistics supply chain is making estimations about the needed Line Replaceable Units and Shop Replaceable Units and when these spare parts are needed. Currently, these estimations are based on theoretical calculations. However, estimations can be made more accurate when information is available about the usage of systems and actual failures of spare parts (as mentioned in Section 4.2.). Estimations can also be made regarding Preventive Spare Parts, by sharing information about the maintenance model, maintenance planning and Preventive Spare Parts needed for Maintenance.

The improvements described above are not comprehensive. Based on the positioning of the Kraljic Matrix (Figure 16) and the observations at Transportation Systems (4.2) about the integral view on the supply chain, the internal project should not only focus on Thales and the suppliers of Thales part of the supply chain, but the whole supply chain from suppliers of Thales towards the end-user on the ship. Information sharing and communication should also be improved. For example, regarding order status, as discussed in Section 4.2.

4.3.2. Overhaul Spare Parts

As shown in the Differentiation Model, Overhaul Spare Parts can also be anticipated on. The demand for Overhaul Spare Parts is even plannable. Therefore, information needs to be shared and communicated about the maintenance model and maintenance planning of Navies. Thereby, it can be communicated which Overhaul spare parts the customer needs and when the customer needs these Overhaul spare parts. The customer can order the Overhaul spare parts needed on time and will have the Overhaul Spare Parts available when needed.

4.3.3. Components

Components are parts, ordered to repair Line Replaceable Units and Shop Replaceable Units. As shown in the Differentiation Model, it is difficult to anticipate on demand for Components. Components have a very high MTBF (for instance, 10 million hours). The failure rate of a Component is based on the Poisson distribution; the standard deviation is equal to the average. Therefore, it is hard to estimate when a Component will fail. A Line Replaceable Unit has a lower MTBF, which makes it easier to estimate if the Line Replaceable Unit will fail.

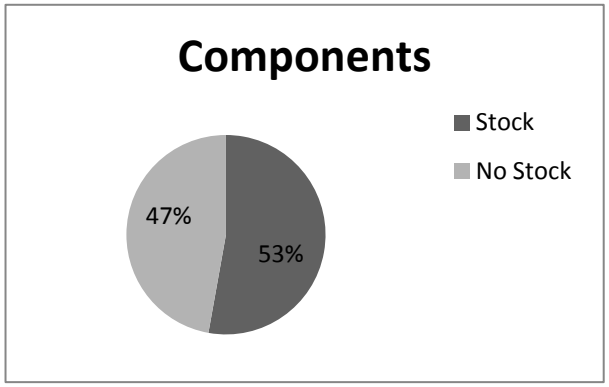


Figure 20: Ordered Components in Stock.

Figure 20 shows that 53% of the Components which are ordered (last 3 years) are in stock. Hence, Thales does have a stock of common components. However, Figure 21 shows that only Components are in stock which represent 11% of the turnover of ordered Components. Hence, the relatively cheap Components are in stock and the more expensive Components are not in stock.

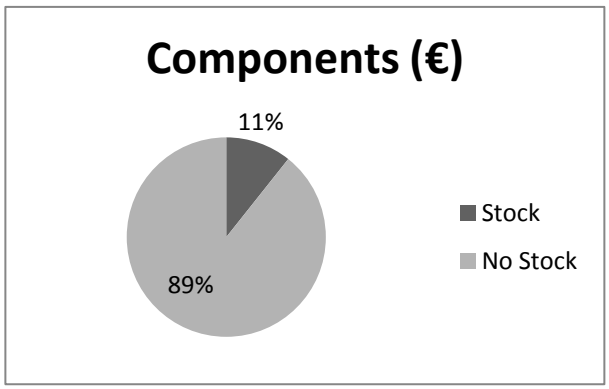


Figure 21: Ordered Components (in €) in Stock.

Components which are in stock can be delivered fast, because those Components do not have a production lead time. Generally, two months lead time is given to Components which are in stock, because of administrative procedures. It can take much longer to deliver a Component which is not in stock, because the administrative procedures of the purchase or production

department are added and the Component needs to be produced. Therefore, the lead time can differ between three months and 18 months.

After this long lead time, it is not sure that the right Component is delivered to the customer or that the customer knows how to replace the Component. For instance, when the customer replaces a Component the wrong way or orders a different Component than the end-user needs. This can lead to unsatisfied customers. Therefore, Components which are not in stock need more attention and information sharing. In order to make this possible, the technical employee of the Navy (Repair Planner) should directly communicate with the technical employee of Thales (Service Desk). Thereby, the right Component can be ordered, the right way of replacing the Component can be communicated and/or an indication about the price and lead time of the Component can be given. Furthermore, when it is not recommended to replace this Component, this can be communicated to the customer before he decides to order this Component. Figure 22 shows the current process of ordering a spare part. Figure 23 shows the direct link between the Repair Planner and Service Desk. After the consultation of the Repair Planner and Service Desk, the official order is obliged to go through the official process. However, the content of the order is already discussed. Therefore, the official process is expected to go faster and the official process only needs to passed through once.

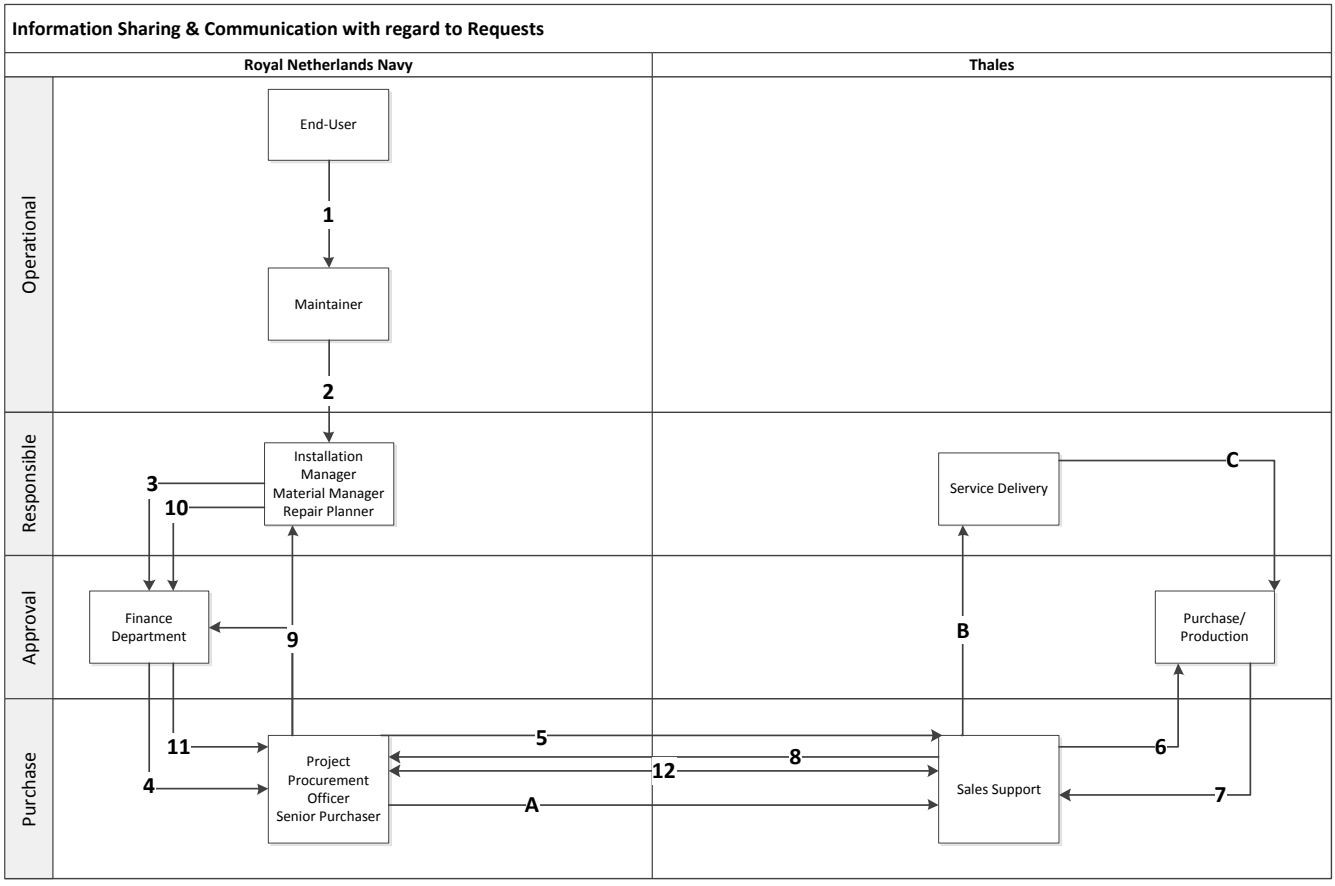


Figure 22: Current process of a request for Spare Parts.

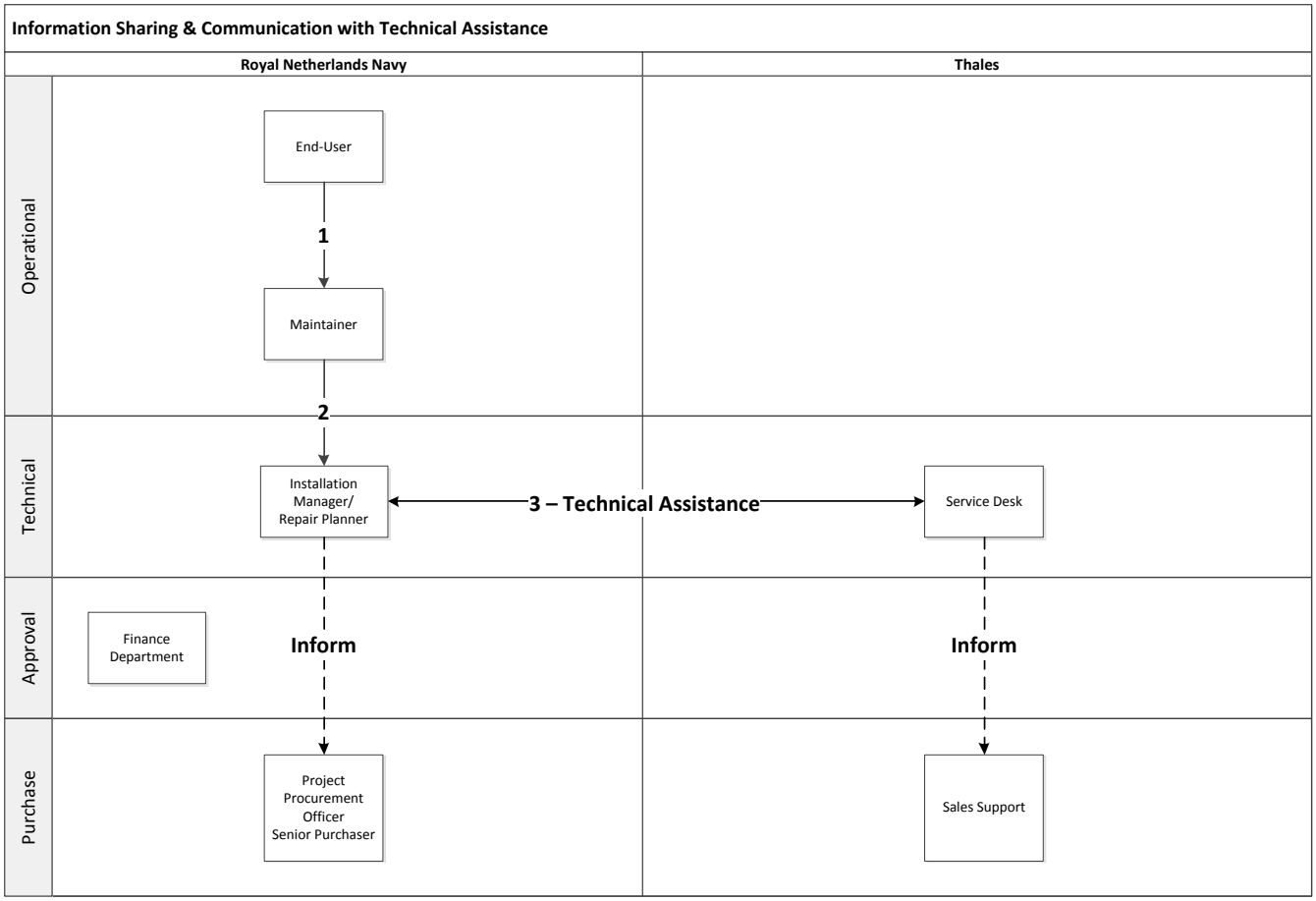


Figure 23: Direct Link Installation Manager – Service Desk

4.3.4. Specials

As mentioned in Section 3.1.6, Specials are spare parts which are not expected to fail during the lifetime of a system. Therefore, the Navy has not ordered these Specials before and this is seen as an external purchase, which takes about two months within the Navy. Figure 22 shows that information sharing takes a lot of time. The Installation Manager provides the Finance Department, Project Procurement Officer and Senior Purchaser with a part number. Subsequently, the Project Procurement Officer or Senior Purchaser sends a request with this part number to Sales Support at Thales. The only information Sales Support has is this part number and based on this part number, it is not possible for Sales Support to identify what sort of spare part it is. Therefore, Sales Support investigates whether a quotation will be made, whether the spare part is available, which problems are known regarding the part number or whether replacements are available. According to the Installation Managers of the Navy, this takes about six months. The Service Desk has a lot of technical knowledge, as mentioned in Section 4.3.3. According to the Service Desk Manager, the Service Desk can ask questions about the need for the Special. Based on that, the Service Desk can come up with temporary solutions, advice to order another spare part which can be delivered faster or advice about more spare parts which need to be replaced while replacing the needed Special. Hence, with regard to Specials, the Installation Manager should also have a direct link to the Service Desk (Figure 23). An example of a situation in which the Service Desk should have been contacted before the order was placed is the case of a large unit (consisting of multiple

Line Replaceable Units) which was ordered by one part number. A promise was made to the customer with a price and lead time. However, it was a very old unit, it was hard to get parts for this unit and it was not able to assay and test this unit. Therefore, the production and assembly of this unit ran into a lot of things and the delivery was delayed every time something went wrong. According to the Service Desk Manager, this could have been prevented if a few technical questions were asked before accepting the request.

