Aalto University
School of Business

AUGMENTED REALITY IN MARINE ENGINE FIELD SERVICE

Case Wärtsilä

Master's Thesis
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Abstract of master's thesis

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Abstract

In this research are studied possibilities to apply augmented reality tools into marine engine field services. The field service is very much related to available resources. Especially, arranging the schedules of personnel of the field service on board are challenging. In this research is not tried to find any particular technological solution, the approach is in developing business development opportunities with new emerging technology. Use of digital devices increases in conventional human related service industry. Digital platforms based tools enable to efficient working procedures and additionally, working methods of new kind.

The term of augmented reality (AR) is rather old and some applications have already been available rather long. Until resent development of computing capacity and efficient communication possibilities has been enabled to utilizing mobile devices efficiently. Because of the novelty, AR have not been available for industry specific procedures. In this thesis has been collected different technological backgrounds, value configuration models and business specific characteristics together.

In this thesis with quantitative methods has been built a picture of the company current service offering to the customers. The services are analyzed and categorized according to their nature. The research has been conducted by interviews and derived from public available marketing and investor information. Additionally, with the external interviews is tried to build an impression of the customer needs and cross industrial perspective use of AR technology in the business.

In the conclusions are presented how the affects of augmented reality tools are compared with the different value configuration models from the marine field service point of the view. The model estimating how augmented reality tools are able to apply. Additionally has been estimate different business model possibilities and how to arrange business with AR tools. This research shows that AR tools that are based on digital platforms could be able to change business logic and open new business possibilities. Utilizing digital platforms information exchange enables the value shop type of business transform towards to the value network model. In the strategic decision-making has to decide what kind of role the company will adopt in this new situation.

Keywords Marine industry, Augmented Reality, Field Service, Value chain, Value shop, Value network, Digital Platforms

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Digitaalisten apuvälineiden käyttö lisääntyy perinteisessä ihmiskeskeisessä palvelutoiminnassa. Digitaalisiin alustoihin perustuvat työkaluilla on työntekoa tehostavia vaikutuksia, mutta lisäksi mahdollistavat uudenlaisten toimintamallien hyödyntämisen. Tässä tutkielmassa selvitetään mahdollisuuksia soveltaa laajennetun todellisuuden työkaluja merimoottoreiden kenttähuollossa. Laivoilla tapahtuvassa huoltotoiminnassa aikataulujen yhteensovittaminen on haasteellista ja asiantuntija riippuvaista. Aikaisempi kirjallisuus ja tutkimus on keskittynyt pitkälti tekniikan mahdollistamaan toiminnankehittämiseen. Tässä tutkimuksessa ei ole etsitty eroja teknologista ratkaisuista. Lähtökohtana tutkia vaikutuksia yleisemmin ja miten se vaikuttaa liiketoiminnan näkökulmasta Marine ympäristössä.

Lisätty todellisuus on terminä jo varsin vanha ja joitain toteutuksiakin on ollut käytössä pitkään. Vasta viime aikoina riittävän tehokkaan tietotekniikan ja tiedonvälityksen kehittyminen on mahdollistanut mukana kannettavien laitteiden hyödyntämisen. Uutuutensa vuoksi tästä aiheesta ei ole saatavilla selviä toimintamalleja eri toimialaoille. Siispä eri teorioita teknologiasta, arvonluontimalleista ja liiketoiminnan luonteesta on koottu yhteen ja koottu näitä yhdistävät osat.

Tutkimuksessa on selvitetty kvalitatiivisten menetelmien avulla yrityksen tämän hetken palvelutarjonta asiakkaille. Palvelut ovat jakautuneet eri arvonluontimallien mukaan. Toimintaa on arvioitu yrityksen sisäisin haastatteluiden ja yrityksen markkinointimateriaalin sekä julkisesti saatavilla olevan sijoittajamateriaalin avulla. Haastatteluissa on lisäksi haettu näkemyksiä tulevaisuuden kehityksestä ja malleista. Laajennetun todellisuuden työkalujen käytöstä on tehty asiakashaastattelu, jossa selvitettiin heidän tarpeitaan ja kiinnostustaan teknologian hyödyntämiseen heidän liiketoiminnassaan.

Lopputuloksena on esitetty malleja, jossa laajennetun todellisuuden työkalujen käytön vaikutuksia verrataan eri arvonluontimalleihin kenttähuollon näkökulmasta. Mallit selvittävät miten laajennetun todellisuuden työkaluja pystytään hyödyntämään. Lisäksi on arvioitu, miten teknologiaa voidaan hyödyntää parhaiten liiketoiminnan näkökulmasta. Voiko teknologian avulla luoda uutta liiketoimintaa tai miten teknologia vaikuttaa liiketoiminnan järjestämiseen. Tämä tutkimus osoittaa, että digitaalisiin alustoihin perustuvat työkalut muuttavat huoltoliiketoiminnan ansainnan logiikkaa ja avaa mahdollisuuksia uudenlaisiin ansaintamalleihin. Alustoja hyödyntävä tiedonsiirtäminen mahdollistaa arvopajamallisen arvonkehittämisen muutoksen arvoverkkomaisempaan suuntaan.

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I want pay special attention to Ilkka Rytkölä. He discovered an excellent subject and his participation. His assistance was essential in information collection and connecting people to gather information. After eventful departures, we managed to start and found the understanding that this research would delight a new way of thinking to the company business.

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List of Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
B2B	Business to Business
B2B2B	Business to Business to Business
DMPTM	Dynamic maintenance planning
EAM	Enterprise Assets Managements
EH&S	Environment, Health and Safety
ERP	Enterprise Resource Planning
ES	Expertise System
FS	Field Service
FSM	Field Service Management
HMD	Head Mounted Display
IoT	Internet of Things
IT	Information Technology
LNG	Liquefied Natural Gas
MR	Mixed/Merged Reality
OEM	Original Equipment Manufacturer
OS	Operating System
PCMS	Propulsion Condition Monitoring Service
PDA	Portable Digital Devise
PDM	Product Data Management
PMS	Personal Skills Management
QR	Quick Response - Code
SEEMP	Ship energy efficiency management plan
VCA	Virtual Customer Assistance
VR	Virtual Reality

1 Introduction

1.1 Background and Motivation

Digital technology development force companies to find ways to develop and improve their current business and to explore new business opportunities. Digitalization affects in enterprises in all areas of business. The impact to blue-collar work is unavoidable. Traditional manufacturing industry companies have to adjust to this development; otherwise, they do not other means than fighting with the product prices. Besides, manufacturing based business has turned to service-oriented business, which has originally been initiated to support the product selling. This phenomena has been described in various articles (Grönroos, 2014; Heinonen and Strandvik, 2015; Spring and Araujo, 2009; Heinonen & al, 2010; Kindström, 2010; Ojasalo and Ojasalo, 2015; Vargo and Lusch, 2004). Customer dominant locig enable companies to involve their customers to the value creation process (Grönroos, 2008; Prahalad and Ramaswany, 2004). In some companies, this service business has grown greater and more important business than the original product-oriented one. A business that is based on digital technology platforms could mean similar leap in business development than changing from product-centric to service-oriented business.

According to Gartner's 'Hype Cycle' (Walker, 2017) emerging technologies in knowledge management will reach the plateau of productivity in the next five to ten years. Adding digital components to service offering is breaking the traditional thinking of business and revenue earning models (Sainio and Marjakoski, 2009). Digital business is blurring the digital and physical worlds (Burton and Basilier; 2016). Similarly, digitation changes traditional ways to work in concrete service business like field services. Use of Expertise System (ES) improves operational efficiency, thus that a client is able to organize and execute the maintenance independently. A value creation of these Expertise Systems is based on self-service –principal, a customer can prosecute necessary action by his own with the guidance, that is served online or offline, depending on a contract and difficulty of a task. Communication between user and ES can be arranged by example with AR-devices. Augmented and virtual realities are changing the work in traditional industry sectors.

There are a lot of discussion about networks, ecosystems and platforms. These terms appear in the same sentences. Networks and platforms are coming important in integrating people, business and things. Augmented services are based on computers and software, so business models do resemble information service business more than traditional service.

Digital services are also driving towards to networks and platformed business models. In fast phased development, a company is not wise use internal development methods in companies. Instead, partnerships are needed to ensure efficiency in introducing new products and services. This needs building a development network, thus faster entrance to markets gives also clients opportunities to use a state-of-art technology. Business success is increasingly related to capabilities to create an ecosystem and enable business operations by providing services (Blosch and Burton, 2016).

Digital platforms leads to networked business models and raise technology in central role in the business model (Palo and Tähtinen, 2011). The Augmented Reality (AR) blurs the digital information to the physical reality. Deployment of AR not only affects processes and effectiveness, impact could be more wide spread to whole organization and business strategies. The claim is that the new technology that enables augmented reality services does not just enable a new way to deliver service but also opens new possibilities to create value to customer and new business opportunities. In theory AR enables new business models as independent technology or connected with existing service business.

At the beginning of this research, the initial goal of the project was to define new business models in field service based on the augmented reality Very fast it was realized that the first step should be defining those areas were AR could practically be implemented in the existing service process and to find the best practices. Thus, a good starting point was the internal use. Challenges are encountered when physical services are turning to augmented services.

AR is relatively young technology in practice. Practically, real working applications are rare and collected experience is slight. Understanding about AR is low and possibilities are not yet recognized. The existing literature discusses a lot of practical benefits of AR. These benefits and limitations are also covered in this research.

1.2 Reseach objectives/questions

Figure 1 shows relationship of different business areas and use of AR in field service. The figure explains the dependences and how these components create the total impact into business environment. It aims to find the business related benefits and affects at the internal and external customer point of view. Assumption is that the use of AR will affect to internal processes, customer operations and relationship with partners. Additionally, the decision-making affects current business characteristics.

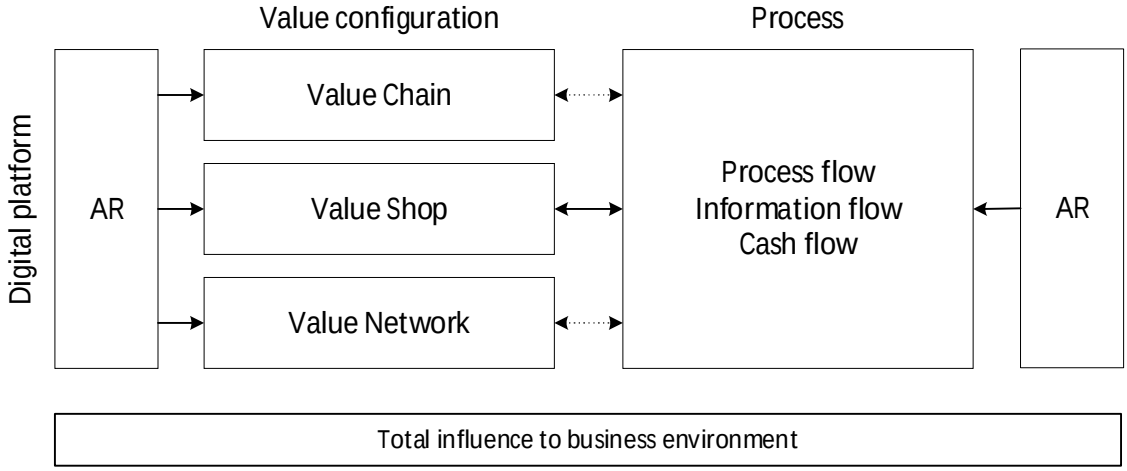

Figure 1 Framework model: AR digital platform influences in business

The research focus on Marine and Services divisions. The research consists of three separate areas to be taken into consideration when estimating the impact of the use of AR.

1. How AR impacts to the company value configuration
2. How AR impacts to field service process
3. What are the limitations that Wärtsilä encounters when implementing AR to the field service

The first question is based on the hypothesis that Wärtsilä's can be divided into different types of value configuration models. The important area is analyzing how AR tools will affect business with different configuration models. That will explain the value capture of an external customer.

The sub questions are:

- How well AR fits into these models and do their need to change, what are advantages and possible limitations.
- What are the possibilities to create new business on AR? How this should organized?
- Is it possible to create revenue out of it.

Digital tools like AR will affect business logic thus these may change value configuration models. This study finds out how AR based tools affect existing business models.

The second question supports the internal client's process efficiency and the value stream. This study uses the field service process of engines in the marine industry. One field of examination is how different stages of field service interact with AR and what the relationships are. This an important question, because improved efficiency increases competitiveness. Internal implementations should be easier to apply than develop a new product or service to customers.

- What effects would be found in short and long term range
- How well current business supports AR in implementations practice.
- How the use of AR will effect to existing business?
- If there is a need for change, how well these needs are recognized and what the readiness for changes in the company?

The third question tries to find the most considerable obstacles while implementing AR technology into traditional business. The sub question is, what is needed to take into account implementing AR based Field service in practice?

1.3 Methodology

AR is new rising technology (ref. Gartner Hype cycle). Although AR is used in several solutions, it is still unfamiliar subject. Existing applications in an enterprise environment are limited available or these require further development in mobility. At the research point of view, there are two main constraints. Firstly, there is almost no experiences available. Secondly, because of the novelty nature of AR would be practically impossible to find measurable evidences to evaluate the results. The subject novelty and unfamiliarity influenced the research method selection. Because of unawareness, the use of computerized virtual technologies, using data-analysis methods like conjoint analysis or perception mapping could not be used because of a lack of proper expectations. Lack of data analyzing limits the use of quantitative research methods. This force selects qualitative research methods to be used in this study.

Particularly in case of new topics case research methods are used (Eisenhardt, 1989). Case research is powerful method, particularly when developing new theories (Voss et al, 2002; Eisenhardt, 1989). The process involves iterations backward and forward (Eisenhardt, 1989). This could happen for example by several investigations and with different data collection methods (Eisenhardt, 1989). Comparison between cases and literature increases the possibilities to create a framework for a new theory (Eisenhardt, 1989). Case study research strategy is selected when the subject is complex organizationally, managerially or due other business issue which is considerably difficult to study with quantitative methods (Eriksson and Kovalainen, 2008).

The starting point in research was to create the initial framework and questions. The framework presents the main topic things that be studied and force to think the structure and variables included into thestudy (Voss et al, 2002). Because of the iterative nature of the case study method, framework and questions refine during the research process. Selected questions are based on the framework and its relation either the configuration model, field service or digital platforms including AR.

In case research sample can be selected based on to different criteria than selecting from population (Eisenhardt, 1989, Yin, 1994). Typical criteria are representative, alternative instances and polar or contrasting characteristics (Voss et al, 2002). In this study are used representative and contrasting characteristics. The company representatives present the typical criteria. The contrasting perspectives are from customer and cross industrial views. Customer perspective is asked from Arctia Oy The cross industrial view is used as a

benchmark (Voss et al, 2002) to compare best solutions and practices. Finnish mechanical engineering company Kone Oy is used as a reference. Inside the company one interviewee was familiar with AR technology, but less experimented with field service. Whereas, people with field service expertise are not familiar with AR. In addition to previous, one view is based on experience on digital platforms.

Typical source of data in Case research is structured interviews (Voss et al, 2002). Interviews are efficient and practical method of collecting information that cannot be found in published form. Preparing questions were selected so that they would support the research as well as possible. (Eriksson and Kovalainen, 2008). With the questions it is possible to find answers with relatively full understanding of the nature and complexity of the complete phenomenon (Voss et al, 2002).

Main idea in case study research is the building the explanation to the theory by the questions that are related to the case (Eriksson and Kovanen, 2008). Selected amount of interviews could present reasonably reliable view of the company situation. The interviews will be formulated to narratives of existing experience of the individuals in a specific business context and analysis and interpretations of the actors, actions, events and processes. (Eriksson and Kovanen, 2008). Especially longitudinal case research is valuable when the cause and effect relation is wanted to be found (Voss et al, 2002). Here the research time did not allow conducting longitudinal observation, so that has been compensated with interviewees long working history. Responders present high or mid management in their companies. Position and experience of the interviewees in the company were relatively high. The answers are presumed to be relatively credible. The use of peer group was not seen necessary for improving the research results quality. In addition, some interviewees have been on the customer position, which brings polarized opinions to answers in buyer role. This was especially positive when the discussion concerned customer acquisition processes.