4.3.5. Emergency Requests

Emergency Requests are requests because of an urgent need for spare parts, which are not available at the Navy. Therefore, these spare parts should be delivered as soon as possible. Within Thales, priority is given to Emergency Requests. The Sales Support Employee, which receives the request, is constantly monitoring and asking (technical) experts to make sure that the spare part is delivered as soon as possible. Thereby, Emergency Requests are delivered as soon as possible.

However, Emergency Requests should be minimized. To minimize the Emergency Requests, it should be known how many Emergency Requests are requested and what are the causes of these Emergency Requests. Subsequently, causes of Emergency Requests can be eliminated by the Navy or by Thales. For instance, one of these causes is the cannibalization of one system to make sure that an other system is operable. Thereafter, spare parts should be ordered for the cannibalized system. However, this does not always happen. Subsequently, when the cannibalized system is needed, an Emergency Request is send to the OEM (Thales). Hence, the Navy should take actions to minimize the cannibalisation of systems. When a system is cannibalized, a good analysis should be made which spare parts are needed for the cannibalized system.
An other example is a request because the radar is broken by careless handling of steel pipes close to the radar, but the radar needs to go on a mission within a week. The Navy should take actions to prevent that this happens again. For instance, by putting extra protection around the radar when it is not on a mission.

Furthermore, the actions of navies, to prevent Emergency Requests, can be communicated to other navies by the After Sales Managers. Thereby, it can be prevented that the same Emergency Requests are send by other navies.

4.3.6. Factors that Influence all Customer Demand Streams

There exist some factors that influence all customer demand streams. Those factors are explained in this Section. According to the interviewees (within Thales and within the Royal Netherlands Navy), these factors need to be considered with regard to improving the service.

4.3.6.1. Export regulation

According to the After Sales Managers and Sales Support Employees, an important factor which influences the customer demand streams is export regulation. Some spare parts of Thales require an export licence. This is based on the country of destination of the spare parts and on the strategic value of the spare parts. For instance, while exporting to Belgium or Luxemburg, no licence is required. Besides that, when exporting to members of the European

Union, Norway, Iceland or Liechtenstein a different licence is required than when exporting to other countries. For some countries it is possible (and already arranged) to get an ongoing license. For countries within the European Union, without an ongoing license, it takes about 6 to 8 weeks to obtain this license. Outside the European Union, without an ongoing license, it can take about 6 months. Therefore, it is not always possible to obtain this licence in the right time or even obtain it at all. Hence, this has a negative influence on the delivery of spare parts. Therefore, it should be considered in the promised lead time to the customer whether a spare part requires an export license or not.

Approximately 70% till 80% of the spare parts, sold by Thales, are not produced at Thales. These spare parts are bought from suppliers. Some of these suppliers are located outside the Netherlands, for instance in the USA. When an US company wants to export defense articles or services, these products or services need to meet the requirements of the International Traffic of Arms Regulations (ITAR) and the Export Administration Regulations (EAR). One of the main requirements is an end-user statement. This statement needs to be provided by the customer. Therefore, this takes time. Besides that, spares and end-user statements are checked by the US government for every order. This can take up to 6 months in total. Hence, this also has an impact on the replenishment of spare parts for customers of Thales. Therefore, these export regulations should be considered in the promised lead time to the customer.

Besides obtaining the spare parts, the ITAR and EAR regulations also influence the transportation of those spare parts from the customer to another country. For instance, when a spare part is send back to the OEM or when a spare part is send to a ship in another country. Therefore, it is important for customers to know which spare parts are bounded to these export regulations and how to deal with these spare parts. According to the interviews at the Royal Netherlands Navy, the knowledge regarding export regulations within the Navy is insufficient. The relevant employees are not informed about the spare parts which are bound to export regulations and how to deal with these spare parts. Therefore, this can be improved by proactively sharing information regarding export regulations, the consequences of export regulation and spare parts which are bound to those regulations. Therefore, an export regulation expert of Thales should present and discuss the consequences of export regulations for the customer with the customer. Besides that, for spare parts which are probably ordered by customers during the lifetime of a system (Line Replaceable Units, Shop Replaceable Units, Preventive Spare Parts and Overhaul Spare Parts), it should be communicated proactive which spare parts are bounded to export regulations and which impact this has on the lead time.

4.3.6.2. Tendering regulation

The end-users of Thales are Navies and Navies are part of governments. Therefore, Navies need to adhere to government regulation. With regard to spare parts, the most important government regulation is tendering. Tendering means that governments make a public request for products or services. Subsequently, interested companies which can offer these products or services can make an offer to the government organization. After a determined period, the government organization evaluates the offers according to a predetermined set of aspects. The company with the best offer, according to these aspects, is given the order. Within Europe, all government companies need to make the request public for all orders with a value of more than €134.000. However, there are some exceptions to this regulation. Some

products or services are not available on the free market. Therefore, there is no need for this products or services to make a public request. Besides that, for some requests it is needed to provide sensitive security information. Therefore, it is also not obligated to make a public request.

According to the Project Procurement Officer, the Tendering process takes about 5 till 6 weeks. Hence, the lead time of a spare part which is bounded to this regulation is increased by 5 till 6 weeks. Therefore, customers should consider tendering regulations in their inventory management and ordering process of spare parts.

4.3.6.3. Budgeting Issues and Prices of Spare Parts

According to the Installation Managers, the maintenance budget does not allow to place all spare parts on stock. Therefore, the costs of spare parts are very important. The costs of stocking expensive spare parts are higher than the costs of stocking less expensive spare parts. Therefore, the inventory calculation tool of the Navy will prefer to put less expensive spare parts on stock.

The size of the maintenance budget is different for every country. Therefore, some countries can spend more money on spare parts than other countries. Also in terms of the amount of inventory which they are able to maintain. Therefore, customers should calculate the optimal amount of inventory with their available budget.

The prices of spare parts, used to determine the optimal stock level, are historical prices. Hence, prices which the Navy previously paid for their spare parts. However, prices may fluctuate over time. Therefore, the stock level determined by the Navy may differ from the optimal stock level.

Besides that, financial approval is also based on the historical prices of spare parts. Subsequently, the Project Acquirer or Senior Purchaser places a Request for Quotation at Thales. The price within this quotation can differ from the price which is approved by the financial department. Therefore, the request which is sent to the financial department for financial approval needs to be adjusted. Subsequently, the request needs to be financially approved for the second time, this takes approximately 4 till 6 weeks. Therefore, customers should consider actual prices in inventory management and ordering spare parts. Thales should inform customers proactive about the actual prices of spare parts which they probably need during the lifetime of a system. Besides that, customers can ask advice to Thales about the needed spare parts at the right locations, by means of the inventory optimization service of Thales.

4.4. Pricing Strategies

To answer RQ 3: ‘Which pricing strategies should be used to price spare parts within different groups of customer demand?’ different pricing strategies are described and their practical relevance. The pricing of spare parts should be based on the customers’ willingness to pay (Choudhary et al., 2005; Cohen et al., 2006; Gallagher et al., 2005; Lamas et al., 2013). Therefore, pricing strategies are discussed which take into account the customers willingness to pay. In section 4.4.1. customer value based pricing is discussed and in section 4.4.2. the focus is on priority pricing. In section 4.4.3. dynamic pricing is discussed. Subsequently, a pricing method is suggested in section 4.4.4.

4.4.1. Customer value based pricing

Improving the after-sales pricing depends largely on moving from cost-based to value-based pricing (Knecht et al., 1993,). Managers should treat pricing from the customers point of view and always keep their customers in mind (Avlonitis & Indounas, 2005). Therefore, customer value based pricing is described within this section. Figure 24 shows the difference between cost-based pricing and value-based pricing (Harmon et al., 2009).

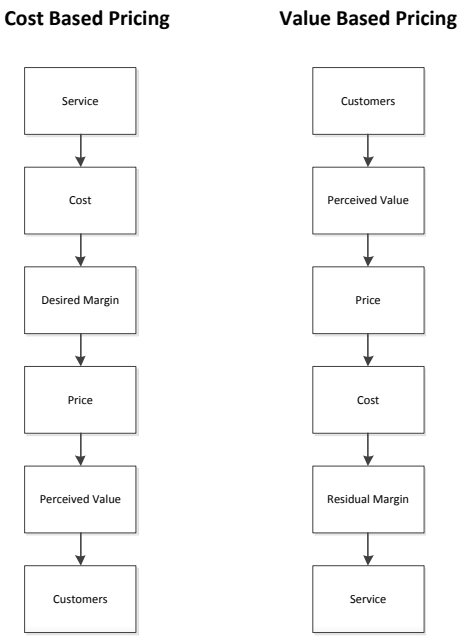


Figure 24: Comparison cost based pricing with value based pricing.

Within literature, the main definition of the value to the customer is: the customers willingness to pay or the price of an alternative + the value of the differentiating features of the companies offer. (Liozu et al., 2012; Hinterhuber, 2008) Customer value-based pricing is often recognized in literature as the superior pricing strategy. (Ingenbleek et al., 2003; Monroe, 2002; Hinterhuber, 2008). Also practitioners have recognized customer value-based pricing as one of the best pricing strategies (Hinterhuber, 2008). However, a couple of difficulties with regard to customer value-based pricing remain. For instance, making the right value assessment, communication of the right value by customers, segmentation of the market, convincing sales force management and acquiring top management support (Hinterhuber, 2008). When these difficulties can be reduced, customer value based pricing can be the best pricing strategy.

4.4.2. Priority pricing

Priority pricing is based on the principle that pricing of spare parts should be based on the priority of the order; companies can ask higher prices for emergency orders (Cohen et al., 2006; Gallagher et al., 2005). Therefore, priority pricing will be discussed within this section. Especially within the computer network industry, priority pricing is popular (Cocchi et al., 1991; Gupta et al., 1995; Marbach, 1999; Harks & Poschwatta, 2005). The basis principle of priority pricing is that customers can choose a priority level and pay according to this level. As an example, a short description of the research of Cocchi et al. (1991) is provided. By means

of this, the basic principle can be explained clear and simplistic. Cocchi et al. (1991) describe a network which can be used by one customer. There are four different service classes, based on these service classes it is determined which customer can use the network. Besides that, pricing is based on the priority of the service class. For the simplicity it is assumed that P(1,0) and P(0,1) are similar. Table 5 shows these different service classes along with their price. The last column of Table 5 shows the relative price with priority classes compared with the price without priority classes.

Table 5: Priority service classes and priority pricing

Priority	Price	Price with priority/Regular price without priorities
P(0,0)	p-priority	0,5
P(1,0) – P(0,1)	2*p-priority	1
P(1,1)	3*p-priority	1,5

Every customer can use the network, as long as there is no other customer using it with a higher priority. As shown in Table 4, the customers with a higher priority pay more than customers with a lower priority. Therefore, customers which do not use the network a lot, or have no trouble waiting before they can use the network, will consider the lower priority. Customers, who cannot wait at all, will consider the highest priority. (Cocchi et al., 1991) This is the basic principle of priority pricing. Therefore, customers could give a certain priority to spare part orders to improve the delivery time. However, customers will have to pay more for these orders. Hence, this is also a mechanism to make sure that customers give the right priority to their orders.

4.4.3. Dynamic Pricing

Another pricing strategy which is based on differentiation, is dynamic pricing. The benefits of dynamic pricing are mainly studied within the aerospace and electricity industry (Faruqui & George, 2002; Borenstein et al., 2002; Maglaras & Meissner, 2006; Besbes & Zeevi, 2009). However, dynamic pricing is also considered within the service industry and can be used to modify demand (Cohen et al., 2004). Therefore, this section will focus on dynamic pricing and explain what the main principle of dynamic pricing is.

Dynamic pricing can be applied to capture economic benefits and maximize the total expected revenues of a firm (Faruqui & George, 2002; Maglaras & Meissner, 2006; Gallego & Van Ryzin, 1994; Besbes & Zeevi, 2009). The simple form of dynamic pricing is that prices only vary during extreme supply conditions (Faruqui & George, 2002). Hence, prices are constant, but when it is extremely busy, prices go up and when it is extremely quiet, prices go down.

An example of this is time-of-use pricing in electricity markets (Borenstein et al., 2002). Customers pay different prices for the use of electricity in certain time blocks. When it is busy, customers pay more for their electricity than when it is quiet. Therefore, customers pay more for the same electricity during the week and less in the weekend. Hence, there is no differentiation based on the quality of the product or service, just on the timing of the demand.

Besides that, the different prices with regard to the different timing of demand is clear to the customer.

4.4.4. Pricing Spare Parts

Navies buy spare parts with government money. Therefore, prices needs to be transparent and it is difficult to implement customer value based pricing, priority pricing or dynamic pricing. Besides, it is difficult to determine the value of a spare part to the customer, which price needs to be linked to a certain priority or which price needs to be linked to the timing of the demand. What can be investigated, is the costs of the improvement for different categories of customer demand. Therefore, it is chosen to differentiate the prices of spare part based on the costs of the improvement. Spare parts which are most important to customers, demand for high improvement. Therefore, spare parts which are most valuable to customers, will relatively be more expensive to customers and vice versa. Hence, the price of an ordered spare part is:

P = Rsp + Ci + m

P = Price of the spare part

Rsp = Regular sales price of the spare part

Ci = Cost of improvement

m = Regular Margin

For every spare part, the cost of improvement is different. For instance, the extra service for a Special. Therefore, one example of a Special is described. This Special is ordered within the last three years and is a cable-assembly in order to make sure that the cables do not break when the system rotates. The customer has ordered three of these Specials. According to the order lists, the selling price a piece is €7750,- and the total selling price is €23250.-. Assuming that the Regular Margin is 10%. The regular sales price is €7750/110*100 = €7045,45. According to the Service Desk Manager, the Service Desk assumes that every request takes approximately 10 hours time. Therefore, the standard price to the customer will be 10*hour rate. With an hour rate of €100,- the price of the three cable-assembly's will be: €7045,45*3 + 1000 + 10% = €24350.-.

4.5. Summary

Improvements can be made by communicating factors as Price, Lead Time, MTBF, Criticality, Export Regulation and Tendering Regulation to the customer. Thereby, customers can consider these factors in inventory management and ordering spare parts. For example, stocking of critical spare parts with high lead times. This information can be communicated regarding Line Replaceable Units and Shop Replaceable Units, because these are expected to be ordered by the customer.

Regarding information sharing and communication, the Sales Support Employee who receives the order should also provide a timely confirmation of the order. Furthermore, per order, one Sales Support Employee should be responsible within Thales and one Project Procurement Officer should be responsible within the Navy. These responsible persons should posses all information regarding the order. When this improvement is implemented

and working, it can be worked towards a situation of proactive information sharing between Material Manager, Installation Managers and Purchasers of the Navy with the Sales Support Employee, Service Delivery Employee, Purchase/Production and Service Desk of Thales. Related to that, it is recommended to collect data about the usage of systems and failures of spare parts and share the information under a Non Disclosure Agreement. Thereby, estimations about needed spare parts can be more accurate. Furthermore, information about the maintenance model and maintenance planning should be shared between the Navy and Thales. Thereby, it can be better anticipated on the needed spare parts.

Components which are not in stock need more attention and information sharing than Components which are in stock. In order to make this possible, the technical employee of the Navy (Repair Planner) should directly communicate with the technical employee of Thales (Service Desk). Regarding Specials, the Installation Manager should also have a direct link to the Service Desk.

Currently, Emergency Requests are delivered as soon as possible. However, Emergency Requests should be minimized. Therefore, it should be known how many Emergency Requests are requested and what are the causes of these Emergency Requests. Subsequently, causes of Emergency Requests can be eliminated by the Navy or by Thales. The actions of navies, to prevent Emergency Requests, can be communicated to other navies by the After Sales Managers.

It is chosen to differentiate the prices of spare part based on the costs of the improvement. Spare parts which are most important to customers, demand for high improvement. Therefore, spare parts which are most valuable to customers, will relatively be more expensive to customers and vice versa.

5. IMPLEMENTATION AND PROMISES

Within this chapter, RQ 4: ‘How should this differentiation be implemented?’ is answered.

It is suggested to Thales to implement the improvements together with the Navy. Therefore, the implementation of these improvements within Thales is described within this chapter. Besides, the improvements should also be communicated to the customer. This is called: the Supply Chain Promise. In other words: What can customers expect from Thales with regard to the different categories of customer demand? However, it is better to have a dialogue rather than one way communication. Therefore, the supply chain promise should also help to start the dialogue with customers.

The implementation of the improvements within Thales is discussed as well as the associated promise. Based on the Differentiation Model, different ways of handling requests and orders of different categories of customer demand are proposed. The Differentiation Model shall be validated as well by means of discussing it with the relevant employees at the Royal Netherlands Navy. Therefore, when a request is send to Thales, the employee of the Navy who sends the request already shall indicate in which category the request fits in. The Sales Support Employee of Thales who receives the request should know how to handle the request. Hence, the Sales Support Employee who receives the request should be able to recognize and validate in which category of demand the spare part belongs. Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts are merged as these have the same dynamics.

5.1. Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts

5.1.1. Implementation

Information about the usage of systems and actual failures of spare parts should be used in estimating the spare parts needed and timing of spare parts needed. This information is available within the Navies ERP system and mission planning. Therefore, the Material Manager of the Navy can communicate the information about actual failures of spare parts once a year within a Non Disclosure Agreement. The usage of systems can be estimated by the Installation Managers and can be communicated once a year within a Non Disclosure Agreement.

A further improvement can be reached when information is shared about the maintenance model and maintenance planning of Navies, to anticipate when and which Preventive Spare Parts are needed. This will be further explained in Section 5.1.2.

The internal project is identifying per system which spare parts should be identified as Line Replaceable Unit, Shop Replaceable Unit or Preventive Spare Part. Therefore, these will be marked in the ERP system as ‘saleable’. Hence, when a request is send to Thales, it can be recognized whether a spare part is a Line Replaceable Unit, Shop Replaceable Unit or Preventive Spare Part.

5.1.2. Promise

The internal project team is working on guaranteed prices and lead times with regard to Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts. Therefore, these prices and lead times will also be fixed in a spares list, from which customers can order their spare parts. These lists will also include factors as MTBF, export license and where the spare part is used in the system.

However, within these spares lists, it should also be communicated about criticality, export regulation in the form of ITAR or EAR regulations, tendering regulation and influence of partner involved. Besides that, spares lists should not only be provided to the Project Procurement Officers or Purchasers of customers, but also to the Material Manager and Installation Managers of the Navy. The Material Manager of the Navy should include the information, stated in the spares lists, in the ERP system of the Navy. Thereby, the Material Manager, Installation Managers and Repair Planner can consider actual prices and lead times within managing inventory and ordering spare parts. Furthermore, it is known to the Material Manager, Installation Managers and Repair Planner which spare parts are critical, probably needed, bounded to export regulations and/or tendering regulations, and which time is needed to follow the process through the partner.

Hence, the Supply Chain Promise of Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts consist of a promise per spare part including all relevant information, regarding managing and ordering the specific spare part. This promise is stated in the spares list. Table 6 shows an example of such a spares list. The thick line after the total lead time is to show that, after that line is explained where this lead time emanates from.

Table 6: Example of a spares list.

Spare Part	Price	MTBF	Where Used	Criticality	Total Lead Time	Production Time	Export Regulation	Tendering Regulation	Partners Involved	Customs
1	€1000	1000 hours	cooler	100%	24 Months	14 Months	ITAR = 6 Months	Yes = 2 Months	Yes = 1 Months	Yes = 1 Months

5.2. Overhaul Spare Parts

5.2.1. Implementation

Overhaul Spare Parts can be improved by collecting information about the maintenance model, maintenance planning and Overhaul Spare Parts needed of Navies. The Installation Manager of the Navy should proactive communicate to the After Sales Manager of Thales: who is going to perform Overhaul, which Overhaul Spare Parts are needed and when these Overhaul Spare Parts are needed. Subsequently, the After Sales Manager of Thales can consult with Logistic Engineering and Sales Support about the delivery of the Overhaul Spare Parts. For instance, advice can be given to let Thales perform the Overhaul, include or exclude Overhaul Spare Parts in the Overhaul. Besides that, an estimation can be given about the lead time of the Overhaul Spare Parts, so that the Installation Manager of the Navy can order the Overhaul Spare Parts on time.

When the maintenance planning of the Navy changes, the Installation Manager of the Navy should communicate this to the After Sales Manager of Thales. Thereby, it can be anticipated on the change in the need of the customer. For instance, by delivering the Overhaul Spare Parts earlier or later.

By proactive sharing of information about the planning, when the customer is going to replace Overhaul Spare Parts and which Overhaul Spare Parts the customer needs, these can be delivered on time. When customers communicate with Thales which Overhaul Spare Parts they need, these spare parts can be marked in the ERP system as Overhaul Spare Parts.

5.2.2. Promise

For Overhaul Spare Parts the Supply Chain Promise depends on the collected information of the customer. When the customer communicates proactively about the Overhaul Spare Parts needed and when these Overhaul Spare Parts are needed. The Supply Chain Promise should be that the customer gets timely advice and the Overhaul Spare Parts will be delivered on time.

5.3. Components

5.3.1. Implementation

With regard to Components, a difference is made between components which are in stock and components which are not in stock. Components which are in stock, can be delivered out of stock and Thales has an up-to-date database (MAN-66-Inventory Overview) which states which spare parts are in stock. Hence, these Components can be recognized in the system by looking in the database and can be delivered out of stock.

When the Repair Planner (responsible for Components) of the Navy has a need for a Non-Common Component, the Repair Planner should call directly to the Service Desk of Thales. The Repair Planner needs to know this before he has this need. Therefore, this should be included within the commercial material of Thales, which is send to the Repair Planner, and the After Sales Manager should communicate this to the Repair Planner.

When the Repair Planner of the Navy has called the Service Desk regarding a Component, the Repair Planner should inform the Project Procurement Officer/Senior Purchaser of the Navy and the Service Desk should inform Sales Support of Thales. Subsequently, the requests for Components can be marked in the ERP system of Thales and the Navy. Based on this, Logistic Engineering can analyse this data, search for demand patterns and advice to put Components which are regularly ordered (at least once a year) in stock.

It is hard to determine, in advance, what the effect of this improvement will be regarding customer satisfaction. Therefore, a pilot can be undertaken with the Royal Netherlands Navy to investigate the statistical effect of the improvement regarding lead times and customer satisfaction. The statistical effect of the improvement can be used in convincing other customers to make the same changes.

5.3.2. Promise

With regard to Components, Thales should inform the customer about the common Components which are in stock. This can be implemented by including the common Components within the spares lists of Line Replaceable Units, Shop Replaceable Units and Preventive Spare Parts. Logistic Engineering can, together with a Data analyst, look in the (MAN66) Inventory Overview and identify the common Components which are in stock. The lead time of these Components depends on the transportation of the Component towards the customer and the price is fixed. This lead time and price will be stated in the spares lists and the Material Manager can include this in the ERP system of the Navy.

With regard to Non-Common Components, the Repair Planner of the Navy should call directly to the Service Desk. Hence, when a Component is not included in the ERP system of the Navy, the Repair Planner should call the Service Desk. The fastest and best solution to the customer will be advised by the Service Desk. Therefore, the Supply Chain Promise should be provided by the Service Desk about the fastest and best solution. Thereby, also the costs of the Service Desk can be included. It can also be promised that the customer can always call the Service Desk and pay a yearly fee for this. The price of this yearly fee shall be based on an estimation of the amount of calls from the customer. This estimation can be made, based on the ordered Non-Common Components and Specials of previous years. The customer will have the choice between paying a yearly fee or paying case-by-case.

5.4. Specials

5.4.1. Implementation

As mentioned in Section 4.3.4., for Specials the same direct link should be available as for Non-Common Components. Therefore, when the Installation Manager (responsible for Specials) of the Navy has a need for a Special, the Installation Manager should call directly to the Service Desk of Thales. Similar to the implementation regarding the Non-Common Components, this should also be included in the commercial material, be communicated by the After Sales Managers. The Project Procurement Officer/Senior Purchaser of the Navy and Sales Support of Thales should stay informed and requests for Specials should be marked in the ERP systems of Thales and the Navy.

Similar to the improvement regarding the Non-Common Components, this improvement can be included in a pilot with the Royal Netherlands Navy.

5.4.2. Promise

With regard to Specials, the Supply Chain Promise should be that the Installation Manager can communicate directly with the Service Desk. Thereby, the fastest and best solution can be advised to the customers. Hence, the Supply Chain Promise should be provided by the Service Desk about the fastest and best solution. Similar to the Non-Common Components, the costs of the Service Desk should be added to the price of the spare parts and should be included in the promise to the customer. And it can be promised that the customer can pay a yearly fee for the Service Desk. Again, the customer will have the choice between paying a yearly fee or paying case-by-case.

5.5. Emergency Requests

5.5.1. Implementation

According to the After Sales Managers and Sales Support Employees, customers contact Thales when it is an Emergency Request. Hence, it is known which requests are Emergency Requests. As mentioned in Section 4.3.5., Emergency Requests should be marked in the ERP system, the causes should be investigated and actions need to be taken to eliminate these causes. Subsequently, the actions can be communicated to other navies to prevent that the same Emergency Requests are coming from other navies.

When Sales Support gets an Emergency Request, the Sales Support Employee should make a small report of the cause of the Emergency Request. Once a year, these reports can be checked by the Sales Support Manager, Service Desk Manager and After Sales Manager. When there are multiple, similar Emergency Requests the After Sales Managers can give advice to the navies how to eliminate the cause. One example of this can be the advice to buy a steel protection box for radars which are not on a mission. Thereby, the radar is protected from damage from the environment, for instance steel pipes or forklifts.