In this case since the subject is new and there is no anything previous experience, it was difficult to execute. Selected interview methods combine different technics. Empirical primary (Eriksson and Kovalainen, 2008) data is collected both semi-structural and unstructured informal questionnaires. The first interview was organized using semi-structural questionnaires. According to the value configuration model a question package (Appendix E) was formulated for discussion basis and acquiring background information. These questions were reinforced with technology specific subjects. Thus, managed to collect reasonable amount of background information according to selected framework. This information was further used in the following interviews and it was supplemented with

empirical secondary (Erikssson and Kovalainen, 2008) information form the company marketing material.

The rest of the interviews were unstructural informal discussions were the interviewer has prepared specific questions, aiming to deepened the understanding of situation based on the first interview information. How and why questions were used to theory testing and theory development (Yin, 1994). The researcher role was to introduce the discussion with the technical background information and to guide the discussion to the subject. Because of the subject novelty, specific questions about AR knowledge could not asked. The goal was collecting information about the company current situation so that we could compare created theories into practice.

Discussions are divided mainly in three distinguishing parts according to the value configuration models, which present the value configuration part of framework (Figure 1). The discussions strive to describe existing processes in the company and the customer point of view. How these experts see the current situation, how to organize AR in the business and where AR could help them best. With these discussions it is possible to assess different options operational viability using AR in field service.

During the interviews, notes are written on spot and discussions are recorded, when possible. If recording has not been done, the memo is written immediately after meeting, supported to on-spot notes. Tape recordings were transcribed. In the transcriptions single comments are jointed to context thus single responder answers and opinions are merged to entity.

1.4 Thesis structure

This thesis divided into 8 sections. In Table 1 is displayed the structure of the thesis.

The second chapter after this introduction explains some history and current visions and goals of the company. This chapter has also the purpose to explain how a company can change duration of the history.

Following three chapters will introduce related literature and theories according to this case study is based on.

Chapter 6 covers the company current situation and environment. It describes how the company different business are. The end part of the chapter covers field service operations.

Chapter 7 present the Wärtsilä's customer Arctia Oy perspective to use of AR and cross industrial opinion from Kone Oy.

Chapter 8 summarizes findings related to value configuration models and introduced new framework that explains AR technology impact to the field service value stream.

Table 1: Structure if the thesis

Chapter	Subject
I	Introduction
II	Description of the company
III	Literature and theories
IV	
V	
VI	Current situation in the company
VII	Customer perspective and industrial benchmark
VIII	Discussion and conclusions

2 The Company Wärtsilä

In this Section, the purpose is to introduce the company to reader, so that all introduced theories are easier to link into the company activities. Secondly, it is so fine story to explain, how the company can change over the decades and in winds of market changes. Perhaps, these changes are not the last. The source of this chapter is from the company web-pages www.wartsila.com, "Tämä on Wärtsilä"-booklet and the Financial Statement release 2016.

Originally, Wärtsilä was established 1834 as a sawmill. In history, the company has been involved in the industries of a different kind including steel mill, engineering in paper machines, locks, porcelains and shipbuilding. Current business around engines is origin from time when the company owned shipyards. In that time, engine production based on licensed plans at shipyard machine workshops. Between some branches are cut off. In 1980, engines were separated to independent company. From the beginning of 2000 century, the company has been specialized in diesel engine plants and related.

Today Wärtsilä is a global company, operating in more than 70 countries. The company is listed on Nasdaq Helsinki. Stock value at 31.12.2016 was 8418 million euro. In 2016, the company generated 4,8 billion euro revenue with about 18000 employees. It is one of the leading in marine and energy markets as an engine and power plant provider for its customers. The company is on business-to-business markets and deliveries are project based. The company is divided into three strategic business divisions, Energy solutions, Marine and Services. During the history total amount of installed engine power is approximated 180GW.

Energy solutions division has been delivered power plants in 176 countries. In 2016 Energy solutions' sales was 943 million euro, which present 20% of the company revenue. Installed capacity 2016 was 63GW.

Marine Solutions is the original business area of the company. The company has expanded this part of business. Today it also comprehends other offering than engines, including other engineering and total propulsion systems in vessels. On the global markets in 2016 Marine generated 1667 million euro revenue, which presents about 35% of the company sales.

Services is the biggest part of the company. This division generates almost half of the company's revenue, in 2016 2194 million euro. Where Energy and especially Marine division are sensitive to economic cycles, services provide quite stable cash flow over cycles. In Services' network works approximately 11000 professionals globally. The business is mainly supported to the previously sold engine base. Both Energy and Marine are mainly

new delivering systems to customers that consists of also so some services related to these delivered projects.

Wärtsilä is uniquely positioned as the industry's only true provider of a total marine offering. The extensive range of products is supported by world-class ship design, engineering, and project delivery capabilities, all of which facilitate the provision of solutions that optimize the lifecycle value of customer installations. As a solutions provider, Wärtsilä is ready to deliver everything from a single product to the complete lifecycle support of complex systems for powering ships; from concept development to operational use.

The previous story explains how the company has been changed over the years. The company is strongly looking forward to digital business. In the annual report 2016, the company announced that they have been enforced their operational management board with Chief Digital Officer. The company is strongly looking for a new digital era. For underlining the digital transformations, the company introducing in the annual report the digital Wärtsilä Genius – maintenance portfolio and Skylight efficiency monitoring services.

3 Augmented reality

This research wants to study what possibilities Augmented Reality (AR) enables in business environment. The interest is not about technology behind that makes it possible or features of it, rather understanding of some possibilities and challenges. In this Chapter, there is an introduction to this technological theme. The technology enables changes to business processes. This section presents AR definition, benefits, limitations and development goals.

3.1 Definition

"An augmented reality present a virtual world that enriches, rather than replaces, the real world, instead of blocking out the real world" (Feiner et al, 1993).

"Spatial augmented reality: merging real and virtual worlds" (Bimber and Raskar, 2005).

"Augmented reality (AR) is the real-time use of information in the form of text, graphics, audio and other virtual enhancements integrated with real-world objects and presented using a head-mounted-type display or projected graphics overlays. It is this real-world element that differentiates AR from virtual reality. AR aims to enhance users' interaction with the environment, rather than separating them from it." (Blau et al, 2017).

Augmented reality is defined as integrating computed information into the real-world environment. Whereas Virtual Reality (VR) is synthetically created information, but devices might be connecting with the real world for controlling purposes. Roots of these methods are not so far from each other. AR is a special case of VR and in others argue that is vice versa (Bimber and Raskal, 2005). Sometimes it would be difficult to see the difference, for example, a flight simulator is a mixture of real world space and controls on totally synthetic environment. On the other side military industry is using planes that fly remotely from the other side of the world in a virtual cockpit. Recent definitions have combined these two together (Figure 2), and introduced new terms Merged Reality or Mixed Reality (MR). MR combines technical functionalities of AR and VR (Feiner et al, 1993; Blau et al, 2017). Sometimes could be difficult draw lines between these technologies. VR tools are used visualization to support in decision-making.

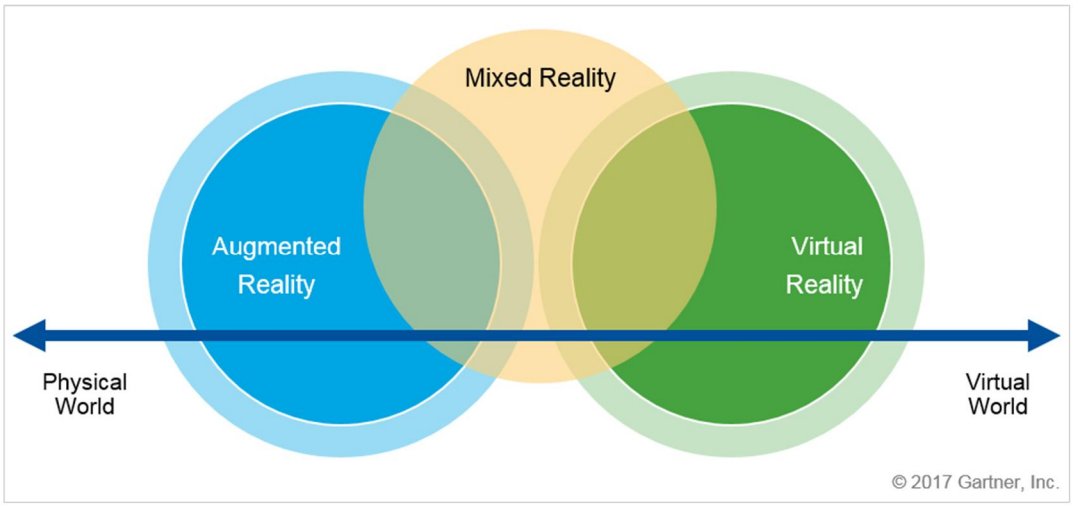

Figure 2 Relations between AR, MR and VR, Gartner 2017

Bimber and Raskar (2005) mentioned that in 1950's was introduced the first equipment that combine existing environment to a virtually created one. However, these gears were clumsy and hence indented to work only in laboratories for demo purposes. In the early 1960s in MIT professors developed a tiny computer that was intended to access computer-generated algorithms while playing roulette (Fernandez, 2014).

In Gartner hyper cycle (Figure 3) state of technology of these technologies is seen reach the plateau of productivity within the next five to ten years. Both AR and VR together with HMD's, need to improve in terms of quality (Blau et al, 2017).

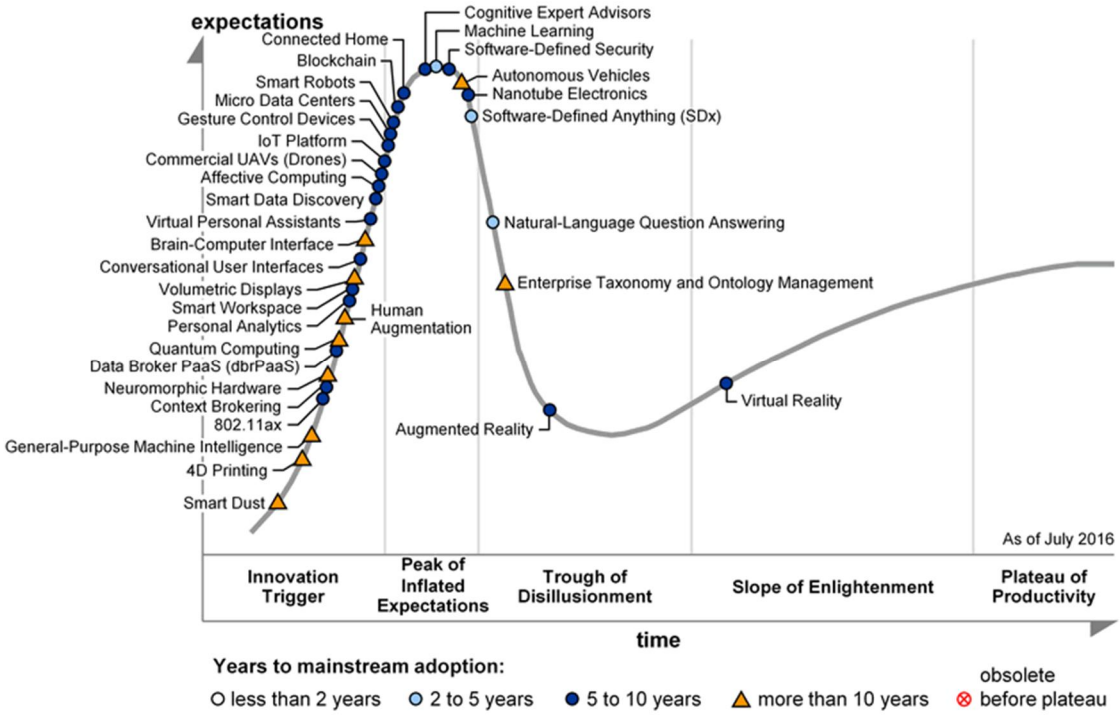

Figure 3 Emerged technologies hype cycle, Gartner 2016

Manusama et al (2016) described a virtual customer assistance that consists of four technology components.

- Natural-language processing engine
- User interface that receives the request and delivers the response via speech or text
- A search and knowledge engine that can traverse the big data repositories of knowledge and content
- A context engine to analyse the intent of the individual and deliver personalised answers and other actions

Virtual assistance is based on the voice and text recognising. The image recognising and overlayered visual information are not expressed separately.

In Augmented reality, live picture or video is fed into a computing. The information is processed and the additional information is rendered to original information. This combination will be displayed back to user's interface. It can integrate real-world objects with text, graphical, audio or other virtual enhancement information (Ngueyen, 2013). The process is described in Figure 4.

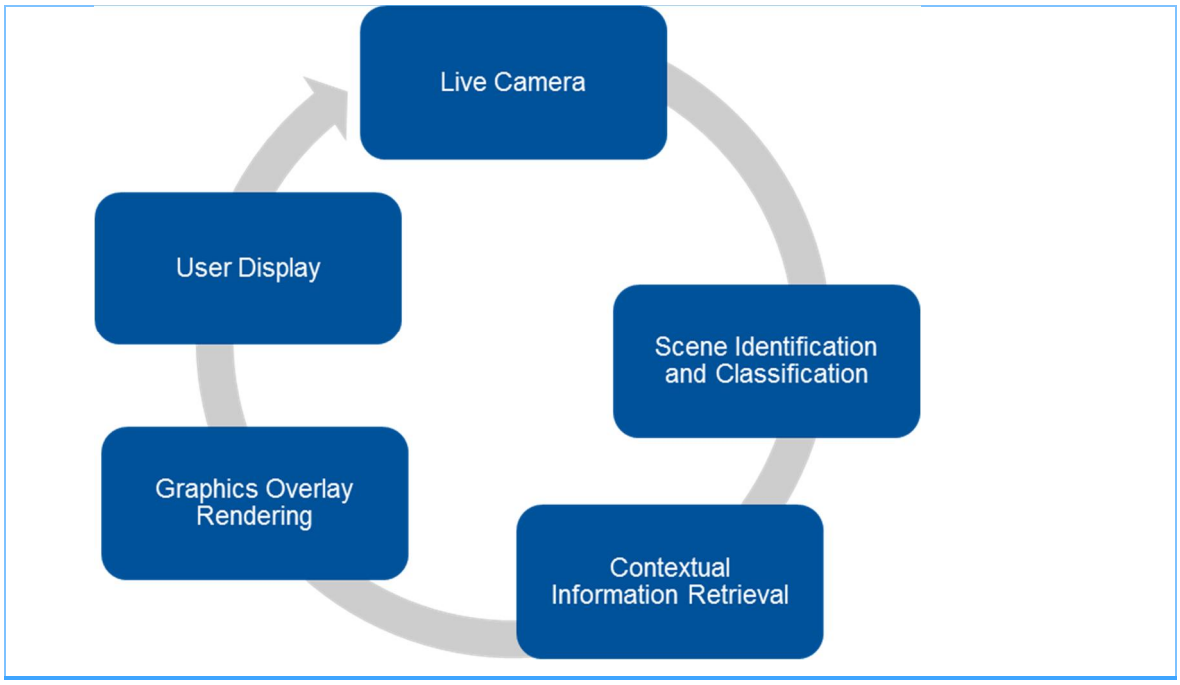

Figure 4 Augmented reality process, Gartner 2014

Nquyen and Blau (2014) divided typical AR implementations into two main categories; business users and consumer users. The consumer implementations are publicly available solutions like marketing, advertising, gaming, education. Many of us remember the recent gaming hit Pokemon Go.

In business, the implementations are closed or internal systems. These solutions include maintenance and training, prototyping and the visualisation of products and parts. These tools are seen as solutions that improve productivity and safety.

Here in this study AR is produced by human carrying equipment in real environment, which is combining that information to digital one and producing synthetic information locally or remotely by computers or by other humans. Figure 5 explains how different technologies differences from immersion and device related.