5.5.2. Promise

With regard to Emergency Requests, the Supply Chain Promise should be that Thales does everything within their power to deliver these spare parts as soon as possible. However, this means that other requests may be postponed and more hours work will be put in delivering these spare parts faster than usual, this costs money. Therefore, the customer will have to pay more for Emergency Requests. It can also be promised that Emergency Requests are monitored and investigated in order to come up with solutions to minimize the Emergency Requests.

5.6. Information Sharing and Communication

With regard to Information Sharing and Communication, it is mentioned in section 4.2 that one Sales Support Employee within Thales and one Project Procurement Officer/Senior Purchaser within the Navy should be responsible per order. Information needs to be shared constantly between the Installation Managers, Material Manager, Repair Planner, Finance Department, Project Procurement Officer and Senior Purchaser at the Navy. Information needs to be shared constantly between Sales Support, Service Delivery, Purchase, Production and the Service Desk. This can be implemented by weekly meetings within the Navy and within Thales.

5.7. Summary

The Differentiation Model shall be validated by means of discussing it with the Project Procurement Officer, Installation Managers and Material Managers at the Royal Netherlands Navy.

Regarding information sharing, the Material Manager of the Navy can communicate information about actual failures of spare parts once a year within a Non Disclosure Agreement and the Installation Managers can communicate the usage of systems once a year within a Non Disclosure Agreement. The Installation Manager of the Navy should proactive communicate to the After Sales Manager of Thales: who is going to perform Overhaul, which Overhaul Spare Parts are needed and when these Overhaul Spare Parts are needed. Subsequently, the After Sales Manager of Thales can consult with Logistic Engineering and Sales Support about the delivery of the Overhaul Spare Parts. When the maintenance planning of the Navy changes, the Installation Manager of the Navy should communicate this to the After Sales Manager of Thales. If the Installation Manager provides this information, Thales delivers the Overhaul Spare Parts according to the customers' maintenance planning.

When the Repair Planner (responsible for Components) of the Navy has a need for a Non-Common Component, the Repair Planner should call directly to the Service Desk of Thales. When the Installation Manager (responsible for Specials) of the Navy has a need for a Special, the Installation Manager should call directly to the Service Desk of Thales. This advice should be included within the commercial material of Thales and communicated by the After Sales Managers of Thales to the Repair Planner and Installation Managers of the Navy. The Project Procurement Officer/Senior Purchaser of the Navy and Sales Support of Thales should stay informed. The Supply Chain Promise is to call the Service Desk for the best and fastest solution. The price of the Service Desk will be added to the spares price or a yearly fee can be paid. A pilot can be undertaken with the Royal Netherlands Navy to investigate the statistical effect of the improvement regarding lead times and customer satisfaction. Subsequently, the results of this pilot can be used to convince other customers that a direct link improves their service.

Regarding Emergency Requests, the Sales Support Employee who receives the request should make a small report of the cause of the Emergency Request. Once a year, these reports can be checked by the Sales Support Manager, Service Desk Manager and After Sales Manager. When there are multiple, similar Emergency Requests the After Sales Managers can give advice to the navies how to eliminate the cause. The Supply Chain Promise is that Thales does everything within their power to deliver these spare parts as soon as possible. However, this costs money, so the spare parts are more expensive. Furthermore, Thales is monitoring and investigating Emergency Requests to minimize Emergency Requests.

Weekly meetings should take place within the Navy, with the Installation Manager, Material Manager, Finance Department, Project Procurement Officer and Senior Purchaser. Thereby, information regarding the need for spare parts and orders of spare parts can be shared. Weekly meetings should also take place within Thales, with Sales Support, Service Delivery, Purchase, Production and (if applicable) Service Desk. Thereby, information regarding the ordered spare parts and changes in prices or lead times can be communicated.

Spares lists are provided regarding Line Replaceable Units, Shop Replaceable Units, Preventive Spare Parts and Common Components. Within these spares lists, it should be communicated about prices, lead times, MTBF, criticality, export regulation in the form of ITAR or EAR regulations, tendering regulation and influence of partner involved. The Material Manager of the Navy should include the information, stated in the spares lists, in the ERP system of the Navy.

6. CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the main research question: *How can the service, with regard to the replenishment of spare parts, be improved and priced by means of a differentiation of customer demand?* is answered. Therefore, sub-questions 1, 2, 3 and 4 are answered. Subsequently, recommendations are given, based on the answers on the sub-questions.

6.1. Conclusions

6.1.1. How should customer demand be differentiated?

The service, with regard to the replenishment of spare parts, can be improved by means of differentiating customer demand into different categories. The different categories are:

- Line Replaceable Units
- Shop Replaceable Units
- Components
- Preventive Spare Parts
- Overhaul Spare Parts
- Specials
- Emergency Requests

These different categories are divided into anticipated demand and unanticipated demand, based on the predictability of demand. Besides, the different categories are ordered based on the urgency of demand. Therefore, Table 7 shows the differentiation of customer demand.

Table 7: Differentiation model.

Urgency of Demand ↑	
	Unanticipated Demand
	Emergency requests
	Specials
	Components
	Anticipated Demand
	Line Replaceable Units
	Shop Replaceable Units
	Preventive Spare Parts
	Overhaul Spare Parts

6.1.2. How can the service be improved with regard to these different categories of customer demand?

Thales and the Navy should cooperate together to achieve the biggest improvement.

Regarding *Line Replaceable Units, Shop Replaceable Units* and *Preventive Spare Parts*, more accurate estimations about needed spare parts can be made by sharing information about actual failures of spare parts and usage of systems. Furthermore, Thales can help the customer by proactive communication of Prices, Lead Times, MTBF, Criticality, Export Regulation, Tendering Regulation and Influence of Partners Involved to the customer.

With regard to *Overhaul Spare Parts,* information should be shared between the Navy and Thales about the timing of Overhaul and the spare parts needed. Thereby, this category of demand can also be anticipated on. By sharing the long term upkeep plan with Thales the Navy can benefit from the ability of Thales to make estimations.

With regard to *Components,* common components can be delivered out of stock. However, for Components which are not in stock, a different approach should be available. These Components should be marked by the Sales Support Employee in the ERP system as Component and this data can be analysed by Logistics Engineering to search for demand patterns. Based on this demand patterns, it can be decided which Components to put on stock.

When there is still a need for a Component which is not in stock, the Repair Planner of the Navy should call the Service Desk for Technical Assistance and advice about the replenishment of this Component. The need for the Component should be identified and the urgency of demand for the Component. When it is difficult to deliver the Component or it is difficult for the customer to replace the Component, the Service Desk should provide Technical Assistance or advice to replenish a Line Replaceable Unit or Shop Replaceable Unit. Furthermore, the Service Desk can help, for example, with temporary solutions.

Regarding *Specials,* the Installation Manager of the Navy should call the Service Desk for the best and fastest solution. Thales has a Service Coordination Centre in place for this. Hence, this Service Coordination Centre should also be used regarding demand for Specials.

With regard to *Emergency Requests,* priority is given to these requests and it should be decided case by case which approach is the best to deliver these spare parts as soon as possible. However, Emergency Requests should be minimized by means of improving the non-Emergency Requests, information sharing, communication and investigating the causes for Emergency Requests. Thereby, the causes for Emergency Requests can be minimized.

Information sharing and communication can be improved for all orders and this can help to improve the process regarding the replenishment of spare parts. A situation as by Transportation Systems should be created by proactive information sharing within the Navy and within Thales. Information about the need for spare parts, ordered spare parts and order status should be shared constantly between the Material Manager, Installation Managers, Finance Department, Project Procurement Officer and Senior Purchaser of the Navy and Sales Support, Service Delivery, Purchaser, Production and the Service Desk of Thales. Furthermore, a timely confirmation of orders should be given by the Sales Support Employee who receives the request.

6.1.3. Which pricing strategies should be used to price spare parts within different groups of customer demand?

In the ideal situation, pricing should be based on the customers' willingness to pay. However, within the Navy market, this is difficult. Therefore, prices should be differentiated on the improvements which are suggested. Spare parts which are most important to customers demand for most improvement. Therefore, spare parts with a high value to customers shall relatively be more expensive and vice versa. The price of an ordered spare part is the cost price of a spare part plus the cost of the improvement regarding the spare part and a regular margin.

6.1.4. How should this differentiation be implemented?

The Differentiation Model shall be validated by means of discussing it with the Project Procurement Officer, Installation Managers and Material Managers at the Royal Netherlands Navy.

The Material Manager of the Navy can communicate information about actual failures of spare parts once a year within a Non Disclosure Agreement and the Installation Managers can communicate the usage of systems once a year within a Non Disclosure Agreement. The Supply Chain Promise of *Line Replaceable Units, Shop Replaceable Units* and *Preventive Spare Parts* consist of a spares list with Prices, Lead Times, MTBF, Criticality, Export Regulation, Tendering Regulation and Influence of Partners Involved to the customer. The Material Manager of the Navy should include this information in the ERP system of the Navy.

The Installation Manager of the Navy should proactive communicate to the After Sales Manager of Thales: who is going to perform Overhaul, which *Overhaul Spare Parts* are needed and when these Overhaul Spare Parts are needed. Subsequently, the After Sales Manager of Thales can consult with Logistic Engineering and Sales Support about the delivery of the Overhaul Spare Parts. When the maintenance planning of the Navy changes, the Installation Manager of the Navy should communicate this to the After Sales Manager of Thales. If the Installation Manager provides this information, Thales delivers the Overhaul Spare Parts according to the customers' maintenance planning.

Common *Components* can be delivered out of stock. Therefore, the common Components which are in stock should be included in the spares lists to the customer. Logistic Engineering can investigate, based on the demanded components, which components are common components and this should be adjusted once a year. Thereby, the common Components which the customer demands for will be in stock.

When the Repair Planner of the Navy has a request for a Non-common Component, the Repair Planner should call the Service Desk of Thales. Thereby, the fastest and best solution can be proposed to the Repair Planner. This instruction to the Repair Planner should be included within the commercial material of Thales and the After Sales Managers should explain this to the Repair Planners.

When the Installation Manager of the Navy has a request for a Special, the Installation Manager should call the Service Desk of Thales. This instruction to the Installation Managers should also be included within the commercial material of Thales and the After Sales Managers should explain this to the Installation Managers.

When an *Emergency Request* is requested at Thales, the Sales Support Employee who receives the request shall write a small report concerning the cause of the Emergency Requests. The Sales Support Manager, Service Desk Manager and After Sales Managers can, once a year, check the list of Emergency Requests. When there are multiple similar causes, actions can be taken to eliminate these causes.

Improvements with regard to information sharing and communication should be implemented within Thales as well as within the Navy. Within Thales, per order, one Sales Support Employee should be responsible and posses all information regarding the order. For instance, regarding order status, who is working on the order and changes in price or lead time. Within the Navy, also one person should be responsible and posses all information regarding the order. For instance, regarding the need for spare parts and maintenance planning. Besides that, between Thales and the Navy, information should be shared proactive about prices, lead times, MTBF, criticality, usage of systems, export regulations, tendering regulations, maintenance timing and the need for spare parts.

A pilot with the Royal Netherlands Navy can be started to investigate the statistical effects of the improvements on the lead times and customer satisfaction. Thereby, the results can be used to convince other customers of the improvement of the service.

6.2. Recommendations

6.2.1. Navy

Currently, estimations of spare parts needed are based on theoretical calculations. This can be more accurate by sharing information regarding actual failures of spare parts and usage of systems. Therefore, the Material Manager and Installation Managers should share information, regarding actual failures of parts and usage of systems, within a Non Disclosure Agreement.

The Installation Managers should share information regarding their maintenance planning. When the Navy is going to perform Overhaul and which spare parts the Navy need for this Overhaul. Thereby, spare parts can be delivered according the customers' maintenance planning.

The Installation Managers and Repair Planners of the Navy should call the Service Desk when there is a need for a not-common Component or a Special. Thereby, the best and fastest solution can be advised to the customer. Currently, this information sharing follows the same stream as the official request stream, which takes a lot of time and information gets less accurate.

The Material Manager, Installation Managers, Finance Department, Project Procurement Officer and Senior Purchaser of the Navy should plan weekly meetings to share information regarding the need and demand for spare parts and the ordered spare parts.

The Material Manager of the Navy should include the information of spares lists in the ERP system of the Navy. Thereby, this information is accessible to Installation Managers, Material Managers, Repair Planners, Finance Department, Project Procurement Officers and Senior Purchasers within the Navy. Subsequently, this information can be used in the inventory management and ordering process of the Navy.

6.2.2. Thales

First of all, Sales Support should provide timely confirmations of the ordered spare parts. Currently, the Navy is not always receiving a confirmation of the order. Therefore, Sales Support should, at least, confirm within a week that the order is received at Thales and that they are working on it. The exact delivery date and price can be confirmed when this is investigated.

Logistic Engineering should consider information regarding actual failures of parts and usage of systems within their estimations about spare parts needed. Currently, these estimations are based on theoretical calculations, this can be made more accurate.

Thales should include criticality, export regulation in the form of ITAR or EAR regulations, tendering regulation and influence of partners involved within the spares lists. In addition to the prices, lead times, MTBF, export license and where the spare part is used. Thereby, the customer has more information which the customer can use to manage their inventory and replenishment process better.

The After Sales Managers can communicate information about the maintenance planning of Navies to Logistic Engineering, Sales Support and Service Delivery to make sure that the Overhaul Spare Parts are delivered according to the customers' maintenance timing.

Sales Support and Logistic Engineering should investigate demand patterns of demanded Components. Thereby, the most common components (ordered on average at least once a year) can be put in stock. Subsequently, the common components can be included in the spares lists.

Sales Support should mark Emergency Requests and write a small report where the cause of the Emergency Requests is explained. Based on this, once a year, the Sales Support Manager, Service Desk Manager and After Sales Manager can check this list and see which actions can be taken to minimize the causes of Emergency Requests.

Sales Support, Service Delivery, Purchase, Production and the Service Desk of Thales should plan weekly meetings to share information regarding the need and demand for spare parts and the ordered spare parts. Furthermore, information regarding changes in prices, lead times or export regulation of spare parts can be shared.

Thales should further investigate the pricing of the spare parts within the different categories.

The last recommendation is to start the implementation of the improvements with a pilot with the Royal Netherlands Navy. Based on the results of this pilot, other customers can be convinced about the increase in service.

7. DISCUSSION

In this chapter, limitations of this research are discussed and recommendations for future research are given.

7.1. Limitations

The first limitation is that it was not able to interview all customers. Therefore, the Supply Chain of the Royal Netherlands Navy was validated for the other customers by discussing it with the After Sales Managers. However, it was not known for all customers how the Supply Chain of Spare Parts exactly looks like. Besides, it may be that some customers do not recognize the Differentiation Model or the improvements based on the Differentiation Model. Furthermore, as mentioned in the introduction, customers differ based on culture, local legislation and the influence of agents or partners. Therefore, some recommendations need adjustment for different customers.

This leads to the second limitation, which is about the improvements and recommendations. Many improvements and recommendations are based on the sharing of information and communication with customers. Within the Royal Netherlands Navy, this is possible. However, regarding local legislation and culture, improvements and recommendations for other customers may need a different approach.

The third limitation is about the pricing of spare parts. As mentioned before, customer value based pricing seems the superior pricing strategy. However, at this moment this is difficult to implement within the Naval market. Therefore, not the best pricing strategy can be proposed within this research.

The fourth limitation is about the many different actors which are influenced by or influence the complete supply chain of spare parts. A lot of interviews are held and sometimes inconsistent information was gathered from different interviewees. Hence, not all of this information could be made quantitative.

The last limitation is about the effect of the recommendations on customer satisfaction. This effect should be visible in the future. However, at this moment, it is not able to give clear evidence about the effect of the recommendations on customer satisfaction.

7.2. Future Research

Based on limitations one and two, it can be investigated how local legislations and cultures influence the proposed improvements. Thereby, it can be further elaborated what differences in legislation and culture should be considered in improving the service for customers within different countries.

An other interesting subject for future research is the implementation of customer value based pricing within the Naval market. More general, the implementation of customer value based pricing in a business to government context. This can also differ between governments. Therefore, this can be investigated with regard to different countries.

Furthermore, a longitudinal research can be executed to investigate the impact of the improvements on customer satisfaction. This impact is not visible within one or two weeks,

but should become visible over time. Therefore, a longitudinal research can be executed to investigate this impact.

REFERENCES

Aronis, K. P., Magou, I., Dekker, R., &Tagaras, G. (2004). Inventory control of spare parts using a Bayesian approach: A case study. *European Journal of Operational Research*, *154*(3), 730-739.

Avlonitis, G. J., & Indounas, K. A. (2005). Pricing objectives and pricing methods in the services sector. *Journal of Services Marketing*, *19*(1), 47-57.

Babbie, E. (2007). *The practice of social research.* Belmont: Thomson Higher Education.

Besbes, O., & Zeevi, A. (2009). Dynamic pricing without knowing the demand function: Risk bounds and near-optimal algorithms. *Operations Research*, *57*(6), 1407-1420.

Borenstein, S., Jaske, M., & Rosenfeld, A. (2002). Dynamic pricing, advanced metering, and demand response in electricity markets. *Center for the Study of Energy Markets*.

Buiting, M. A., Tan, T., Topan, E., Pollmann, K. B., Navy, R. N., &Sluijter, P. T. An integrated repairable spare parts management methodology: An application in the maritime sector.

Caggiano, K. E., Jackson, P. L., Muckstadt, J. A., &Rappold, J. A. (2007). Optimizing service parts inventory in a multiechelon, multi-item supply chain with time-based customer service-level agreements. *Operations Research*, *55*(2), 303-318.

Cocchi, R., Estrin, D., Shenker, S., & Zhang, L. (1991, August). A study of priority pricing in multiple service class networks. In *ACM SIGCOMM Computer Communication Review* (Vol. 21, No. 4, pp. 123-130). ACM.

Cohen, M. A., Agrawal, N., &Agrawal, V. (2006). Winning in the aftermarket. *Harvard business review*, *84*(5), 129.

Deshpande, V., Cohen, M. A., & Donohue, K. (2003). An empirical study of service differentiation for weapon system service parts. *Operations Research*, *51*(4), 518-530.

Faruqui, A., & George, S. S. (2002). The value of dynamic pricing in mass markets. *The Electricity Journal*, *15*(6), 45-55.

Fisher, M. L. (1997). What is the right supply chain for your product?. *Harvard business review*, *75*, 105-117.

Gallagher, T., Mitchke, M. D., & Rogers, M. C. (2005). Profiting from spare parts. *The McKinsey Quarterly*, *2*, 1-4.

Gallego, G., & Van Ryzin, G. (1994). Optimal dynamic pricing of inventories with stochastic demand over finite horizons. *Management science*, *40*(8), 999-1020.

Gelderman, C. J., & Van Weele, A. J. (2003). Handling measurement issues and strategic directions in Kraljic's purchasing portfolio model. *Journal of purchasing and supply management*, *9*(5), 207-216.

Harks, T., & Poschwatta, T. (2005, November). Priority pricing in utility fair networks. In *Network Protocols, 2005. ICNP 2005. 13th IEEE International Conference on* (pp. 10-pp). IEEE.

Harmon, R., Demirkan, H., Hefley, B., & Auseklis, N. (2009, January). Pricing strategies for information technology services: A value-based approach. In *System Sciences, 2009. HICSS'09. 42nd Hawaii International Conference on* (pp. 1-10). IEEE.

Hinterhuber, A. (2008). Customer value-based pricing strategies: why companies resist. *Journal of business strategy*, *29*(4), 41-50.

Holmqvist, M., &Pessi, K. (2006). Agility through scenario development and continuous implementation: a global aftermarket logistics case. *European Journal of Information Systems*, *15*(2), 146-158.

Huiskonen, J. (2001). Maintenance spare parts logistics: Special characteristics and strategic choices. *International journal of production economics*, *71*(1), 125-133.

Jalil, M. N., Zuidwijk, R. A., Fleischmann, M., & van Nunen, J. A. (2011). Spare parts logistics and installed base information. *Journal of the operational Research Society*, *62*(3), 442-457.

Knecht, T., Leszinski, R., & Weber, F. A. (1993). Making profits after the sale. *The McKinsey Quarterly*, (4), 79

Kranenburg, A. A., & Van Houtum, G. J. (2004). *A multi-item spare parts inventory model with customer differentiation*. Beta, Research School for Operations Management and Logistics.

Lee, H. L., &Billington, C. (1992). Managing supply chain inventory: pitfalls and opportunities. *Sloan management review*, *33*(3).

Liozu, S. M., Hinterhuber, A., Boland, R., & Perelli, S. (2012). The conceptualization of value-based pricing in industrial firms. *Journal of Revenue & Pricing Management*, *11*(1), 12-34.

Maglaras, C., & Meissner, J. (2006). Dynamic pricing strategies for multiproduct revenue management problems. *Manufacturing & Service Operations Management*, *8*(2), 136-148.

Marbach, P. (1999, September). Pricing priority classes in a differentiated services network. In *PROCEEDINGS OF THE ANNUAL ALLERTON CONFERENCE ON COMMUNICATION CONTROL AND COMPUTING* (Vol. 37, pp. 1075-1084). The University; 1998.

Molenaers, A., Baets, H., Pintelon, L., &Waeyenbergh, G. (2012). Criticality classification of spare parts: A case study. *International Journal of Production Economics*, *140*(2), 570-578.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *the Journal of Marketing*, 41-50.

Pfohl, H. C., & Ester, B. (1999). Benchmarking for spare parts logistics. *Benchmarking: An International Journal*, *6*(1), 22-45.

Pourakbar, M., & Dekker, R. (2012). Customer differentiated end-of-life inventory problem. *European Journal of Operational Research*, *222*(1), 44-53.

Sundin, E., Ölundh Sandström, G., Lindahl, M., Öhrwall Rönnbäck, A., Sakao, T., & Larsson, T. C. (2009, April). Challenges for Industrial Product/Service Systems: Experiences from a learning network of large companies. In *Proceedings of the 19th CIRP Design Conference–Competitive Design*. Cranfield University Press.

Töllner, A., Blut, M., & Holzmüller, H. H. (2011). Customer solutions in the capital goods industry: Examining the impact of the buying center. *Industrial Marketing Management*, *40*(5), 712-722.

Ulaga, W. (2003). Capturing value creation in business relationships: A customer perspective. *Industrial marketing management*, *32*(8), 677-693.

Veenstra, A. W., Zuidwijk, R., &Geerling, B. (2006, June). Maintenance logistics in the Dutch dredging industry. In *Service Operations and Logistics, and Informatics, 2006. SOLI'06. IEEE International Conference on* (pp. 436-441). IEEE.

APPENDIX 1: INTRODUCTION NUMBERS AND FIGURES

Table 1: Thales presence: main countries (more than 1.000 employees) with their workforce.

Country	Workforce
France	34.650
United Kingdom	7.820
Germany	4.500
Australia	3.330
United States	3.000
Italy	2.800
Netherlands	2.030
Spain	1.850
South Korea	1.820
Canada	1.370

Figure 1 shows that the Thales Group is for 48,3% owned by free float shareholders, which is the biggest group of shareholders. The French state possesses 26,4% of the shares and the company Dassault Aviation possesses 25,3% of the shares. Dassault Aviation is a company which builds aircrafts, for civil purposes as well as military purposes. Next to that, the employees of the Thales Group also posses 2,0% of the total shares.

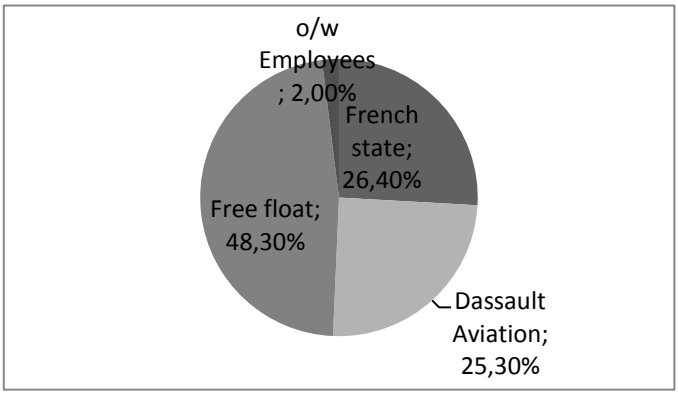
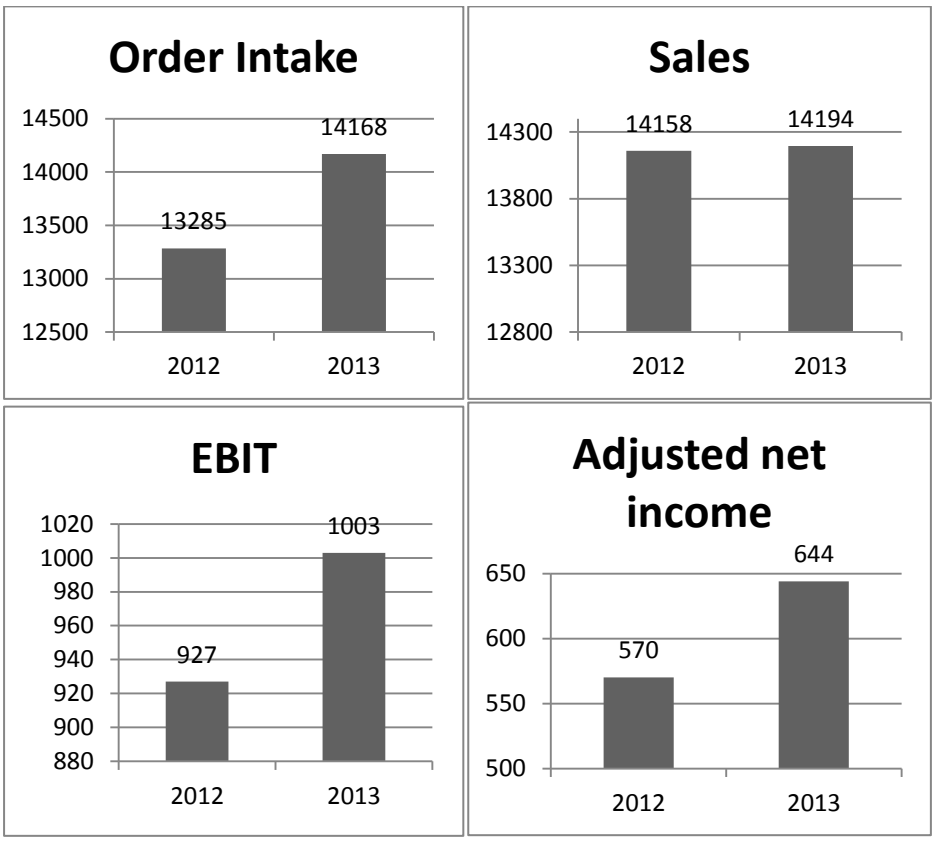