Bimber and Raskar (2005) name three basic elements for AR

- Tracking and registration
- Display technology
- Real time rendering

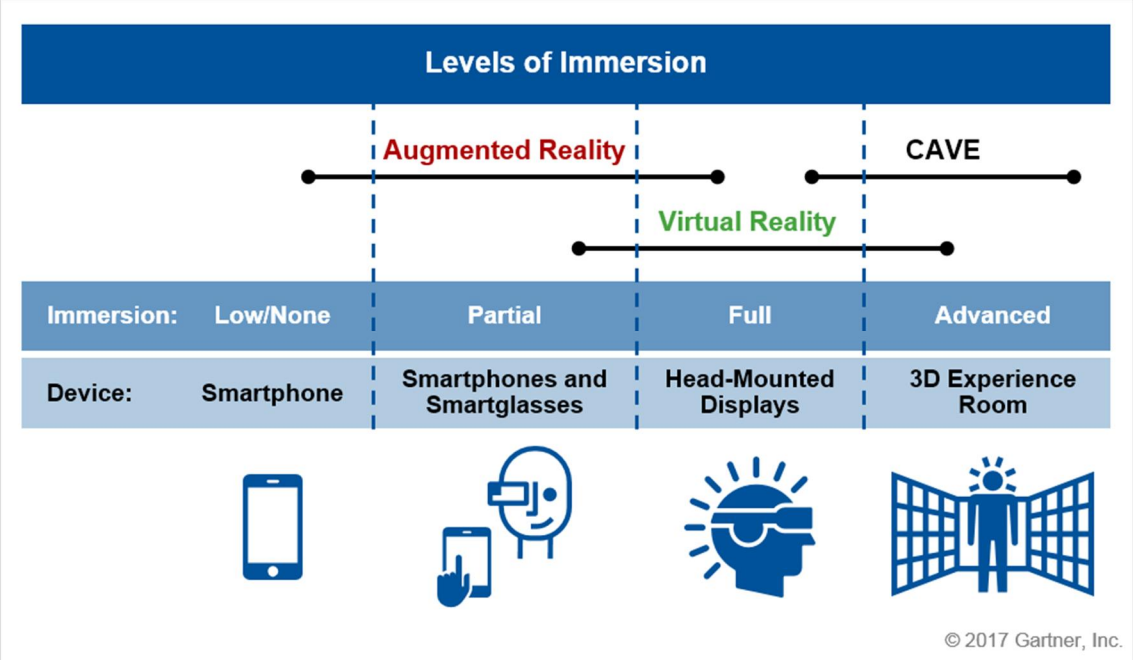

Figure 5 AR and VR covers wide variety of devices, systems and capabilities, Gartner 2017

In ten years, the computing and communication efficiency development and reduced size of displaying gears to more portable and embedded to other divides have improved all these possibilities. Portable digital devises (PDAs) and mobile phones are more promising divices in AR use. Speed of technological development might offer solutions that are not yet recognised in following five to ten years.

3.2 Commercial applications

Today the most common industrial AR solutions are found in TV broadcasting illustrations. That can be found even in live broadcasts. Competitor information is shown in sport

broadcasting. Virtual lines and advertises are added in sport scene at tv-picture. One of the best examples are The American's Cup TV broadcasts (Figure 6), where the sailing venue is complemented with supporting information of venue boarders, boats identification, boat distances, boat speed, round mark zones and advertises. According to the collected dynamic data and defined information, a computer calculates necessary graphics and overlays a camera picture with graphical elements.

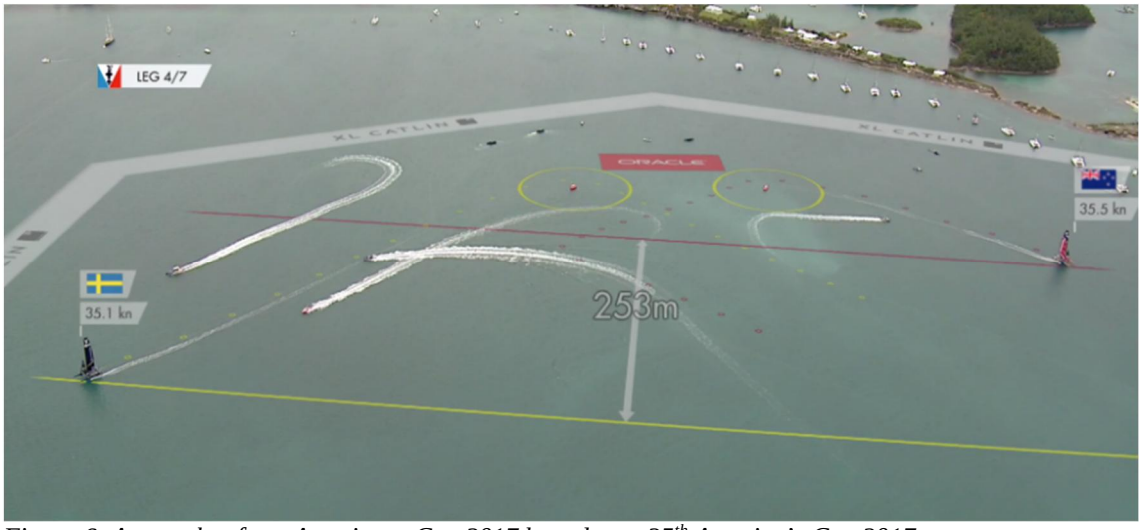

Figure 6: A snapshot from Americans Cup 2017 broadcast; 35th America's Cup 2017

3.3 Possibilities and advantages

In business use, AR provides the highest benefit to efficiency (Nguyen, 2013). It has the potential to improve productivity, enable hands-on experience, simplify current processes, increase available information, provide real-time access to data, offer new ways to visualize problems and solutions, and enhance collaboration. Blau et al (2017) mentioned that AR and VR enable an improved digital experience and will help business to mix real-world and virtual data into meaningfully to users.

Nguyen (2013) recommended to use AR as internal use and find many different uses. Ngueng divide usege into three categories. These are presented in Figure 7. This segmentation gives a clear idea, that the tools are suitable for different purposes. In Field services, the main benefit would be in enhancing business processes. Furthermore, AR provides possibilities to apply work verifications and documentations.

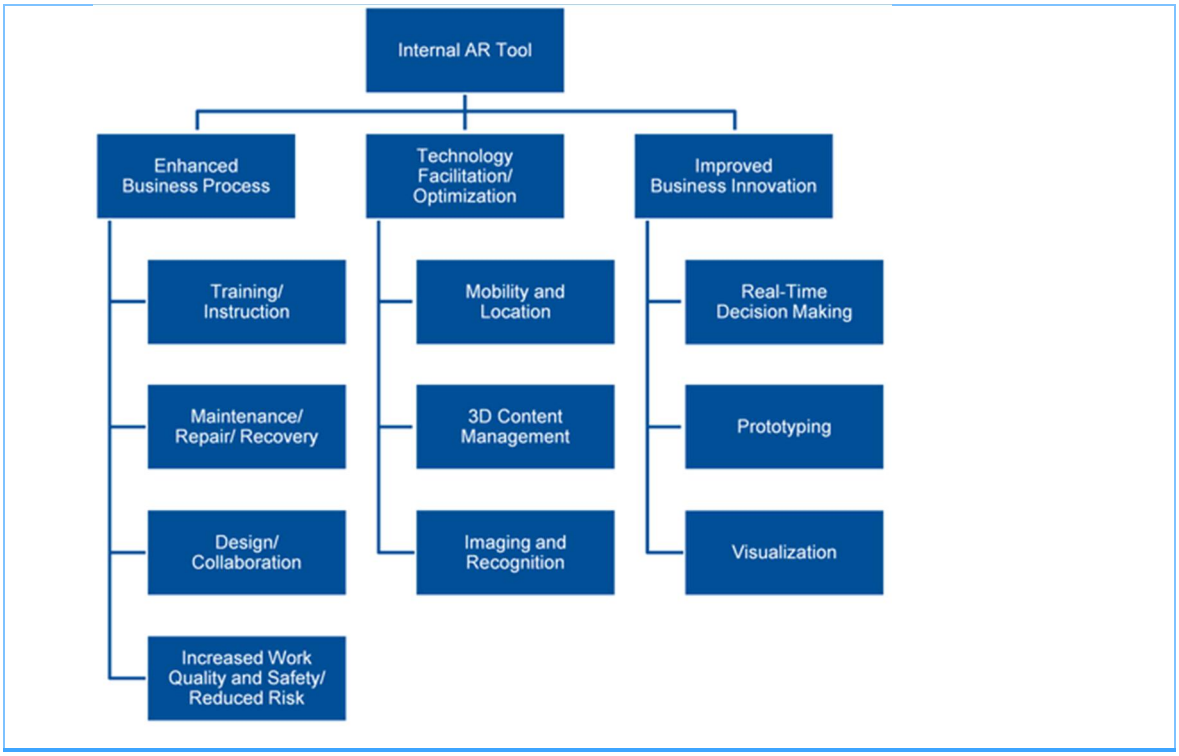

Figure 7 Benefits of using different AR technology, Gartner 2013

According to Manusama et al (2006) enterprises seek to increase customer satisfaction and reduce operating costs. Effective use of virtual customer assistance (VCA) can guide interactions away from phone channels to less expensive, self-service channels. The best benefits of AR are gain in jobs where workers are in the field or have limited access to information as well in works where both hands are needed or operators' attention (Nguyen, 2013).

Camera featured devices increase usefulness by vision-enabled AR apps that provide instructions and live video connection consultation remotely with experts. Wearable head-up displays, tablets or mobile phones could help someone inexperienced to perform as well as with years of experience worker. In expert guidance or with how-to-do instructional diagrams a work can be executed with step-by-step instructions. (McIntyre and Nquyen, 2013) It is possible to use recorded information also for billing used materials and justifying time-based invoicing.

AR devices enable performance recording for later use as verifying or training purposes. With a help of senior engineer, a junior engineer can manage in a job where a long experience is expected. This is particularly beneficial when special expertise needs in several locations simultaneously. Alternatively, it provides a solution if the pre-estimation of a work is difficult. AR is also as a training tool in the employee teaching. All these help a company to reassert the reputation.

Video collaboration with experts in remote locations results in faster repairs and saves the expense of bringing an expert to the site to help. Employees at remote sites can communicate and share video of what they see with experienced workers to get advice on how to diagnose and fix problems. Other savings come from fewer mistakes made during repairs. The AR instructions can help workers double-check that they have done a job correctly, which reduces the number of callbacks to redo repairs. Enterprises can improve the cost-effectiveness of their field service and remote operations by employing more less-experienced workers compared to experienced ones or specialists, thus saving labor costs. (Nguyen et al, 2016)

Robinson et al (2016) listed the most common outcomes for improving Service delivery with Head-Mounted Displays (HMD). These outcomes can generalize with other AR displaying devices.

- Reduced diagnostic time, rework and technician downtime provide **higher efficiency**. A field technician can use checklists, diagrams and manuals without leaving work or equipment.
- New technician training or unplanned on-site support with a senior is costly. Step-by-step guidance, voice, graphical simulations or video remote instructions provide **faster training** for inexperienced, high-growth or geographically dispersed teams.
- Visual records can be used justifying completed work for customers. This **improves customer retention**.
- Recording and storing work performance improve consistency and quality. This enables later required audits for EH&S, regulations or other compliance reporting, thus **improving compliance**.
- HMD free technician’s hands to concentrate on the work carrying thus **improving safety**
- In a work conditions development, a technician feels **higher satisfaction** if he has possibility to illustrate and proof that equipment, tools on-site or on-site support are not adequate.

One vision is use AR in communication between service help desks and customers. There are a couple of benefits. A service help desk will create better understanding about a customer's problem. Secondly, some cases AR increases probability to a help desk solve a customer problem within a call to the service center.

Mobile tools like AR can be used as a data source for Artificial Intelligence (AI). In practicing on-site, AR enables simultaneous advising of several trainees. Some of the cases might resolute by remote guidance, which improve first-time fix rate because original technician can solve a problem without sending another person on site. Collaborative communication can be improved by adding a feedback loop and visual elements into information.

Higher efficiency and faster training can clearly be measured in monetary values. Rest of the outcomes more or less relate to perceived satisfaction.

- Distinguishing operations from competitors
- Engage to use OEM parts
- Commit partners to use common platforms
- Additional information for customer's use
- Enable to integrate systems to customers systems
- Reduce customers' investments on their own systems → increase customer loyalty
- Marketing advantage to other competing providers (classification societies)

Blau et al (2017) listed three categories where improvements will be happening in near future.

- **Hardware systems:** HMDs require improvements in resolutions, sensing and optics. Computer systems needs more efficiency in processing and rendering purposes
- **Software systems:** Particularly software that provide data into graphics or data integration and immersion to business data systems.
- **Business issues:** Companies need to have strategies how they will employ immersive technology or use that in their business. There is lack of strategies how to overcome common challenges.

3.4 Limitations and disadvantages

Privacy and Security

Fernandes (2014) mentioned that it is obvious that current technology is not provided with design with security as a priority. Camera recognition technology rises enterprise security and privacy problems (McIntyre and Nquyen 2013). Cameras are recording constantly pictures from the location. Similarly, it is recording material and information that is under secrecy or privacy. Even encryption is breakable with efficient computing, so delicate material might get to wrong hands. Source-based face recognition and blurring can be used

to prevent the unintentional invasions of privacy. Nevertheless, there are still many questions about industry and governmental secrecies.

Content producing

Digital content producing is one of the biggest challenges (Nguyen et al, 2016). It is timely and costly. Once it is produced it is easy to copy, but still need updating while real world products are changing. In case of a self-service expertise systems, this is a big challenge.

This thesis focuses on project deliveries. Each project is one of a kind. In the projects there are certain similarities between deliveries, because engines are made as mass products although implementations are customised accordance to customer specifications. This is supporting more online expert guidance than artificial intelligence-based guidance.

3.5 Goals

Development does not only mean technological development of computer applications and instruments. Before companies can deploy AR technology in their use, it is important to identify goals clearly and define how to reach these goals (Nguyen, 2013). For example, how the company organises an access to information and arranges appropriate training for the users.

Development projects can be divided near-term and long-term development initiatives (Robinson et al, 2016) with Head-mounted displays (HMD). These initiatives are listed in tables on appendix A. Near-term initiatives fit to pilot projects. Those are easier to deploy, ready to use, apply existing technology, and ensure probably contentment. Long-term initiatives are more complex but create more value addition. Instead of use of HMD these outcomes can apply in another AR arrangements too.

The lists are not complete but give good understanding of capabilities and explains how to start and achieve results. Initiatives are easier to turn into metrics for estimating total benefits. These benefits determine value capture that a customer is willing to pay.

Measures are essential part of the development projects. Without proper measures is not possible estimate achievements in development process. Measures create a base for counting and estimating the value capture. Calculations require the related data of costs of the company.

Robinson et al (2016) have listed quite a comprehensive list of measures (Appendix 3) that are related to the use of AR. Some of these measurements are qualitative, these are

not easy to transform to economic figures. In addition, some of the quantitative measures are difficult to realize, but those still give a good hint of progress.

3.6 Layered structure

Software development is more on the hands of specialised companies and applications are publicly available. End users' task is to utilise the solutions.

Nquyen and Blau (2017) forecast that crowing number of organizations are looking to use AR as a workplace tools. Companies are developing solutions internally using custom hardware and software; they are not willing to publish their development because of potential competitive advantage (Nquyen, 2013). Now when technology is developing rapidly and software is more device independent, internal development is not required that much.

SuperVentures is venture capital company who is investing in solution developing start-ups that augment the human experience using AR, VR, and MR. They are publishing and updating spreadsheet called The AR Landscape (Appendix C). This spreadsheet is collection of companies around AR technology and their role in business. It is easy to notice that the business is layered and fragmented to multiple segments in each layer. Nevertheless, this group of companies is not forming clear platforms, these are rather separate pieces of solutions that tries to solve some specific problems. Solution providers in this business are desperately trying to find co-operators and references among the sponsors, such as Wärtsilä, when they are building new service solutions.