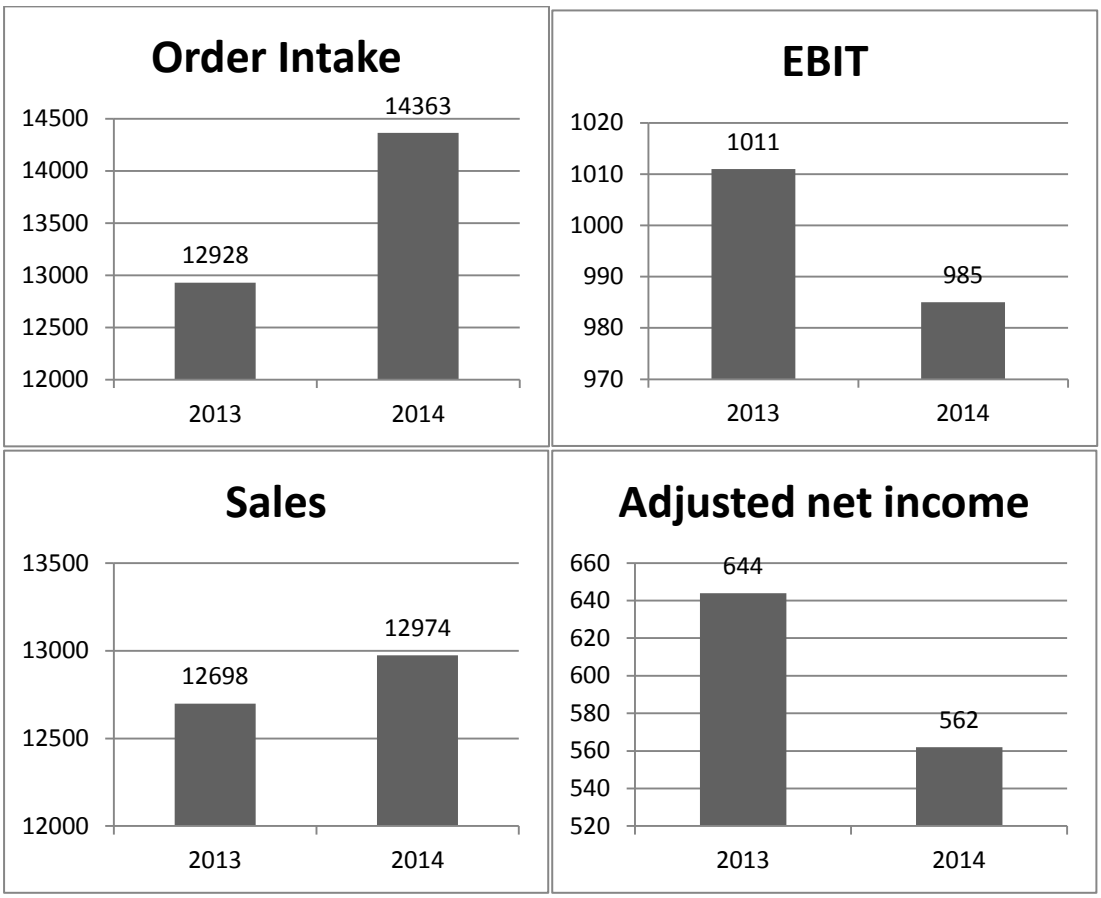
Figure 1: Division of Shareholders (June 2014)

Table 2.1-2.4: Order intake, Sales, EBIT and Adjusted net income 2012 and 2013.



Tables 2.1 until 2.4 show that the order intake and the sales in 2013 were approximately 14.2 billion euros. The EBIT of the Thales Group was around 1 billion euros and the adjusted net income 644 million euros. All the changes, relative to 2012, were positive.

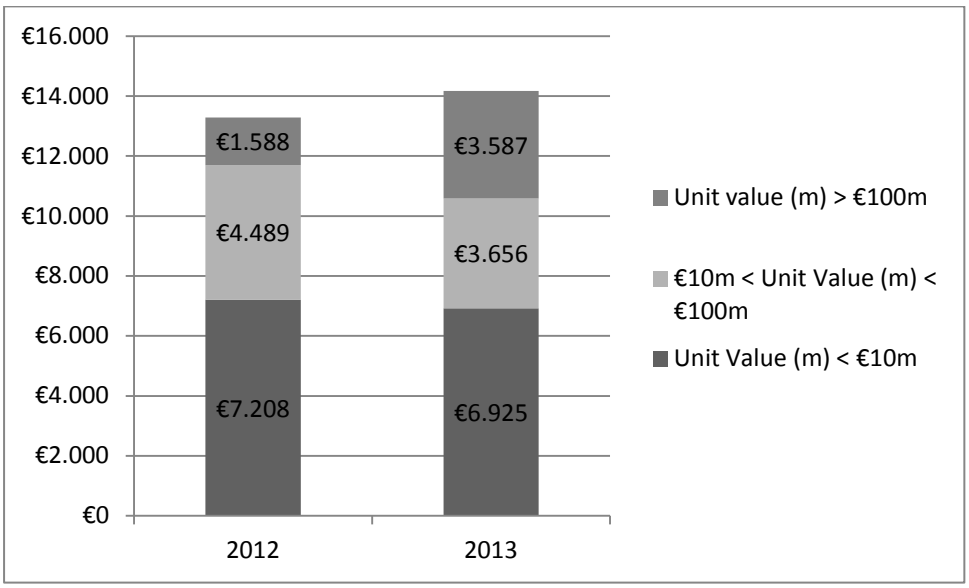
Table 3.1-3.4: Order intake, Sales, EBIT and Adjusted net income 2013 H1 and 2014 H1.



Tables 3.1 until 3.4 show that the order intake and the sales of 2014 were increasing, relative to 2013. However, the EBIT and the adjusted net income were decreasing, because of losses of DCNS. This has such an impact on the Thales Group, because they have 35% of the shares of DCNS.

-The numbers of 2013 are adjusted, due to the introduction of IFRS 10/11.

Table 4: Global order intake by contract size, 2012 and 2013



The increase in the global order intake in 2013 is due to the increase in orders with a value of more than 100 million euros, as shown in Table 4. This matches the strategy of the Thales Group, which states that the focus should be laid on orders with a value of more than 100 million euros.

Table 5: Global order intake by contract size, 2013 H1 and 2014 H1

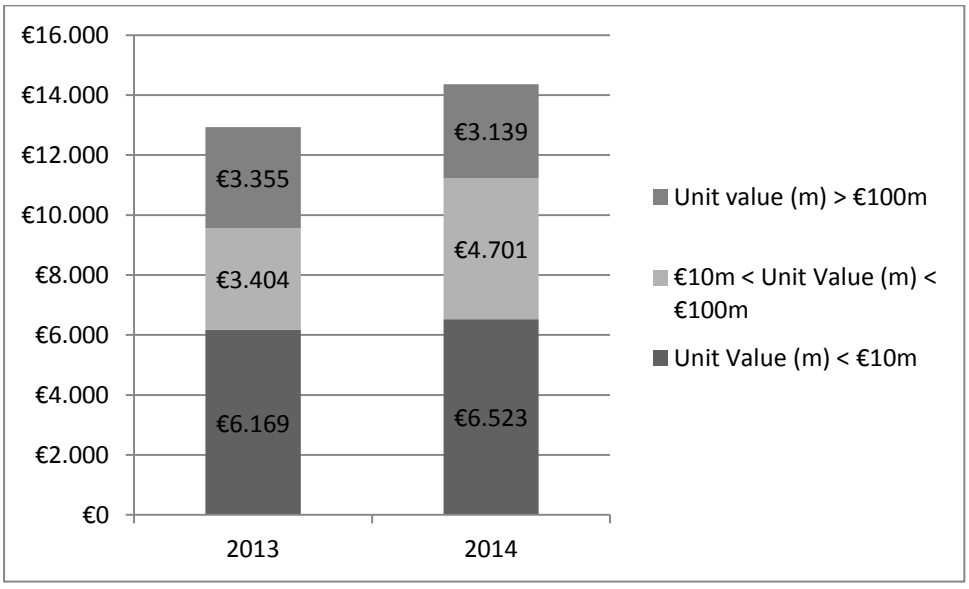


Table 5 shows that the global order intake in total was increasing in 2014, relative to 2013. The order intake of orders with a value of more than €100 million was decreasing, but the order intake of orders with a value of less than €100 million were increasing more.

Appendix 2: Sales by Destination

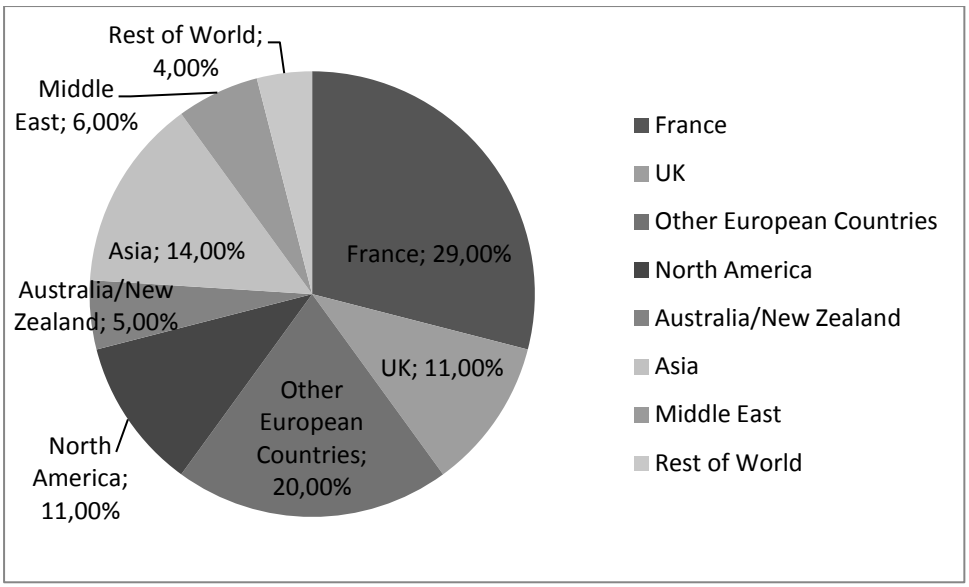


Figure 1: Sales by destination (2013)

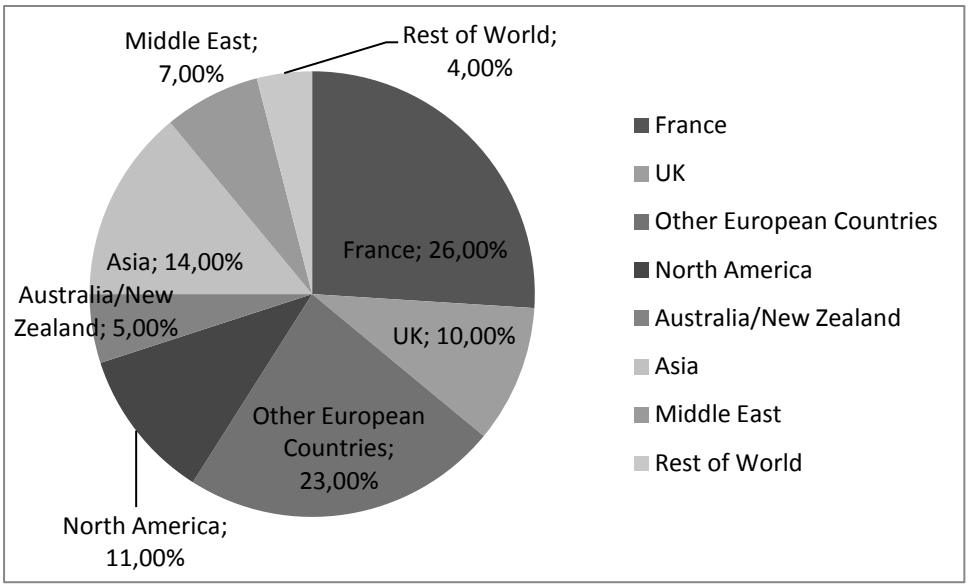


Figure 2: Sales by destination (2014)

Appendix 3: Customer Satisfaction Table

Appendix 4: On Time Delivery Figures

Appendix 5: Stakeholders involved

It is addressed multiple times in literature that different customers can have different needs, because of the different stakeholders involved. Companies should be aware of this and act according to this. (Cohen et al., 2006; Gallagher et al., 2005; Sundin et al., 2009; Lee & Billington, 1992) Because the supply chain of Thales towards the end-user influences multiple stakeholders and is influenced by multiple stakeholders, this factor is described below.
To understand the customers' needs, companies should better understand the customers' customer and the needs which arise from customers of the customer (Cohen et al., 2006; Gallagher et al., 2005; Sundin et al., 2009). Therefore, the supply chain of spare parts at the navy is mapped and the different demand streams and needs associated with this supply chain are investigated. For example, Figure 1 shows a simplistic model of the supply chain of spare parts from Thales towards the end-user and the focus of this research. This research is focused outside-in. Hence, from the end-user towards Thales.

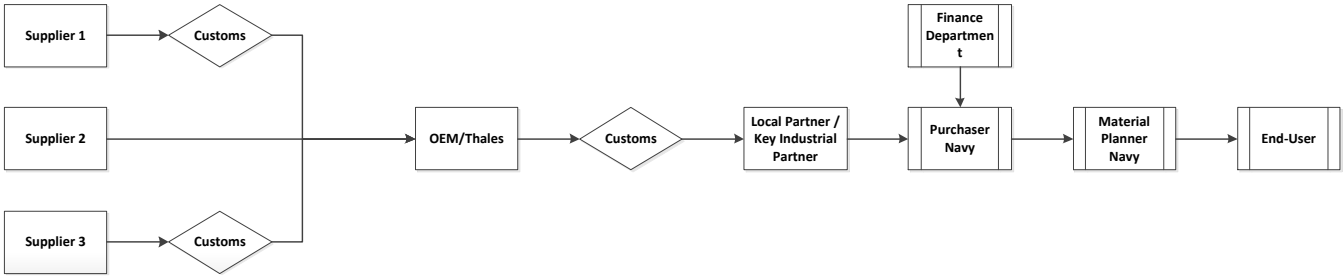


Figure 1: Supply chain of spare parts

Figure 1 shows that there are a lot of stakeholders involved. For instance, Customs, Local Partners, Purchasers, Material Planners.
Companies should understand the needs of the stakeholders that affect or are affected by the supply chain (Lee & Billington, 1992). Therefore, customer demand should be differentiated on the needs of these stakeholders and the influence of the different stakeholders on the process.

Appendix 6: Supply Chain of Spare Parts Royal Netherlands Navy

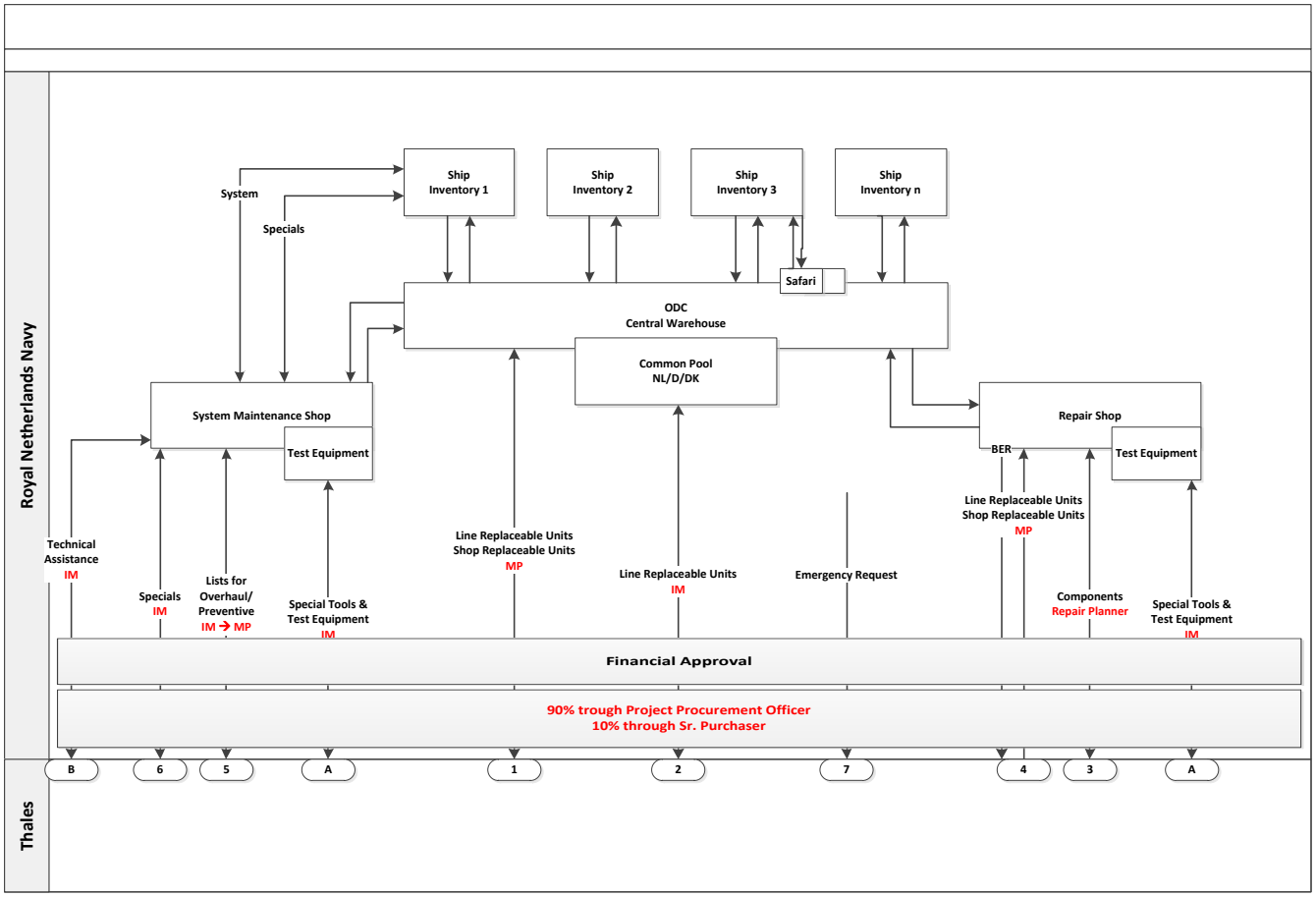


Figure 1: Supply chain of spare parts at the Royal Netherlands Navy.

Figure 1 shows the supply chain of spare parts at the RNLN, as explained during the interviews with the Project Procurement Officer, Material Planner and Installation Managers of the RNLN. Figure 1 shows that there are a few categories of spare parts which rise from this process. Therefore, these categories should be the basis for a differentiation. Figure 1 shows that the Royal Netherlands Navy has several similar ships with the same maintenance requirements. All of the ships have their own inventory of spare parts. Besides that, when the ships go on a mission, the ships take out mission packages of spare parts. Therefore, enough spare parts are available at the ship to complete the mission. These mission packages are also called Safari packages. When the ships arrive back in the harbor, failed parts are retransferred to the central warehouse (ODC) and are replaced with new spare parts from the ODC. The different customer demand streams which rise from this supply chain of spare parts are explained in Section 2.1.

Figure 1 shows also the persons responsible for the different categories of customer demand (IM=Installation Manager, MP=Material Planner).

Besides, every demand of the customer should be financially approved, before this is send to the Project Procurement Officer of Senior Purchaser.

Appendix 7: Criticality classifications

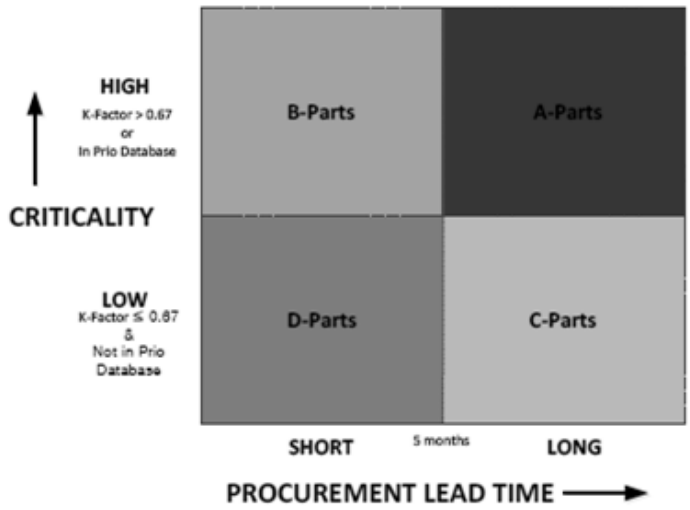


Figure 1: Criticality and Lead time classification out of the perspective of the Dutch Navy. (Buiting et al., 2014)

Table 1: Criticality, Value and specificity classification and respective strategies and policies. (Huiskonen, 2001)

Categorization of control situations and respective strategies/policies

			Criticality	
			Low	High
Standard parts	Value	Low	• Order processing simplified e.g. by automated orders or • Outsourcing of inventory control to a supplier	• User's decentralized safety stocks and generous replenishment lot-sizes
		High	• Stock pushed back to the supplier	• Optimized user's safety stock (with high and smooth demand) • Time-guaranteed supplies from established service company (for lower and irregular demand) • Several users' co-operative stock pools (for very low demand)
User-specific parts			• User's own safety stock + partnership with local supplier to shorten leadtimes, to increase dependability and get priorities in emergency situations. • In the long run, standardization of parts when possible.	

Table 2: Criticality classification of spare parts in a petrochemical plant. (Molenaers et al., 2012)

Criticality criteria	*Categories*		
	Vital	*Essential*	*Desirable*
Equipment criticality class	Criticality classes A, B	Criticality classes C, D	Criticality classes E, F
Probability of item failure	≥ 1/year	≥ 1/5 year and < 1/year	< 1/5 year
Replenishment time	> 1 month	> 2 days and ≤ 1 month	≤ 2 days
Number of potential suppliers	Only 1 supplier	> 1 and ≤ 3 suppliers	> 3 suppliers
Availability of technical specifications	Not available	General specifications available	Detailed specifications available

Table 3: Criticality classification of spare parts within weapon control systems. (Deshpande et al., 2003)

Part Essentiality Code Mission criticality code	Very High	High	Medium	Low
High	A	B	C	D
Medium	E	F	G	H
Low	I	J	K	L

Appendix 8: Kraljic Matrix

The Kraljic Matrix combines some factors of process criticality and control criticality in a matrix. In origin, this is a purchasing portfolio model (Gelderman & van Weele, 2003). However, this model can also be applied with regard to spare part purchasing and supply.

The two factors on which the spare parts are differentiated are: the financial impact of the spare part and the supply risk of the spare part. Figure 1 shows an example of such a Kraljic matrix.

LOW→**Financial Impact** HIGH	Leverage Items	Strategic Items
	Non-Critical Items	Bottleneck Items
	LOW →**Supply Risk**	HIGH

Figure 1: Kraljic Matrix. (Gelderman & van Weele, 2003)

The financial impact of the spare parts is related to the process criticality of spare parts (3.1.3.). The supply risk of spare parts is related to the control criticality of spare parts (3.1.3.).

Based on the financial impact and the supply risk, spare parts can be divided into four categories.

- Strategic spare parts: spare parts with high financial impact and high supply risk
- Leverage spare parts: spare parts with high financial impact and low supply risk
- Bottleneck spare parts: spare parts with low financial impact and high supply risk
- Non-Critical or Routine spare parts: spare parts with low financial impact and low supply risk.