4 Value configuration

The first research question is asking how AR will affect to the company value configuration. A company has several ways to create value that customers are willing to pay for. These are called the value configuration models. The configuration models explain what kind of competence they need and how that would be organized and maintained. The configuration models are value chain, value shop and value network.

In the literature also present dominant logic perspectives that are product, service and customer dominant logics (Grönroos ,2014; Heinonen and Strandvik, 2015; Spring and Araujo, 2009; Heinonen & al, 2010; Kindström, 2010; Ojasalo and Ojasalo, 2015; Vargo and Lusch, 2004). This taxonomy is younger, more marketing related and does not explain reasonably the elements that are needed in value creation.

The following sections will introduce three main value configuration models and study how platformed business model is related to these.

4.1 Value chain

Michael E. Porter introduced the most common and oldest value configuration model, the Value chain model. It is explained in a versatile way his book Competitive Advantage, Creating and Sustaining Superior Performance, 1985. The same year, he published a couple of articles around the subject. In his articles, he explains that technology has an important role in the value chain as a competitive advantage, and together with Victor E. Millar they explain how information can give competitive advantage.

Porter (1998) boiled down the definition of the value chain in one sentence: “The value chain displays total value, and consist of value activities and margin.“ In this model, the activities are divided into two categories: support activities and primary activities. Primary activities are related directly to products. On the other words, these activities are direct cost of product in production. The service concept is wider, but can be simplifying, these are related to product delivery.

This approach is very straightforward and it is valid for pure products where the final price is important to a customer. Because producing a certain product needs to pass the manufacturing process, each action in a process adds value to the product. If the products of different manufacturers are almost similar, customer is willing to choose the most economic one. Therefore, a manufacturer has to find competitive advantages improving his efficiency by optimizing the costs of activities.

Value creation logic

A customer can acquire needed equipment, products, goods or immaterial commodities without producing it. Raw materials and intermediate products are typically transported to the production facility that transforms the inputs into products, which are shipped to customers.

A producer organizes all necessary facilities, workshops, tools and warehouses and the whole supply chain material sources, work force, transportation, subcontractors.

“Customer value is defined either by the cost reductions that the product can provide in the customer's activities or by the performance improvements that the customer can gain by using the product.“ (Porter and Millar, 1985)

“Post-purchase service is performed to ensure proper use of the product by the customer, to remedy defects or to increase the lifespan of the product.“ (Porter and Millar, 1985). Practically, installation on customer, adjusting, commissioning, maintenance, repair and support services such as help desks.

Primary activities

Name of the configuration model describes well the value creation formation. Each activity in the process adds more value to a final product. In value chain model Porter (1985) divides primary activities in five parts: Inbound logistics, Operations, Outbound logistics, Marketing and Sales, and Services.

Internal activities and customer related activities are easy to recognize in the value chain. Inbound and outbound logistics, manufacturing, sourcing are related to internal activities. Marketing and services are more customer centric activities. These five primary elements are general in all industries (Porter, 1998).

In Figure 8 is explained content of Porter’s theory, where the primary activities of value chain are presented as consecutive actions and secondary activities support the entire process.

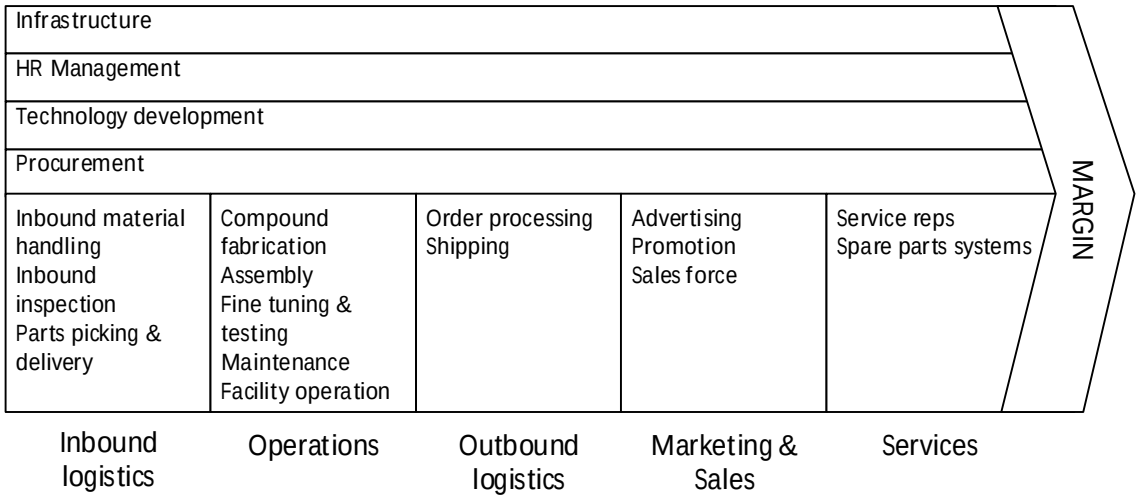

Figure 8 Porter model of value chain activities, Porter (1985)

This study is explores delivering marine engines and services. Marine engines are good example of products, which need to be fabricated and distributed to customers. All the primary activities are included in the process.

Porter (1985):"The value chains of firms in an industry differ, reflecting their histories, strategies, and success at implementation. One important difference is that a firm's value chain may differ in competitive scope from that of its competitors, representing a potential source of competitive advantage. Serving only a particular industry segment may allow a firm to tailor its value chain to that segment and result in lower cost of differentiation in serving that segment compared to competitors."

Summarizing this, according to Porter (1985) a company can find advantage in the market in the following ways:

- Cost advantage
- Differentiation
- Technology and competitive advantage
- Competitor selection

Competitive advantage is relative to existing and potential competitors. Competitors are defined by product and market segment scope. A third dimension is scope in terms of value activities in the business value system of interlinked firms. Functions in product life cycle management are strategic decisions and define the competitive position in the industry. We still have to remember that uniqueness does not lead to differentiation unless it is valuable to the buyers.

Complementary products

The value chain model is not only focusing on a manufacturing of products; it can also cover the value chain of information.

"Most industries are affected in some way by complementary products – that is, products are used joinly with their product by the buyer. Sometimes a number of complements are part of a firm's product line, while in other cases complements are supplied by the other industries" (Porter, 1985)

"An important concept that highlights the role of information technology in competition is the "value chain". This concept divides activities of a company into the technologically and economically distinct activities it performs to d business. We call these 'Value activities'. The value a company creates is measured by the amount that buyers are willing to pay for a product or service." (Porter and Millar, 1985)

Limitations on Porter's Value Chain theory

Stabell and Fjeldstad (1998) paid attention and criticism to Porter's is value chain analysis. They claim is narrowed view to the value configuration. As mentioned the value chain explains very efficiently how consecutive actions increase the value of products. As Stabell and Fjeldstad (1998) impress value chain analysis, it is the method to understand how important strategic activities influence to costs and value of products. It also detects much impact on unit costs. Dividing value chain activities in five categories is generic model for management, and it is not absolutely answering to questions. As Stabell and Fjeldstad (1998) have criticized, this categorization rather obscures than illuminates the essence of value creation.

Porter's model does not explain all value creation models, thus Stabell and Fjeldstad introduced two new models: Value shop and value network models. Distinctive characteristic in these models relate to services. Services in many cases are intangible, where in value chain an outcome the customer is a tangible object.

4.2 Value shop

Stabell and Fjeldstad (1998) claimed that in value shops functions or units are most often represented as support activities in a value chain configuration. Therefore, the value shop configuration can be used to explain the value creation logic of critical support activities.

Field service is typical example of supporting activities. Increasing number of companies are solving problems on behalf their customers using knowledge (Fjeldstad and Andersen, 2003).

Value creation logic

In the value shop configuration essential is solving customer's problems. A distinctive characteristic of the value shop model is a strong information asymmetry between the provider and client. The service provider understands the client's needs.

Although that client's problems are unique, the problem-solving process is often standardized. Problems to be solved, born either naturally or created in information process. Learning and innovate problem-solving are essential for value shop operations. Companies also search ways to improve and stream line their problem-solving process with new technology. (Stabell and Fjeldstad, 1998)

Primary activities

The value creation process is cyclic and have five steps: Process steps and actions are presented in Figure 9. Stabell and Fjeldstad (1998) divided this value creation process primary activities followingly:

- Problem finding and acquisition
- Problem solving
- Choice
- Execution
- Control and evaluation

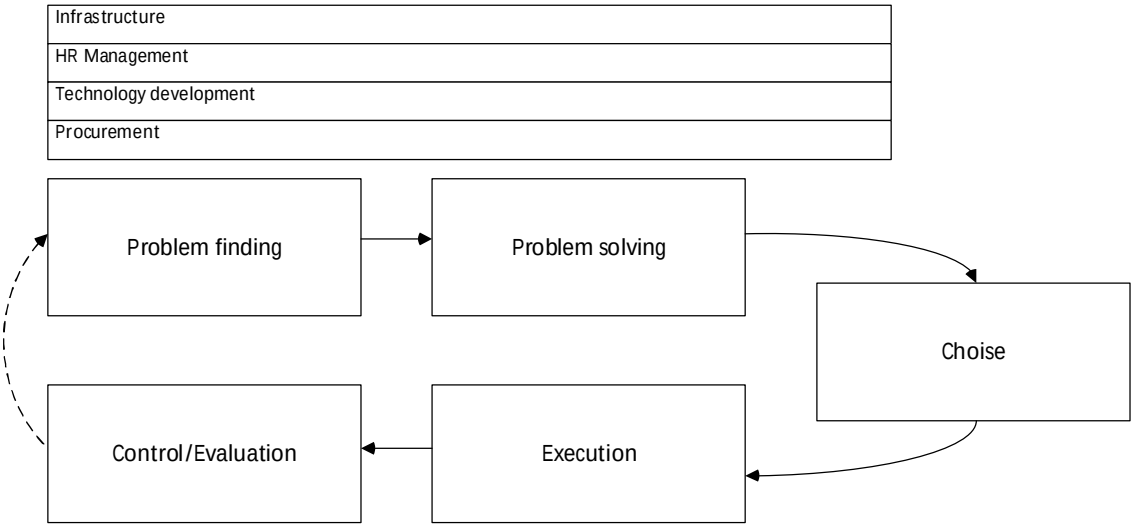

Figure 9 Value shop diagram, Stabell and Fjeldstad (1998)

A process can continue in recurrent cycles. Following cycles use information gathered in previous stages for decision-making. Recurrent cycles contribute to excluding unwilled options in a decision-making process. Conclusions can be made by different experts than in the deduction on the previous cycles.

Business logic

Value drivers as opposed to cost drivers are of critical importance in value shops. Competitive advantage follows from the fact that clients are primarily looking for relatively certain solutions to their problems, and not for services that have low prices as their main attribute.

Demanding projects and clients provide the basis for effective learning. Further, demanding successfully performed projects provide the basis for building relationships and reputation. Success affects and is affected by the shop's ability to recruit, retain, and develop high-quality personnel. High-quality personnel transcends the effect of drivers such as linkages across activities, learning, and spillovers.

In general, large number of very small value shops suggests that there are limited advantages of scale and significant advantages of location in the value shop. This is in part because of the relative value of outstanding professionals, the costs of coordination of large groups of specialists and the need for effective communication in problem-finding and problem-solving.

The professionals - or rather their reputation - is often the critical marketing resource. In value shops, the evaluation of firm-level relative value advantage is more difficult than the evaluation of a cost.

A company can choose a business of expertise services according to the value shop model instead of the value chain model. Engineering consultants prepare necessary drawings and calculations to manufactures. Information produced in a value shop is utilized in value chain. A value shop company determines a field of expertise where to concentrate on their work. Expertise and brand value must develop constantly.

4.3 The Value Network model

The third value configuration model, which Stabell and Fjeldstad (1988) introduced with the value shop is the value network model. Value creation in this model achieved by facilitating a network relationship between the company and their customers using mediating technology. The company itself is not the network. The network would link clients

or customers who wish to be connected. The company provides service. Allee (2000) mentioned that virtually any organisation could be understood as a value network.

Value creation logic

Stabell and Fjeldstad (1998) defined value creation logic in value networks is linking the organization and facilitating exchange between customers. This is that service provider creates environment where clients can exchange information or goods.

The role of a service provider is to maintain a network technically and take care of governance. Technical aspects comprehend network structure maintenance, monitoring and interface standardization. “A value network generates economic value through complex dynamic exchanges between one or more enterprises, its customers, suppliers, strategic partners” (Allee, 2000).

Primary activities

In the value network, there are three overlapping primary activities (Stabell and Fjeldstad, 1998):

- *Network promotion and contract management*, that consist of new members persuasion to join the network, initiation, management and termination of contracts that allows service provider to charge
- Service provisioning includes duties for establishing, maintaining and terminating contacts between the users and billing the network use. Billing may need measurement of use.
- *Network infrastructure operations are maintaining and running the network and respond to clients' requests.*

Figure 10 explains how these primary activities are arranged compared to each other.

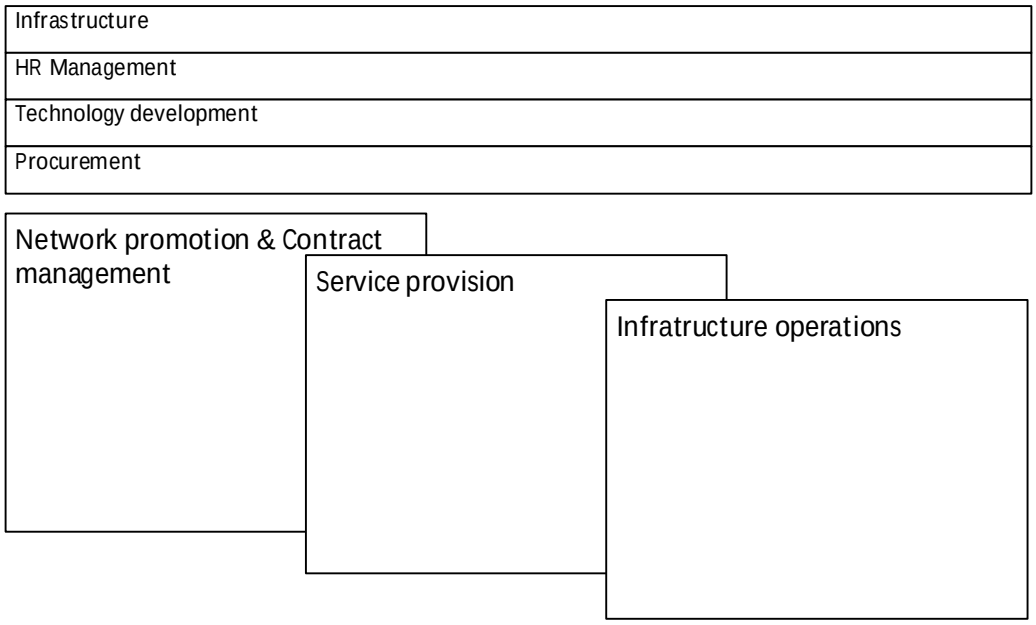

Figure 10 The value network diagram, Stabell and Fjeldstad (1998)

Business logic

Scale and network structure are important drivers, in both value and cost. Value of the network is depending how much clients are willing to pay of the use of the network. Value of network increases with the growth of network clients. Connections between network members increase more than added number of new members, thus the value of net increasing exponentially.

In the network model, the importance to a customer affects the customer's willingness to change a network negatively, more importance less willingness to change. Similar, the costs of change are rising. If, the network value is clear and switching costs are high, that’s more likely to increase loyalty. Contrast to the traditional product or to the service-based approach is clear.

On the cost side, a new member in a network is not significantly affecting network costs. The cost per client is reducing almost linear to the number of clients. This phenomenon increases the profit of a service provider almost directly. Only the network admiration costs grow in similar the number of members. Naturally, in this, there are some benefits from economies of scale.

The typical examples of network models are banks and telephone companies. Networks can operate independently or horizontally connected. Customers can also act multi-homing, they belong several similar kinds of networks, like having several credit cards. A network can also utilize another network structure and build on that, which represents the layered arrangement.