Appendix 9: Transportation Systems

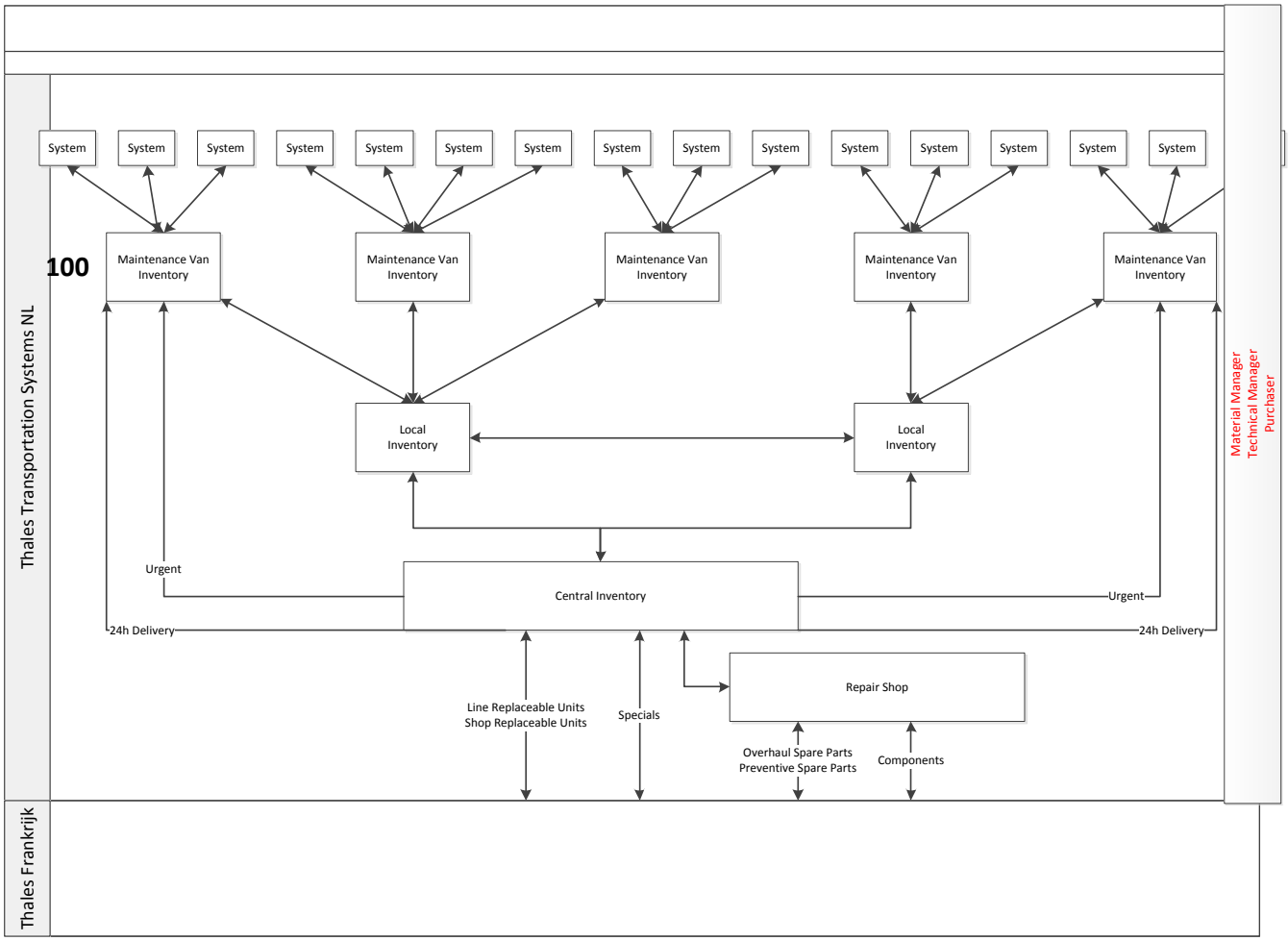


Figure 1: Supply Chain of Spare Parts Transportation Systems

Figure 1 shows the Supply Chain of Spare Parts of Transportation Systems. Compared with the Navy, the process has a couple of differences. However, there are also similarities. Similarities and the differences may lead to input for recommendations for improvement. Transportation Systems has a couple of customers, which are located in the Netherlands. These customers are public transport organizations, for instance NS, ProRail and Connexxion. The main requirement of these customers are the same of the Navy, the availability of their systems. The unavailability of these systems have a huge impact on their business.

Transportation Systems has a lot of systems operable at different customers. The first line of maintenance are the maintainers with a Van. Within this Van, spare parts (Line Replaceable Units) are stocked which are probably needed during the maintainers work shift and spare parts which are not permitted to have travel time. For example, critical spare parts. These Vans are comparable with the inventory on the ships of the Navy. After every work shift, the failed spare parts are replaced with new spare parts at the local inventory. Subsequently, the failed spare parts of the local inventories are replaced with new spare parts of the central inventory. This central inventory is comparable with the Central Warehouse of the Navy. Besides the regular process, there exists an urgency process and a 24h delivery process.

Urgent demand of mechanics, which can not be fulfilled by local inventories, are fulfilled by these urgent processes.

The main difference between the Navy and Transportation Systems, is the quantity of similar systems in use. Transportation Systems has a lot of similar systems in use in the Netherlands. Therefore, most parts within a system are probably needed as spare part within a relatively short time. Hence, it is easier to anticipate on this by putting these spare parts in stock, compared to the Navy. Besides that, it is a civil market and all information can be shared about the usage of systems and fail rates of spare parts. Therefore, it is also easier to estimate which spare parts are needed at which time, compared to the Navy.

Appendix 10: Current information streams

Requests

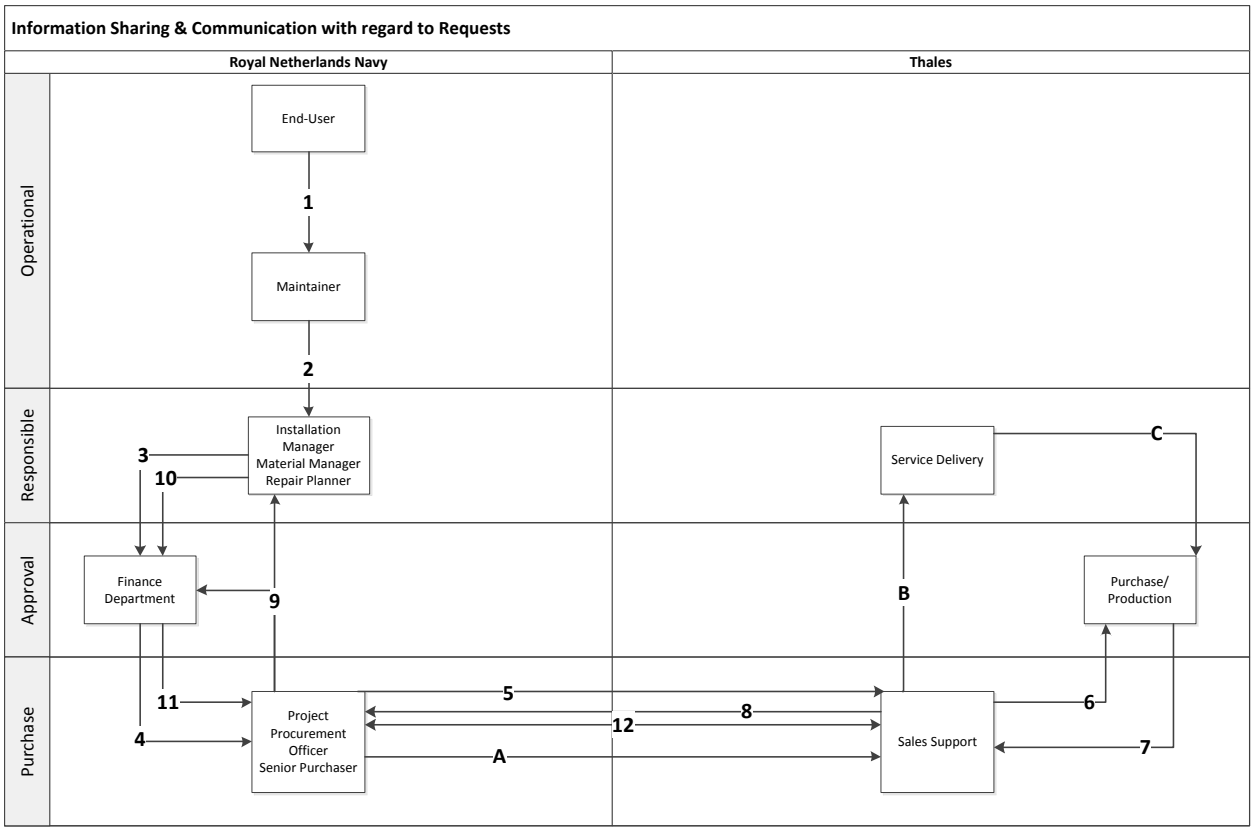


Figure1: Information Sharing and Communication with regard to Requests.

1. *The information stream with regard to requests* starts at the end-user. The end-user communicates to the maintainer that a spare part is needed.
2. The maintainer communicates to the Installation Manager, Material Manager or Repair Planner that a spare part is needed.
3. A request for a new order of spare parts is placed at the Finance Department.
4. When this request is approved, this is send to the Project Procurement Officer or Senior Purchaser.
5. The Project Procurement Officer or Senior Purchaser places the request at Sales Support (Thales).
6. When the price and lead time of the spare parts are not known, Sales Support will ask a price and lead time at the Purchase or Production Department.
7. The Purchase Department will communicate the price and lead time to Sales Support.
8. Sales Support will submit the offer to the Project Procurement Officer or Senior Purchaser.
9. If the offer differs from the request, approved by the Finance Department, this is communicated to the Installation Manager, Material Manager or Repair Planner and the Finance Department.
10. A change in the request to the Finance Department needs to be made and communicated.
11. If the Finance Department approves this change in request they will communicate this to the Project Procurement Officer or Senior Purchaser.

12. The Project Procurement Officer or Senior Purchaser will negotiate about the offer with Sales Support. For instance, negotiations with regard to price, lead time, packaging and control issues.

A. When an agreement is made in the negotiation, the order is placed at Sales Support.
B. Sales Support will book the order to Service Delivery.
C. Service Delivery will start acquiring the spare parts, by communicating this to the Purchase or Production Department.

Order Status

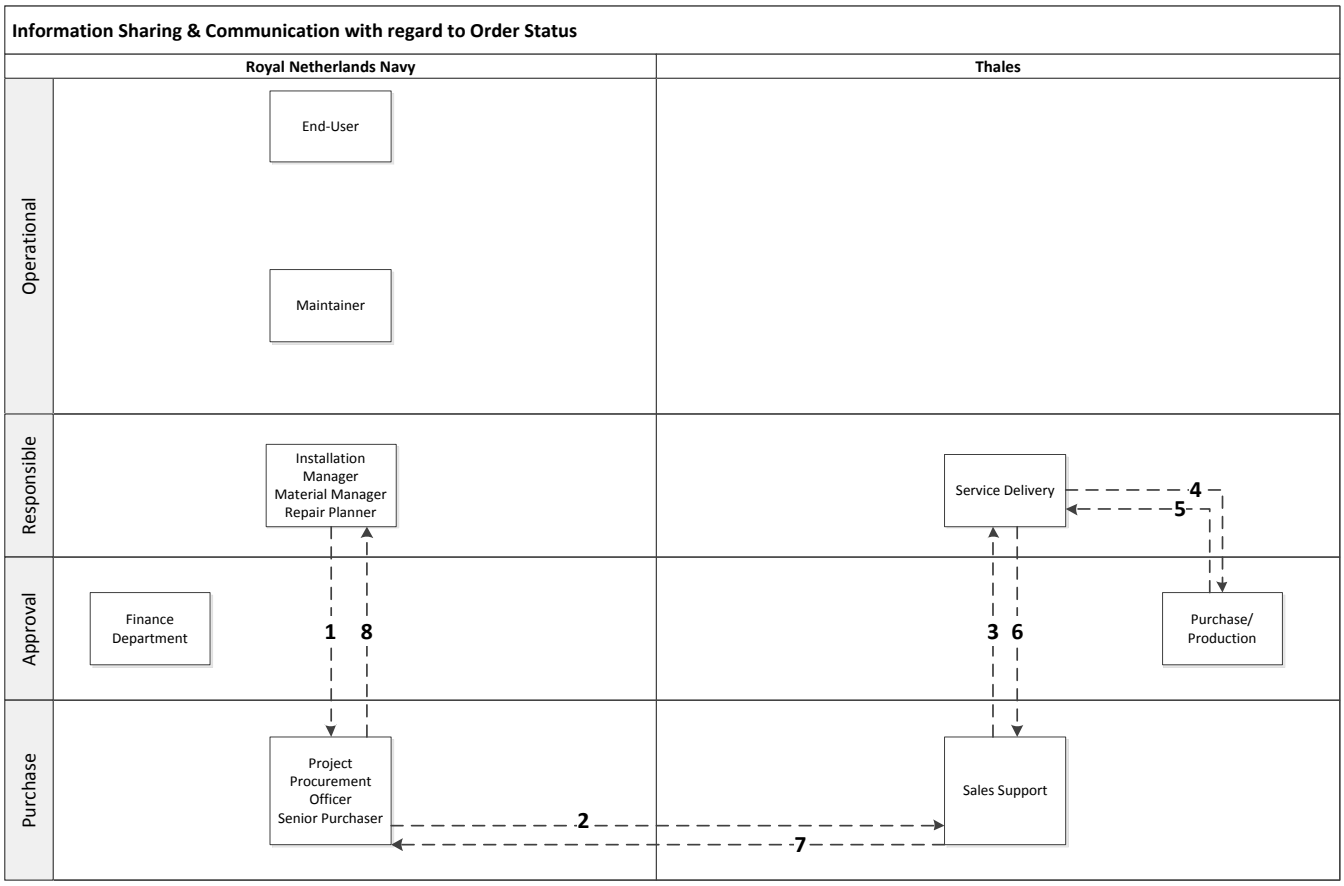


Figure 2: Information Sharing and Communication with regard to Order Status.

Figure 2 shows the flow of information sharing and communication with regard to order status. After the order is placed, the Installation Manager, Material Manager or Repair Planner wants to know when the spare parts are being delivered, or why the spare parts are not delivered yet.

1. Therefore, *the information stream with regard to the order* starts at the Installation Manager, Material Manager or Repair Planner who asks information about the order at the Project Procurement Officer or Senior Purchaser. For example, the delivery date of the spare parts.
2. The Project Procurement Officer or Senior Purchaser will ask this information at Sales Support.
3. If Sales Support does not have the right information, Sales Support will ask this information at Service Delivery.

4. If Service Delivery does not have the right information, Service Delivery will ask this information at the Purchase or Production Department.
5. The Purchase or Production Department will acquire the right information and communicates this to Service Delivery.
6. Service Delivery communicates this to Sales Support.
7. Sales Support communicates this to the Project Procurement Officer or Senior Purchaser.
8. The Project Procurement Officer or Senior Purchaser will communicate this to the Installation Manager, Material Planner or Repair Planner.

According to the Project Procurement Officer of the Navy, this information flow is time consuming and can be improved. According to the Project Procurement Officer of the Navy, not all communication with regard to order status needs to go through the Project Procurement Officer or the Senior Purchaser. Therefore, it is suggested to let the responsible person within the Navy, with regard to the delivery of the order, directly communicate with one responsible person within Thales. This responsible person within Thales should have all information regarding the order.