Innovating in networks is increasing user connectivity. There are two types of improvements. First, improving ability to use basic services. Secondly, user-located innovations improve users to use the network abilities to transact. (Fjeldstad, 2008). Improving the use of basic services leads to the layered use of networks. For example, the use of phone networks connected to computers enable the wide spread use of internet.

Network principles

There are two recognisable principles of network properties.

One-side

First, the simpler, that is the one-side model. In this model, there is a network owner and customers. Customers can communicate via network to each other. The role of the participants alternate; seller-buyer or sender-receiver.

Two-sided

Two-sided networks have user in different roles on each side. On the other side, there is demand and other side there is offering. Normally, customers are on a demand side and offering is on service providers. These service providers are not network owners.

In the two-sided network model, there are two possible positions in the revenue point of view. A network owner who is managing the network also holds the risk of the network failing. Other possibility is to be a content provider or developer, when risks are smaller and the revenue model differs from the ownership.

The term "platform" is connected to the network in several contexts. When Stabell and Fjeldstad introduced their value configuration model in 1988, the computerized world and the possibilities of internet were not yet recognized nor the digital technology platform. The term of the digital network platform is often used. There are some similarities to the value network but these are different concepts.

4.4 Platforms

There is lot of discussion about digital platform economy or business. We claim that digital platforms are not necessary according to the network configuration. Therefore, platforms are presented here separately, because these are difficult to position to previously introduced value configuration models. Perhaps due to the digital platforms relatively young phenomenon Stabell and Fjeldstad did not cover these in their framework 1998.

Some definition of digital technology platforms.

en.wikipedia.org/wiki/Computing_platform:

"*Computing platform* means in general sense, where any piece of software is executed. It may be the hardware or the operating system (OS), even a web browser or other application, as long as the code is executed in it.

The term '*computing platform*' can refer to different abstraction levels, including a certain hardware architecture, an operating system (OS), and runtime libraries. In total it can be said to be the stage on which computer programs can run.

A platform can be seen both as a constraint on the application development process, in that different platforms provide different functionality and restrictions; and as an assistance to the development process, in that they provide low-level functionality ready-made. For example, an OS may be a platform that abstracts the underlying differences in hardware and provides a generic command for saving files or accessing the network."

Cearley et al, Gartner, 2017:

" 'platform' means that the area is built on services-based principles and architecture. The goal is to create an interoperable set of services that can be brought together to produce applications, apps and workflows. This generates a symbiotic collection of technology capabilities and components that form a platform. A service-first versus application-first mindset is one of the main attributes of a loosely coupled, interoperable platform — think of building blocks (services) that can be easily rearranged to meet any need. The openness and composite nature of a platform is ideally suited to the external-facing capabilities required by new digital business processes, moments and models."

A platform is the subset of components and rules employed by users in most of their transactions (Eisenmann et al, 2007). Components are hardware, software and service. Rules are technical standards, protocol for information exchange and govern policies and contracts.

Platforms in the use

Using a platform, the value creation will be formed in co-creation. By the platform, it will provide opportunity to create value to user. This is diverging from traditional value creation models, which are a provider centric.

In digital platforms there is a recognizable uniformity to the value network configuration activities.

- Actions are needed for inviting users to join and for the administration of contracts and charging. (Promotion and Contract management)
- Service establishing (applications and servers), maintenance and access control activities. (Service provisioning)
- Activities related to maintaining and running of a platform. (Infrastructure operation)

The platform model is mediated similar as the network configuration. It is possible to build a business totally on a digital platform or on the mix of physical and digital environment. Platforms can be presented in all value configuration models. They could be understood as a layer

Pulkkinen et al (2005) presented an example of the web-shop arrangement. Their interpretation was that e-commerce is not changing the original value chain configuration model. The model would be new using electronic platforms but otherwise value creation is similar to the traditional street level shops. The change is that, the client does a part of the value creation in process. However, when a company opens a market place for selling competitor's products, it gains from the network information (Allee, 2000). Using the buying platform the customer is participating in the supply chain process by executing some duties of primary activities. The customer should be able to gain somehow, normally this is timesaving. Logically based on this thinking, electronic information exchange or AR is not changing automatically the value configuration of the business from one model to another. Similarly to this example, platforms act in the other value configuration models, but the network effects are possible be found.

In the value shop configuration model, a service provider shifts some activities to a customer of the platform. A customer will input problem-solving information in the platform manually or automated. Accordingly, this information will be processed on the provider's side, an expert or artificial intelligence gives proposals. This type of solution fits perfectly in the value shop model, where problem-solving is based on standardized procedures. A

virtual talent industry will deliver automated expertise to customers in future (Fenn et al, 2016).

Adding digital equipment to diesels and enabling remote control possibilities, are not yet changing the value configuration. Digital devices enable information to be collected into the chosen device and the place, by the wire. This is the information value chain.

In many value network models, the original business is not based on platforms. Examples of the value network, banks and labor exchange offices, operate originally with manual procedures. Customers are used to be served personally in service. Providers the perform activities. Today the activities are handled by clients on the provider's platform. Layered structure is obvious. A platform changes business activities and value creation to customer's duty.

A platform has versatile and flexible characteristics. Layered structures enable changes in a simple manner. In e-commerce solutions for example, adding a reciprocal client communication and even goods exchange possibilities, changes the value configuration from original value chain to the value network configuration. This also changes the role of the service provider.

New digital business designs blurring the boundaries between physical and digital world lead to the mixing roles of people, business and things (LeHong et al, 2016). Digital platforms development also blur boundaries between different value configuration models. Platforms are more like efficient providers, which Porter and Millar (1985) described as a source of competitive advantage.

Augmented reality is mediating technology, where user's actions are controls. AR mediates thought a digital technology platform. AR-technology provides a platform to integrate computerized reality into the real world. A platform can operate remotely or locally. Thus, it is not necessary need to use any network when it is functioning in off-line mode.

Although that traditional business models are continuing their existence and in some industries core business will stay in simple commodity or material exchange to their customer. More and more business will have new dimensions and digital features are added by a) in value chain products to increase customer value, b) in value shops to improve service quality and speed, c) even in value networks are transforming to complicated and innovated layered structures.

A platform enables value creation in co-creation with the client. Value capturing is depending on customer's willingness to pay the use of platform-based service. A firm have to select the level of openness to create and maintain platforms (Eisenmann et al, 2008).

Due to layered structure, properly working Digital business technology platforms need other IT related operations for effective implementation and integration in practice.

Moyer and Burton (2016) divided digital business platforms in three categories:

- Internal platforms are digital interactions, mobile apps, digital products and service that internal employers and devices are using.
- *Private platforms* are for customers, partners and devices to be connected digitally and are empowered to create value.
- Public platforms enable interactions between known and unknown customers, partners, competitors and devices.

Private and public platforms are external platforms in internal use.

Current AR technology platforms have solutions in all of these categories. Field service solutions are mainly used in Internal and Private platforms.

LeHong et al (2016) listed five different areas of technology platform.

- *Information system* that supports the back office and operations
- *Customer experience* is the main customer interfaces
- *Data and analytics* consist of information management and analytical capabilities.
- *IoT* connects physical assets for monitoring, optimization, control and monetization. This includes connectivity, analytic and integration to the core and operational technology.
- *Ecosystem platforms* are supporting the creation of and connection to external ecosystems, marketplaces and communities

Use of augmented reality is not directly recognized in these areas. Due to different forms of AR, it can be presented in several areas. In Field services business, the main areas are Information system platforms for the company employees and customer experience platforms in B2B interactions.

Fernandez (2014) believe that wearables become integrated into existing information and the ecosystem of online services, so these devices will create platforms in their range of interactions. These platform libraries are coming at the focal point, with one device is possible to execute several different tasks with different programs and applications.

”Digital business drives increases interconnections linking people, devices and organisations in ’Business ecosystem’ “(Blosch and Burton, 2016). The platform will provide the foundation for the ecosystem, which connect and facilitate customers and providers in their interactions. More complex problems need collaborative solutions, despite the problem is new product development, service or concreted problem solving (Blosch, Burton, 2016).

Trends are driving towards to Business ecosystems; Products come more complex and include many technologies. Development of sensor technology and more efficient communication capabilities bring the physical world more close to computerised one. The rise of "as a service”- and ”platform”-based business models is requiring wide participation. (Blosch, Burton, 2016)

Private platforms enable customers and partners to create new applications, products/services, channels and business models. Moving towards to public platforms increases the possibilities develop business ecosystems with third-party developers, partners, companies, vendors, students and even competitors connected digitally to enable new interactions. This will help to build new applications, services and even business models. Figure 11 explains how platforms could appear in different forms of network setups. The Network effect of an open platform can result in the rapid growth of a digital business platform and thus domination in industry. (Moyer and Burton, 2016)

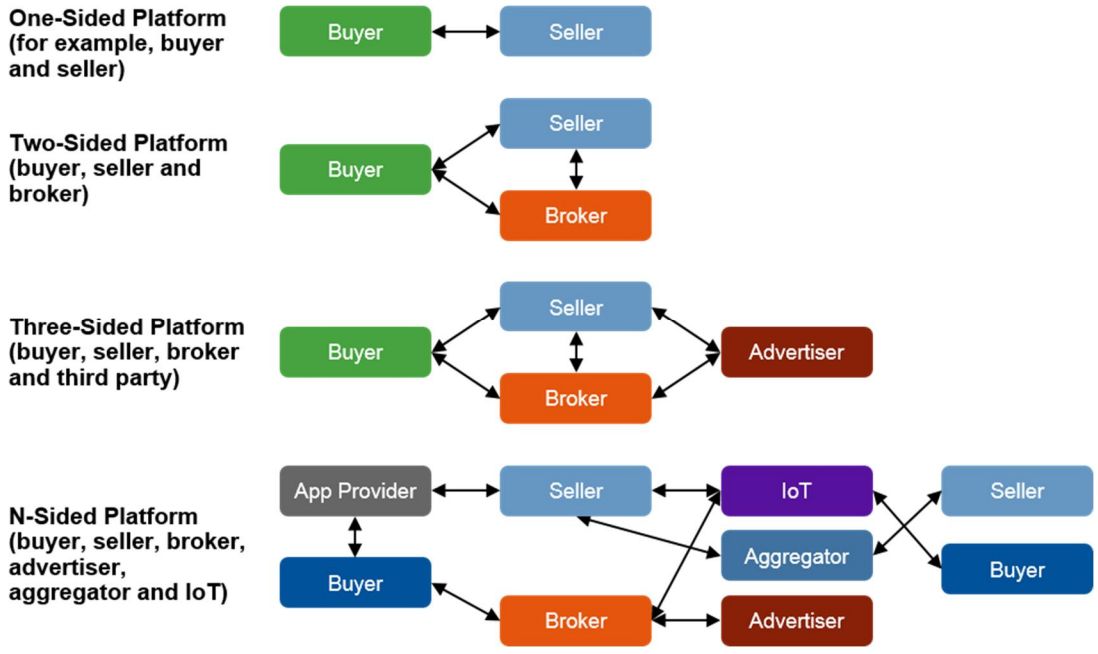

Figure 11 Examples about different platform models. Gartner (October 2016)

As previously mentioned. Digital business blurring the boundaries between physical and digital world by connecting people, things and business (LeHong et al, 2016). Augmented Reality blurring the boundaries between physical and digital world by connecting people, things and information. These two phenomenon have similarities in mixing concrete and abstract together. Does this equivalency similarly cover business models? If so, AR will affect the current way of thinking how to arrange business.

Rochet and Tirole (2003) define two- or Multi-side platform model, which is that one or several platforms enable end-users to interact each other and two or multiple sides charging of use of services. Platform complexity is increasing when more sides are added (Burton & al, 2016).

5 Field Service Management

The third theoretical part of this thesis explains concepts of Field Service (FS) and Field Service Management (FSM). This chapter explains the connection between FSM and other IT applications. This build the background to the second research question: "How AR impacts to field service process."

5.1 Field service

A field service is the responsibility of a service provider to offer service to people or/and their possessions, located at a customer's site. Field services can be divided into three categories. (Agnihothri et al, 2002)

- Pick-up/delivery services, such as package and mail services and garbage collection
- Emergency services such as police, fire fighting and ambulance
- After-sales services, installation, maintenance and repair of equipment

This thesis theme covers mainly the last category. Nevertheless, some repair calls could be an emergency-natured. Service visits on a customer site also cause specialties to arrangements compared with in-house procedures.

Field service is logistic operation. It needs to have schedule, resources and material, right assets in a right time and a place. Field service business is a dynamic environment, the demand changes continuously and it is only partially forecastable. It must exceed customerb expectations, which may vary case by case. A certain service level has to maintained. It is managerial task to balance between service profitability and customer satisfaction (Agnihothri et al, 2002). For this there are different strategies available (Blumberg, 1994).

Trends

Customer-centric orientation (Kindström, 2010) has been increased the number of companies providing field services. The common claim is that, companies have realized that customer' purchasing decision of a product is based on the product value as well as on the availability of service support after the acquisition. Similarly, innovations in technology provide better experience in after-sales services. Companies use Internet and wireless technology to sell their products and services and improve their B2B and B2C services. "Technology enables employees and customers to achieve customization and flexibility, improve service recovery, and provide spontaneous delight." (Agnihothri et al, 2002). We

claim that influence of technology linkages on service quality, perceived value and customer loyalty are still not known well, but we assume that these correlate positively.

Field service and maintenance are important in critical systems and products, even more important than issues of a price, quality and style. Some manufactures have recognized that improving field services, it is possible to increase market share and make sales more profitable. (Blumberg, 1981)

Field service process

The field service is preventing maintenance and acute repairing of the malfunctions. These actions need human resources, which are limited. Optimizing and efficiency needs management. The common conception is that the field service process roughly consist of six timely separate phases.

1. Service request
2. Work planning
3. Travelling
4. Actual work at a customer
5. Invoicing
6. Reporting

The following picture (Figure 12) show the process flow parts and chronological relations. Later, other theories will be compared to this diagram for explaining the convergence between different classifications. The second phase, Work planning, is divided into three different sub tasks.

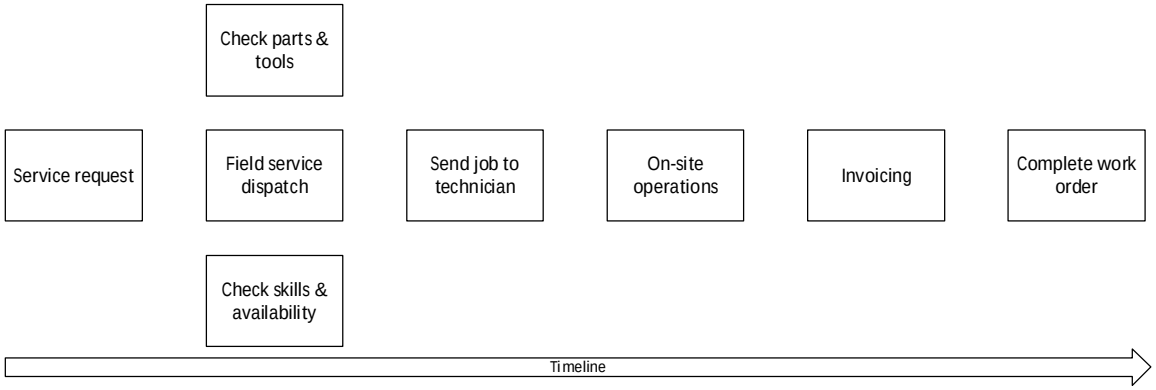

Figure 12 Field service process diagram

Marine environment

Similar to Agnithorthri (2002) has described, Field services in marine business can be divided into four categories.

- New building operations
- Maintenance
- Repair
- Refurbishments

New building and refurbishment operations are scheduled in advance. Difference between maintenance and repair is sometimes unclear. In repairing, something has been broken whereas maintenance is more anticipating operation. Refurbishment belongs to the life cycle management, where original arrangement changes to a new kind.

Maintenance and repairing on board are diverging considerably from other targets. A paper mill will stay in the building location until it is demolished. Ships are operating at all seas on the globe. Ships are operating to move from place to another as airplanes. Difference is that airplanes are available at the airport daily basis. Ships may stay weeks on the waters and in case of oil drilling platforms, shoring is very seldom.

Entering on the board on the waters is also complicate operation. If the waiting time has risk to extend too long, specialized transportation is needed if there is no scheduled shuttle available. Certainty to send proper experience to solve problem on-site rise up when access is difficult. Similarly distances cause inefficiency to the use of field service personnel, a lot of time is used to travelling instead of on-site working.

To avoid unexpected stops in critical scenes, preventive maintenance is used in these. Instead of client's service requests, the initiation of maintenance operations are based on scheduled program or alarm tricking information collected from scene.

Because diesels are not easily changeable, a perception of reliability and maintenance quality is an important factor in acquisition decision-making in a new building phase.

Measures

The common measurable indications in field service management are productivity, quality and customer satisfaction. In addition, some of the measures have financial significance. For example, time to billing measures internal capability, but this is financial related indicator and affect to cash balance.

Quality can be divided into smaller components, like the availability of service parts and the downtime duration. The most important quality performance measure is downtime.

Downtime is divided into response time and on-site time (Agnihothri et al, 2002; Blumberg, 1981). In emergency services, the response time is critical. Although that engine maintenance is mostly in a normal field service category, in some situations a need of service might be so critical that it would be counted to emergency services. Then the response time matters a lot.

It is important to remember that service output is as much dependent on the customer's perception of service performance as on the company activities (Blumberg, 1994). Devoting to response time might be meaningless, if a customer is not prepared to service call. In case of marine business, if a ship has not yet arrived at port of call, although that a technician is waiting on the pier, downtime is not shortened. Blumberg (1994) noticed that in productivity and quality improvements in services have to focus on both internal operational excellence and external communication.

We claim that missing, outdated or inaccurate failure information cause lower field service quality. These lead to extended maintenance times, lack of proper spare parts and decisions to send a "wrong" man on-site. The better and more detailed a customer has described the problem in advance during the service request process, the better is the service quality.

Field service operations have constrains in the use of human resources. This is due to profitably and availability of trained and experienced personnel. It is managerial decision to balance between customer satisfaction and productivity.

Essential metrics in actual field service are:

- response time
- trouble shooting
- problem resolution time
- Other measures related to previous are:
- customer satisfaction
- profitability
- SLAs

5.2 Field service management

The field service is complicated set of actions that are also connected to several other disciplines in enterprises. The field service management is for organizing all the field service phases described earlier. All these tasks and connections to other disciplines should be administrated with managerial tools

"Field service management (**FSM**) refers to the management of a company's resources employed at or en route to the property of clients, rather than on company property. Examples include locating vehicles, managing worker activity, scheduling and dispatching work, ensuring driver safety, and integrating the management of such activities with inventory, billing, accounting and other back-office systems. FSM most commonly refers to companies who need to manage installation, service or repairs of systems or equipment. It can also refer to software and cloud-based platforms that aid in field service management." (en.wikipedia.org/wiki/Field_service_management)

Field service management tools

Practically today the FSM tools are digital applications that connect different databases together. This enables a fluent flow of information between different enterprise systems. The connections have to be established for example to CRM, HR, PDM, PDL and MRP systems. Information about FSM is poorly available, that can be found mainly from application providers. This is mainly sales talk without proven records. The message is similar to information found in Wikipedia, where initiatives and gains of Field Service Management (FSM) tools are said to enable following.

- Increasing revenue
- Profitability
- Cost-efficiency
- Cash effects
- Customer satisfaction and loyalty

We assume that even without proven studies at least partially these claims could be materialized.

According to Robinson (2016) the Field Service Management divides into six categories. In this study, we use this categorization because it shows the relations to other systems.

- Demand planning
- Work planning

- Technical enablement
- Work order debrief
- Operations
- Analytics and Integration

The following picture (Figure 13) describes items that are part of the category in question. These items will not be handled further in detail, they are here examples. The basic principle is that in each of the six categories there are several different applications that are applied to these specific tasks.

The framework (Figure 13) differs from the process phases (Figure 12) of the field service. The reason is found on the connections to the other computer systems of other disciplines. The FMS framework does not cover the actual performance. Extending content of Figure 12, the Figure 14 explains the transitions between the field service process and the FSM categories.

The six FSM categories that Robinson (2016) presented in Figure 13 are explained in detail in the following sections. The explanation does not cover details of single features in each different category. The aim is rather to understand characteristic of each phase.

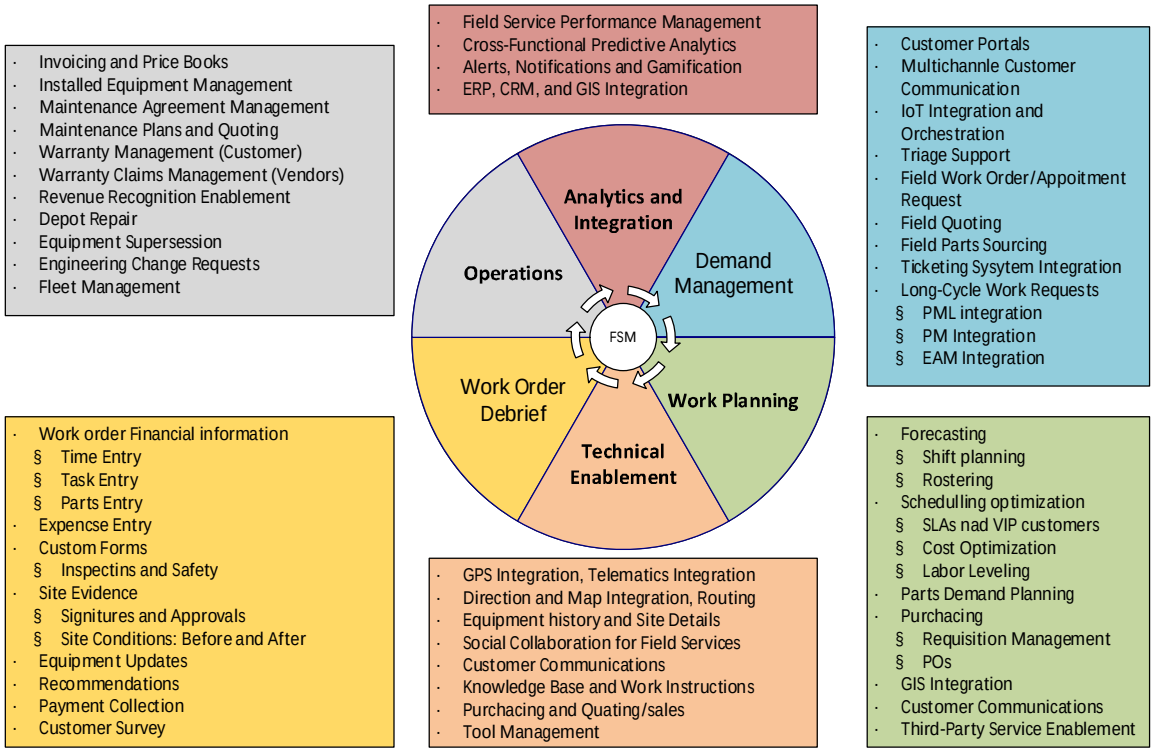

Figure 13 Overview of FSM categories and Functions. Gartner (2016)

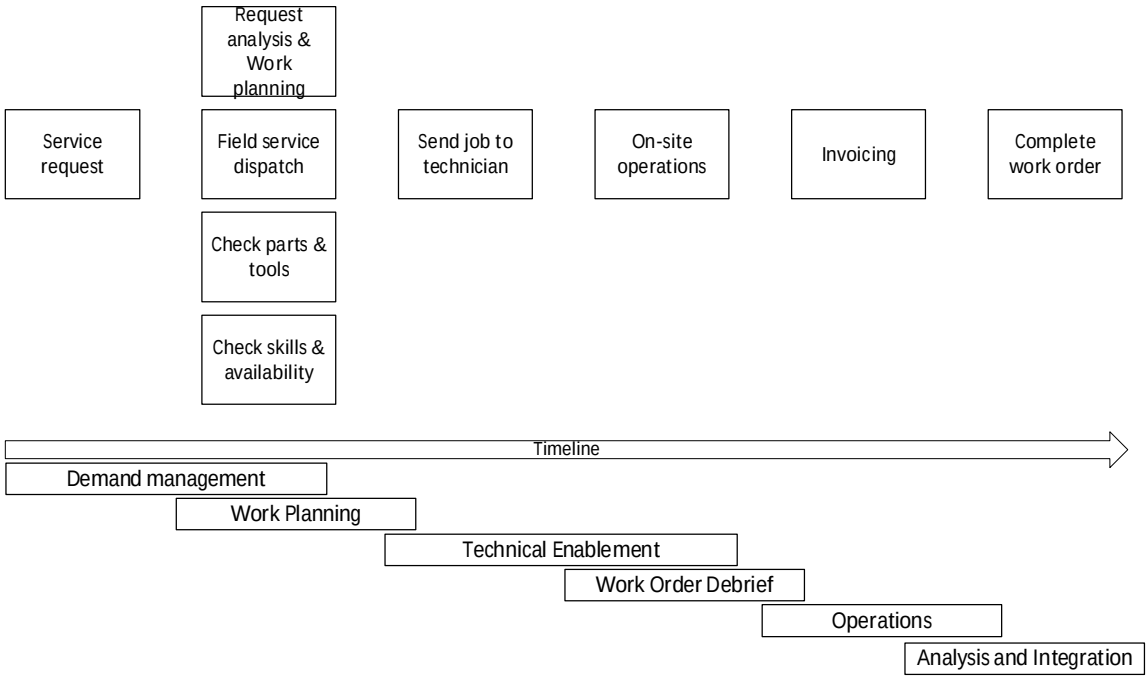

Figure 14 FSM categories related to process and effects to work

Demand management

Demand management is critical. It is gathering information of parts, tools and skills that technicians need for successful operations in one place (Robinson, 2016). Demand management is the first step in process that initiates from ticketing phase or scheduled maintenance.

The objective is to have a picture of the demand of technicians who have particular skills and availability at particular time and place in a geography. It is also needs to ensure that parts needed are available at a correct time. Demand management outcome provides a faster service to customer. It tries to minimize technician visits needed to handle a case. A proper demand management influences positively to service quality by reducing downtimes and improves customer satisfaction.

Robinson (2017) has listed the rules of a successful demand management (Appendix D). Together with these rules, a company has business goals (Appendix D), which guide strategical decision making of the demand management.

Work planning

Work planning is more detailed part of field service planning than demand management. It is optimizing the need of short-term and long-term workforce. This is the tactical part of preliminary actions of the field service planning.

The objective is to ensure a quicker maintenance performing when the actual work is executing. A work planning consist of two main impacts into the process, it improves customer satisfaction and reduces downtimes be shorter completion time.

Technician enablement (Mobile)

Technician enablement is a work order for a technician. It provides a list of appointed tasks to do and thus enables better understanding of a specific task to be completed and provides diagnostics for technicians. It is also prints out list of parts and tools available for the work. With IT tools, it is available with mobile equipment, like mobile phones, tablets and even in AR-form. With mobile equipment, there is a better access to guides and manuals. It can also present what kind of approvals are needed from customer or authorities, which further can be performed in electronic form.

Good technician enablement shortens time used on site. With good instructions and task lists a better quality can be achieved, which further improves customer satisfaction.

Work order debriefing

Work order debriefing reduces manual paper work. It enables reporting of work performance in a real time and feed information to the following phases in the process. It has a connection to a technician enablement phase. Electronic form of approvals are collected and sent to customers separately and/or with billing. It can be used to control list of used materials. All collected information help understanding better about executed operations. Thus, work order debriefing is easier form of collecting information about costs.

Work order debriefing tools enable technicians to concentrate to the actual works and use time on their core expertise. This leads into a better quality of the customer documentation and risks of losing documents reduces. Documentation can be stored and used for future purposes in a form that enables versatile IT tools.

Avoiding manual paper work shortens completion time and make the billing easier. The billing is faster and more reliable. Needed attachments are more reliable and the quality is better, which maintains and builds confidence and thus leads to better customer satisfaction.

In addition, well-functioning documentation enables new services to customers. This can be integrated as a part of the customer’s maintenance systems.

Operations

The Operation phase integrates customer contracts, entitlements, billing and warranty in one package. It keeps the records of equipment, equipment components, coverages, part or tool requirements and planned maintenance. That ensures that the costs, the sums of billing materials and work, are correct which also speeds up billing. It is also important that the records about equipment that have returned to the depot or for the repair are kept available. This simplifies reverse logistics. Operation automates warranty management of old and new parts.

Operations generates a feedback channel from product behavior and longevity by connecting the control information and the maintenance history. Advantages are billing accuracy and speed. Errors or delays in billing ruins customer satisfaction.

Analytics (Field service performance management)

Analytics is a managerial tool for producing analysis and metrics for internal use and for the customer. Managerial information has a special importance when improving procedures and developing skills in the organization. This includes the following possible measurements:

- Technician effectiveness
- Down times
- Work orders completed during first visit
- Mean time of repair
- Mean time between failures
- Predicting failures
- Personal skills to archive tasks

6 Current situation in the company

This section describes the current situation in the company. The information based on interviews and the available information in the company marketing material. The review focus on the Marine business segment. Other segments are mentioned as reference purposes. In the beginning, the purpose is to explain value configuration models in the company and later more on the processes. Following three sections introduce the company's current business and delight their value configuration models.

The discussions with the company representatives are carried out in two phases. The first interview performed with the company R&D manager, who is presented the company digitalization department. He has the best knowledge of AR technology from all interviewed. The discussion was run according to the predefined question packages (Appendix E). This material has been as a background material to connecting practice into theories. Some of the subjects according to theory frameworks appear too wide and needed to focus and limit. Some of the answers were complemented with the product information on company web pages.

6.1 Marine Solutions

Marine Solutions represents the value chain configuration model in Wärtsilä business. This is the original product oriented business of Wärtsilä. It is business-to-business offering. On their own words, Wärtsilä Marine Solutions enhances the business of its marine and oil & gas industry customers by providing innovative products and integrated solutions that are safe, environmentally sustainable, efficient, flexible, and economically sound. Being a technology leader, and through the experience, know-how, and dedication of personnel, Wärtsilä is able to customize solutions that provide optimal benefits to its customers around the world.

Goals

The strategic goal of Wärtsilä Marine Solutions is to be the leading provider of innovative products and integrated solutions to the marine and oil & gas industries. To achieve this, the aim is to build on a deep understanding the customers' needs and:

- Solidify Wärtsilä's leading position solutions of gas fuelled vessels, environmental compliance, and efficiency optimisation

- Further develop Wärtsilä's position as the shipbuilding industry's leading systems integrator
- Provide a competitive offering of products for the growing needs of the marine and oil & gas markets
- Seek further growth through the ability to offer customers the most efficient lifecycle solutions.

Together with the Services business, Wärtsilä Marine Solutions offers ship owners and operators integrated lifecycle solutions with guaranteed performance and availability.

Important mid-term growth opportunities are envisioned solutions for gas-fuelled vessels, environmental compliance, and efficiency optimisation. Wärtsilä is well positioned in these areas, having the most extensive experience and an unrivalled track record in delivering gas engines, a unique portfolio of products for emissions control and abatement, and a holistic approach to ship-level efficiency optimisation through the company's engineering and ship design capabilities.

The strength is in the value chain management. The company is seeking ways to specializing, creating a distinguishing offering compared with competitors. With production and supply chain management, the company constantly seek new ways to maintain high quality and cost efficiency – often in co-operation with other leading industrial partners in key markets.

Figure 15 explains how different actions are contributing in the Wärtsilä Marine Solutions operations. In this study, the main interest is in the customer related parts, Marketing & Sales and delivery related services of the model. These are the parts that are mostly related to the benefits of AR technology.

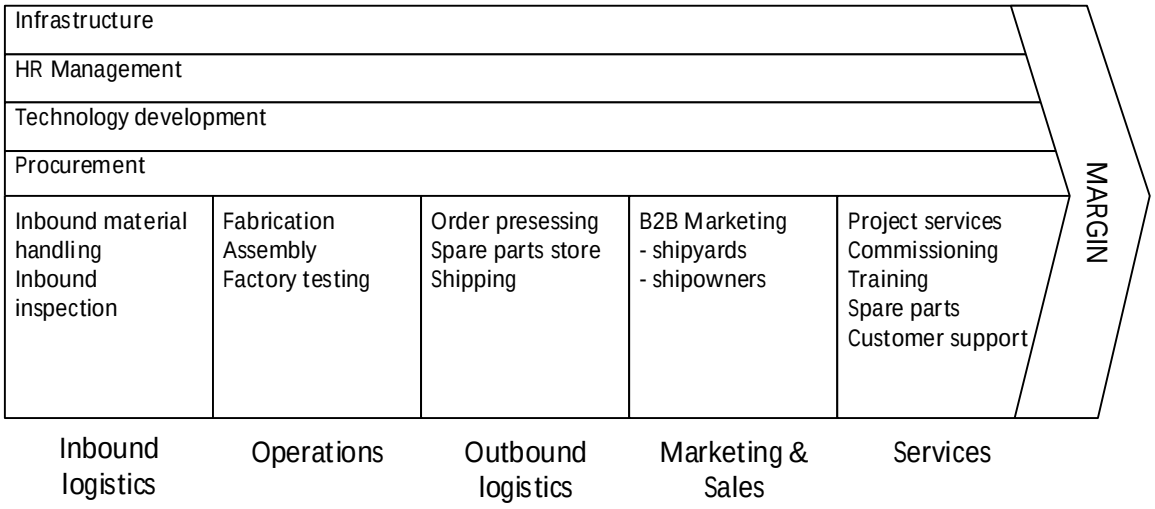

Figure 15 The value chain diagram, Wärtsilä Marine solutions. Based on Porter (1985)

Sales & Marketing

There are differences between customer skills and knowledge. All customers are not necessary that well technically capable to calculate and choose appropriate engine installation set than the others. In those cases manufacturer's technical guidance might be a critical decision factor. Increasingly expertise services are added into the bundle.
Marketing methods are wide. Today more and more marketing happens in a digital form. In ship delivery, contractual participants are mainly a shipyard and a ship owner. Contract parties agree a common specification that is the base and a guideline for a new ship construction. This means that in decision making chain a final user is not probably the acquisition decision maker. Even the crucial component suppliers subordinate for the shipyard. Practically this means that the builder, the shipyard, asks offers from different suppliers as engine manufactures. The spectrum of shipyards is wide. A technical skillfulness and awareness vary depending on a history and geographical location. However, ship owners might have their own favorites. In the decision making chain, often consulting engineering offices are also participants with significant roles.

In a technology company, the value creation is based on selling knowledge and solving customers' problems. The marketing message and service promise is different when selling a product to a ship owner compared with shipyards. When selling to a ship owner then the value propositions are operational. Marketing message is underlining maintenance and efficiency.

A marketing message differs between customers. It can be segment or business related. For example, a navy, mercantile, offshore and cruise industry are different businesses by nature. However, installations could be quite similar in every case. Deliveries are customized to fit according to customer's needs although the delivered products are similar products. Also the significance of the final product, a ship, varies. Diesel engines share of the vessel building cost is between 5 to 20%, depending on the vessel type. In a simple cargo ship, which is the most common vessel type, the share is bigger. In the other hand, in cruise ships where engines are used significantly more than just moving the vessel and installed power reserve is high, the share can be less than 5% of vessel price.

For shipyards, in a primary phase, marketing supports for choosing right setup. This is consulting about which type of a solution should be chosen to achieve the required performance characteristics. Commissioning and guarantee services represent part of the service package. Selling additional services is difficult. A shipyard strives to minimize their

costs and maximize profit. First removing costs are supporting services at an implementation phase. These are the easiest bargain subjects. Additional service might have value in the purchasing, especially when they do not increase the costs. Separate, revenue increasing subjects are difficult to bake into contracts. Rather the procurement process will remove extra costs, the subjects that have the price tags, as soon as possible. Decisions are not always sensible to the final use economy, usability and fluency. However, the certain needed engine power it is possible to produce with one, two or multiple amount of engines, but this decision will dramatically affect the number of maintained cylinders.

Similarly the ship owners have had suboptimization thoughts. Economies calculate the return of investment for used money in a new building instead of the total cost of ownership. This leads to thinking that investment under the main deck is not profitable, the above located hotel and restaurants are those that bring the money. The trend is changing; now an arrangement that is 5% more economic in use might represent a significance difference in buying decision or specification.

In marine business, a long-term trend has been that new installation projects are not actually very profitable. The profit accumulates from the life cycle services. Manufacturing costs are in the important role in competitiveness and profit wise. Economies of scale is difficult because manufacturing is order based. Wärtsilä's engine solution offering is limited in comparison with the competitors that have wider scope. Services are Wärtsilä's strength.

Interface management is challenging. This is operation and information exchange between different participants. In the early stages of selling process project managers are involved in interface management. Operations crossing different organizations should handover easier. Shipyards have the trend to minimize different interfaces and acquire wider entities. In the lower salary countries are enabled to use more work force. This has led to specifying to organizational disciplines. Purchasing demerging goes into small details. System ensembles are rare. This is not good as a marketing point of view. For purchasers building bigger ensembles is awkward, because their mandate is tied to specific part of the delivery. Also the shipyard management does not believe in the alternative operations models. This is in spite of that calculations are able to show advantages. Decisions at shipbuilding phase reflect significantly at the lifetime maintenance.

In the power plants, marketing and new installations are simpler. Wärtsilä offers and sells to customer electricity, practically said Megawatt hours. A customer buys the power plant and has a guaranteed usability, for example 93%. In some cases, operational responsibility completely stays at Wärtsilä.

The ship engine business is divided between a few manufacturers. The main competitors are Mann, MaK (Catepillar) and Pielstick. The product solutions also vary between manufacturers, thus the real competition is not present in all categories. Wärtsilä's specialty is four-stroke engines, where as some others are specialized in two-stroke engines. The most crucial difference is in the service organization. Other manufactures used to emphasize a partner network in maintenance. Wärtsilä can also offer maintenance knowledge in two-stroke engines. In practice, Wärtsilä maintains all other brands on the market.

Customer deliveries

On new building ships, Wärtsilä's deliveries does not include installation. A shipyard will install machines and related parts. A shipyard buys these according to Wärtsilä's recommendations. In spite of this process, the functionality of the machinery is on the supplier and will "collect" all the compliments. The field service will carry on new installation commissioning, which is preparation to start a new diesel for the first time on board. The engines are always tested on a test bed at the factory. At commissioning first operations are to secure that necessary electricity, compressed air etc. is available. At the sea trial, the ship engines will be tested that their fulfill specified performance characteristics according to the delivery contract.

During the building process at a shipyard, Wärtsilä has few possibilities to contribute to the surrounding structures of engines such as pipes, cable trays, service platforms and hoisting points. These installations will influence how well the service operations can be carried during the life span of the ship. A Wärtsilä representative follows installations at a shipyard and can comment on recognized flaws. Because of the contractual situation, it is necessarily not clear that these recommendations are taken into account and the arrangement could be unfavorable to future operations. A shipyard could acquire the whole installation and surrounding as a package, but this is rare. Shipyards wanted to improve their value chain and make it more efficient at economically, thus they attempt to remove costs in the chain. In procurement, this often leads to suboptimization. In operations, this is not always worthwhile even from the point of view of a shipyard total cost of ownership. Instead, a ship owner has certain possibilities to contribute and steer the design.

A ship owner nominates an inspection team to superintend the building process. Skills of these teams have variation. Sometimes inspection teams are experienced to new buildings, but not necessary experienced on running a ship. An experienced chief engineer has an eye

to recognize easily nonfunctional details and crucial solutions. Sometimes recruited team is inexperienced and is not capable of guiding the building process. Typically large cruise ship owners have experienced teams that consist of mixture of operational personnel and system specialists. Inspection team flaws present often with small owners and owners that seldom order new buildings. Owner representatives should be able to secure that a ship would be built easily operational. In the shipbuilding process, technical solutions approvals are made by nominated classification society and owner representatives. The owner side approves invoices.

The selling participate also to the new building process in the delivery phase. They will get direct feedback from the solutions they have sold.

6.2 Services

Field service operations are significantly different from the installation projects. By simplifying, a new building installations duration takes several months. Whereas, field service operations on board take only days. At the beginning of the 70's, there were six people on the field service payroll. Personnel on board managed almost all the maintenance. From those times, personnel on board have been reduced and maintenance is drifting to the service companies. Only the owners' mind set has been limited this phenomenon. Often they want to control the possibility to use other than OEM parts in spare parts.

Services are expanded larger and more important part of revenue with the increase in the installation base. The activities are spread around the globe in the service centers. Wärtsilä's products are installed in every third ship and every second ship has service related relation with Wärtsilä. Thus, Wärtsilä maintains also other manufacturers' products.

Globally the Service is divided into four geographical areas. The North Europe area has a special significance due to Finnish headquarters and development centers. With new engine types, maintenance services are guided primarily to the company own technicians. This is for the educational and training purposes of the increasing knowledge of the products. The North Europe service team is also internal resource pool for the other Wärtsilä's areas. The internal global units are major clients for the North Europe unit.

Operations are focused mainly to existing installations. Services cover marine and power plant installations. Some part of the service is commissioning of new installations. Sales do not have own resources for installation services. Service business is roughly speaking divided into four sectors. The biggest part of service business is spare part

deliveries, other parts are maintenance operations, life cycle upgrades and energy optimization.

Wärtsilä Services supports its customers throughout the lifecycle of their installations by optimizing efficiency and performance. The company's service network of approximately 11,000 professionals in 160 global locations is unmatched in the industry, delivering services to more than 12,000 customers every year. Customer segments are marine, energy and in oil and gas industry. In this thesis, the focus is in the marine segment. The portfolio of services – from spare parts to complete operational, maintenance, and optimization services – is constantly being developed, not only to improve the availability of customers' installations, but also to support them in growing their businesses.

Figure 16 describes the active phases in progress of the customer problem solving circle of Services.

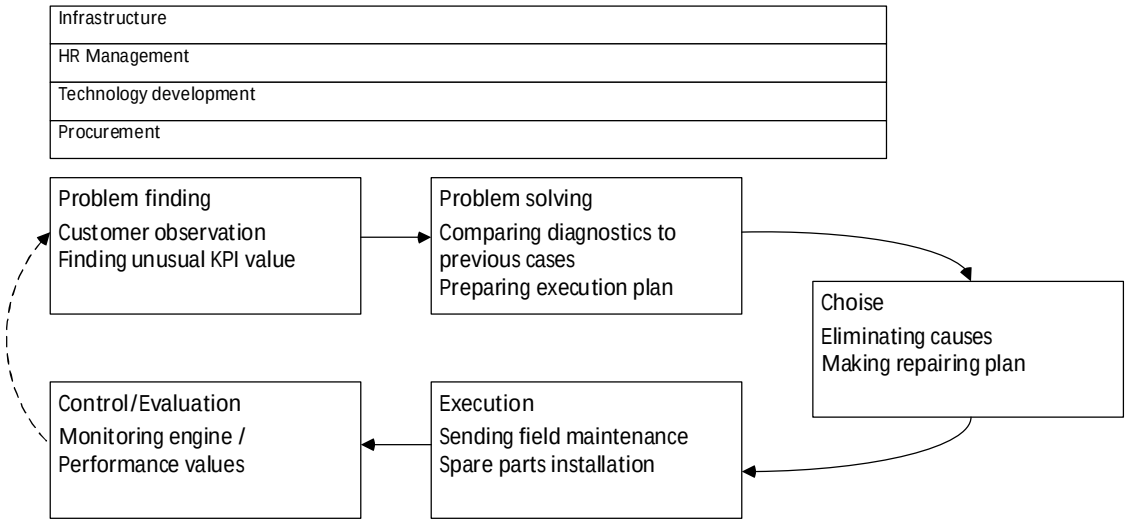

Figure 16 Value configuration primary tasks in marine engine field service. Based on Stabell and Fjeldstad (1988)

Goals

In business, the company is looking for a close customer relationship and thus deep understanding of customers' needs. Thus, the service offering is possible to be seamlessly adjusted to customers' requirements.

Wärtsilä Services strives to be recognised as a reliable service partner; namely competitive, trusted, and easy to deal with. Wärtsilä is committed to growing its service business by:

- Developing closer partnerships with existing customers through superior customer service
- Developing and digitalising the offering to create new competitive advantages

- Exploring opportunities within new customer segments by leveraging on current competences
- Acquiring businesses in growing markets.

Services continuously develop its global footprint and operations in order to meet and exceed customer expectations. Further growth is sought by strengthening service offering in response to customers' increased interest in lifecycle solutions, thereby providing them with both lower costs and improved operational efficiency. Their slogan is, “Wärtsilä is committed to providing high quality, expert support, and the availability of services in the most environmentally sound way possible, whenever, wherever”.

An important growth area is the digitalisation of the existing offering and the development of a new digital offering to further increase revenue potential, transparency, availability, and performance.

These goals have all distinctive features of the value shop configuration:

- Developing brand value by delivering superior service and exceeding expectations
- Increasing knowledge and information asymmetry with existing customers
- Maintain and acquisition suitable expertise according to marketing strategy

Service selling

In the global position, customers are available anywhere. In the near future, the ships are not going to disappear. Important is to stay sufficiently reliable and efficient. Losing small customers is not necessarily devastating. Roughly, 80% of the work generates 20% of revenue. In maintenance, different strategies can be found. Big clients like Maersk and Spliethoff have giant fleets and a lot of technical expertise in-house. They adapt logistical and compliance trends by acquiring constantly new ships and keep their vessels in a shipshape to ensure high performance levels. On the other hand, there are many small ship owners, using second hand ships, neglecting proper maintenance and waiting for wreaking. Ship owners seldom do any big changes until the legal requirements obligate.

Overall, service customers can be divided into several segments Offshore clients were solvent customers, until oil prices drop.

- Authorities (navy, coast guard etc.)
- Merchandise ships (several different sub segments)
- Offshore
- Power plants (this segment is out of the this thesis)

Producing problem solving solutions is the key issue and goal to reduce total costs and improve the operational efficiency of the customer. The products are advance maintenance, monitoring, optimization and service contracts with or without spare parts. The extreme example would be the fully outsourced service operation of an unmanned vessel.
Specialization to the specific product is taking place. Reputation is more and more important criteria.

The service pricing is related to the service model. Starting from spare part delivery up to the full service package, the price is scaling between these offerings. According to customer's needs pricing can based on the annual fee or based on the negotiated list prices. Some customers are willing to do much by themselves and needs only spare parts, others want to have parts and work bundled.

In the current business logic, services are divided into two parts, maintenance work and spare part delivery. The maintenance work selling generates in total more than double compared to spare parts. At this moment, Wärtsilä Services is the most sophisticated on the market. This consist of the best documentation, knowledge and technical support. Other engine manufacturers have not been able to offer similar. This should be highlighted more in the marketing messages. A marketing message should increase the awareness of customers that these service support activities would give more to their everyday work. The spare part delivery has a big share of the Service business. Depending on the motor type and on the market there are available non-OEM parts for the engines. The older or a more popular the model is, the easier the availability of the spare parts from public sources is. This reduces selling of OEM parts. In the new models, situation is opposite. The spare part online services are developed towards comprehensive solution, where other support like assistance and service reports are available with the parts.

6.3 Digital technology services

Wärtsilä has multiple monitoring services that are based on digital platform model. Wärtsilä Online Services is one example of a platform of new digital innovations. The business in these platforms are not organized according to network model. The platform increased transparency and availability for spare parts ordering and tracking and technical support as well as a remote service concept such as the Virtual Service Engineer. The recent Wärtsilä's acquisition Eniram also provides operational efficiency optimization services by data analytics and modelling. Nacos Platinum service combines navigation, automation and

control system featuring Intelligent Route Planning. This is improving customer's operational efficiency

It is good to remember that Wärtsilä is not the only service provider in monitoring services. In the markets, interest has been rising from customers. Competition is getting harder on digital monitoring and analytic service business. On one side there are the component suppliers, who will develop their products and services. On the other side, the classification societies are also keen on to utilizing possibilities that digitalization enables. The drivers are similar, but the approach is different from the point of view.

The classification societies are marketing their service as independent service provider. They have been active with acquisitions and merging independent software houses in their offering. Some of the examples are Japanese NKK that acquired Finnish Napa and Norwegian-German DNV GL, which took the share of the German software house that provides fleet service software.

Even the societies may have a hidden agenda behind their actions. Perhaps they are searching for synergy advantages by combining businesses together. The classification societies grand certifications and approvals, that are needed for insurances. With the operational data, they will gather information for developing their certification products, which are the guidebooks to shipbuilders. Developing the rules, ships are able to carry more cargo and thus have better earning possibilities. For their customers, they are reasoning the use of Fleet Management programs to gain savings in operations.

The difference between these two groups is that the classification societies compete directly from the same customers. Whereas with component suppliers situation is bit difference. Each component in a ship has a specific function, not substituting. Competition existing when suppliers have overlapping products. Sometimes customer segments may vary among suppliers and no real competition exists. Increasing competition may also lead to the acquisitions of competing service providers preventing them to slide to the competitors.

At the moment, data transmission costs in marine business are higher compared to onshore. Now all component suppliers have separate infrastructure for gathering, transmitting and saving. A ship owner has power to choose who it will give access rights to its data. Ship owners may not be interested to arrange necessary access to all requests. Instead, the component suppliers could use a common platform in their digital services and avoid investing into technology on their corner of sandbox. As a customer point of view, it will show sooner or later as a fight on sandbox. Offering common platform data services in equipment control would be marketing advantage to classification societies alternatives.

Information collection could be run as a separate business. Raw data is more or less irrelevant, but it is fuel for processing, that creates value add.

Digital services

For the component supplier like Wärtsilä digital services mean two different things. According to the value shop configuration, these are increasing the knowledge and with analysis base information asymmetry. On the other hand, increased knowledge benefits in product development in the value chain configuration. Products are more efficient and durable; these characteristics increase the value capture. The more efficient field service the customer is served the better is the customer satisfaction. These facts can justify investments into the new technology.

Developing and exploiting can be to divided into two categories, internal and external customers. Business plans are often made according to an external client, because it is easier to estimate newborn revenue. Development for an internal client is however important in many ways. A product for an internal customer can be offered to an external one later. Then it is possible to sell an already tested product with fewer bugs. A customer will receive a tested and approved product that works in practice. Customer satisfaction is better and commitment is higher. An internal customer's operational efficiency improves profitability, but also improves customer satisfaction and similar increase possibilities to sell more to old customers and to the future customers.

The main question with all new digital services in business is, do they bring profitable business? Expensive technologies like data gathering enable new business. However, this is not always explicit clear. Also, the traditional organizations are willing to learn more and exploit new information. From the field service point of view, the company investing much to digitalization. The feeling in the organization is that this happening at the cost of other functions.

Current platforms

Today platforms are not just tailored for a company; they are modular and adjustable according to a company need. Applications need not to run in company premises. Suppliers and end customer are allowed to have access to platforms, but this is not making communication bidirectional or multisided for them. Situation is rather automated information exchange. On a client side, information is fed into ERP system. From a material or spare part supplier point of view, they will part of the distribution channel of a company.

This setup improves value chain efficiency, but although that some signs are found, this is not real value network.

Figure 17 shows how Wärtsilä digital services operational actions are organized according to the Value network model. Even that this arrangement follows the model of Stabell and Fjeldstad (1988) the business is not networked by the nature.

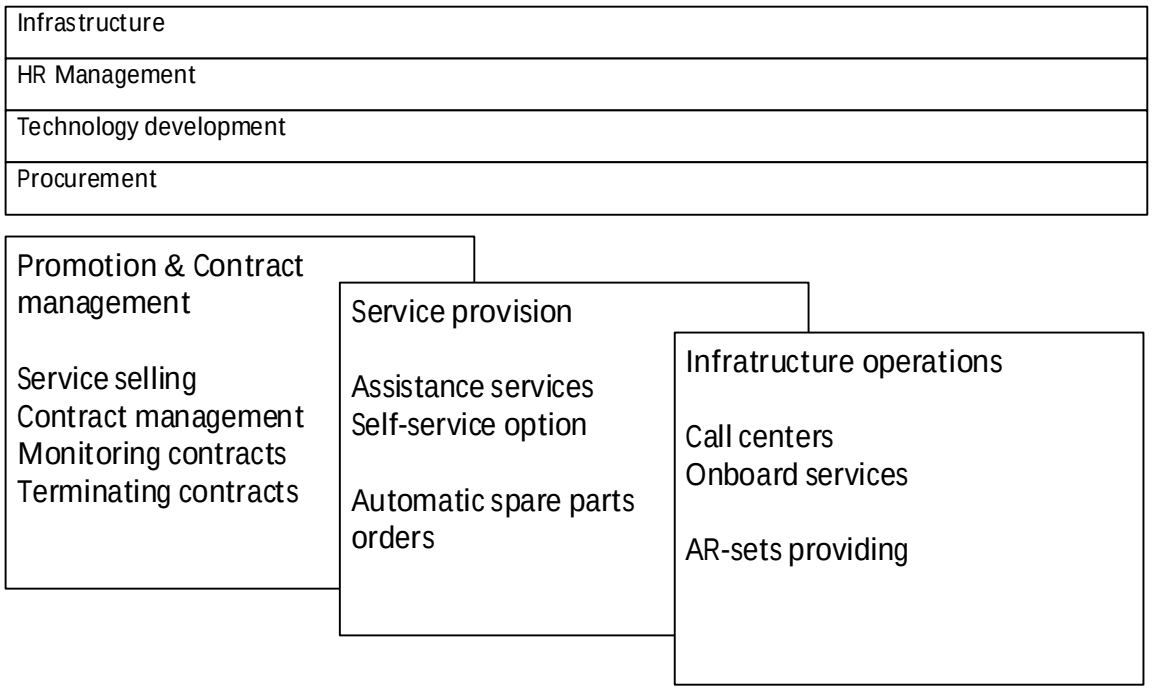

Figure 17 Wärtsilä digital service platform diagram. Based on Stabell and Fjeldstad (1988)

In Wärtsilä, the platforms are build as layers on SAP or SalesForse development platforms. Wärtsilä is the owner of these platforms and stored information is solely Wärtsilä's property. Applications may be run by service providers. Server rooms may still be located in company premises. Some of the information may be sensitive and have to comply with local and flag nation's information security legislation. Wärtsilä digital services is divided into three different categories that are Lifecycle solutions, Monitoring services and Cyber security patching service.

Service products: Lifecycle solutions - Marine

Wärtsilä's lifecycle services are divided into tree solutions; Guaranteed asset performance, Optimised operations and Optimised maintenance. This is the service packet entity that is most near to field services where AR would be the most beneficial.

During 2016 Wärtsilä launched new QuantiServ service which offers field services, onsite maintenance and repairing and commissioning to marine and energy industry customers who use equipment's' from different manufacturer's.

Guaranteed Asset Performance

The business model bases on the value proposition that ensures that agreed levels of performance would be reached and maintained. Guaranteed operations base on actual measured performance. The revenue in the business model bases on shared earnings which are based on agreed and quantifiable performance indicators. These will be evaluated quarterly. Through condition monitoring and audits together with a performance improvement plan higher availability and reliability will be achieved.

Core competence is based on asymmetric information. Vessel's operational performance monitoring real-time and unacceptance measures cause an immediate response. Dedicated experts with senior level technical experience will give advice to onboard crew. This reduced the need for unscheduled maintenance and onboard visits.

The Wärtsilä Guaranteed Asset Performance lifecycle solution guarantees the operational reliability, performance and uptime of the assets. Maximised uptime achieves through optimised maintenance and remote operational and technical support.

Customer can gain following benefits from this arrangement:

- Guaranteed operational reliability and uptime
- Savings in operational costs thanks to improved and maintained ship efficiency
- Maximised uptime through optimised maintenance and remote support
- Performance improvement plan
- Maintenance cost guarantee

Optimised Operations

The Wärtsilä Optimised Operations lifecycle solution ensures that marine and offshore assets operate energy efficiently and that Ship energy efficiency management plan (SEEMP) measures are in compliance with international environmental MARPOL regulation.

Customer benefits:

- Optimised energy efficiency
- Real-time advisory services
- Long-term cost predictability and shared goals
- Performance improvement plan
- Maximised uptime through optimised maintenance and remote support
- SEEMP in compliance with MARPOL regulations
- Global and local co-ordination through network companies with workshops and skilled service experts

Optimised maintenance

The Wärtsilä Optimised maintenance lifecycle solution optimises maintenance intervals utilising its Dynamic maintenance planning (DMPTM) concept. The solution enables to schedule maintenance according to actual needs instead of having to rely on a fixed maintenance schedule.

Customer benefits:

- Maintenance cost and service level assurance
- Long-term cost predictability and shared goals
- Maximised uptime through optimised maintenance
- Remote operational and technical support
- Scheduled work and parts included
- Global and local co-ordination through network companies with workshops and skilled service experts
- OEM spare parts and consumables

Monitoring services

Monitoring services consist of two products, Engine efficiency monitoring service and Propulsion Condition Monitoring Service (PCMS). Here found the recognizable elements of the value shop configuration. Knowledge is in an asymmetric balance. Savings in the operational cost can be reached immediately after corrective actions. The price is not necessarily unit costs based. A customer have two different models of service pricing. Pricing bases on a monthly fee or on sharing of the operational savings.

Engine Efficiency monitoring

The value proposition of Engine efficient monitoring is minimising fuel consumption and optimising operational practises. In service, customer's engines are monitored in the standardized way and operational decision-making is based on actual real-time data. Follow-up and trend analysis improve power production and total fuel consumption. Onshore personnel can also access the installation information through online services. Data is stored on-site and is accessible by an onboard interface. During the contract, the service includes conceptual planning, commissioning, delivery and training, support and expert analysis. Distribution of the service is bundled as a part of the service agreement.

Engine Efficient monitoring is marketed as Wärtsilä Genius services that utilise the advantage of connectivity and real-time data gathering to optimise operations, that deliver more value and enable growth.

Propulsion Condition Monitoring Services (PMCS)

The value proposition of PMCS enables customers to enhance the availability, reliability and profitability of their installation, which is reducing risks and maintenance cost. It provides the customer real-time advice and periodic reports concerning the condition of the machinery and information for maintenance planning. An onboard monitoring is organized in a standardized way with instruments and database tools. Wärtsilä's experts will generate monthly reports based on data. In a case of unusual information, experts prepare their advice. According to this information, the owner can avoid costly unplanned dry-docking for visual inspections. The dry-docking option is always an extra cost and loss of revenue.

Cyber security patching

This is an expert service, which secures that installations are always equipped with the latest technology, in compliance with regulations and ready to defend against the outside threads. This service provides essential updates, patches and hot fixes for applications, operating systems, devices and servers. This is outsourced IT-support for vessels.
The value addition come from increased asset uptime, reduced operational costs, longer lifecycle of computers and applications.

6.4 Processes

AR is a tool that affects to processes. Referring to the Introduction, in this part of chapter, the viewpoint is on the processes where the use of AR should benefit organizational efficiency and operational improvements. The company processes have connection to value creation in different value configurations.

Service operations

Field service is very traditional function and based on workman skills. It is according to the value shop configuration model (see also Figure 16). The field service is much about the logistics and skills of employees. Operations are conducted by the field service coordinator. She/he is acting as a project manager, the foreman of the technicians. She/he defines needed resources; workmanship, tools and necessary parts and ensures that these are at the right time in the right place.

Service coordination:

- First a client fills a tech request-ticket
- Response to request is given as soon as possible
- Value of the solution depends on the expenses, material, trips, man hours

Most of the maintenance work takes place on board. Ships should be kept on duty as much as possible, docking is off the operation time and causes extra cost. However, while docking maintenance is scheduled and is easier to apply. Mainly field service operations are ad hoc actions due to their nature but also scheduled operations exist. In some cases, service orders can be perform with needed parts and tools found on site.

Service operations have to fit customer's logistic puzzle. For the operations, a ship should find a place and time where to stop. Time at harbor is used for the maintenance or loading equipment for the work. Service selling is more than just the maintenance work, it is the fluent process that also cover logistics. Organizing work on site is time consuming if it is not well prepared and planned. A total operational time can be reduced with a good preparatory planning. Sales might miscalculate estimated operational service time if the logistic supplementary times are not taken into account.

The marine customers are used to maintain their ships in the waters. There is high mental threshold giving maintenance operations to the others hands. Offering the maintenance service as subcontracting work is thus difficult issue. Furthermore, the technology in the ships is getting more complicated; all the necessary expertise is not possible to retain on board. Most of the LNG carriers have service contracts at the moment.

Operational personnel are divided into six different levels according to their knowledge: technician, senior technician, service engineer, senior service engineer, intendant and superintendent. Field service coordinators, superintendents and group leaders are coming normally from the higher wage countries. Lower skill requirement employers come from the lower wage countries. Using the doctor-nurse metaphor to the field service, a doctor performs the diagnostic and a nurse does the treatment, similarities are found between different employee groups. There are differences in pricing between the use of different level of technicians. Key personnel are employees in the customer interface, from maintenance workers to account managers.

Service process

In case of alarms, a service request route is complicated. Normally, alarms are made by the ship owner technical intendant, who is informed by an engine chief of a ship. A technical intendant contacts a support center or service account manager. After opening a service ticket, a service coordinator is contacted. A service coordinator starts to plan the service procedure. A service coordinator contacts an engine chief in order to clarifying the origin of the cause. The problem could be small and easily solved by sending needed new parts. Practically contacting engine chief is mandatory, because she/he is sitting on the problem and knows clearly the situation and its seriousness. If the problem is not acute and does not need immediate actions, there is time to fix proper time for a service call. Trying to maintain good service level, in acute situation there is a need to send an available resource even best proper technician is not available.

A customer's problem solving is a management challenge. Right expertise has to be found to a problem. Clients have different products and a ship has many connected systems. Furthermore, ships are sailing in different locations. A timeframe at a harbor is sort. It depends on the customer's level of experience how well they can guide to the sources of the problem. When comparing engine field service to elevator business, problems in a standing building are much easier to limit. An elevator trunk with machine space is clearly defined. Connections to another systems are a few, thus failures are seldom caused by surroundings. In fixed installations, the field service personnel can be situated geographically according to installations. With the ships this is more complicated.

Trouble shooting in diesel field service duties needs experience. Failures have to be able to be found. Currently, the process is on the learned experience of individuals. It is professional skill to detect the difference between mechanical and electrical failures and to locate the source of origin. AR would be one tool in communication with external experts when hunting root causes. Mechanical experts are skillful in checking certain status of indication lights and level of measures, switching a system on and off or just pushing a specific button. On the other hand, with proper tools electrician or automation expert could be assisted to find mechanical failures. This enforces operations over occupational groups. With these tools, even a less experienced technician could be sent on time to do failure diagnostics during a harbor timeframe. With this information, it would be possible to draw up a maintenance plan, define part lists for sending a specialized technician on board later.

Another case is scheduled service calls. These have to be planed properly and send right expert on-site. It is important that a technician has a good understanding of the nature of the work and is skilled to execute the job. A skillful technician can execute maintenance even without tools and necessary parts if needed. A technician can build a temporary arrangement, which helps the customer to survive until necessary parts are available for complete solution. It is the interest of ship operators that a ship is operational and makes money. A temporary arrangement fit fine unless it is not unsafe to people or to risk a cargo. In such a situation, customers are almost ready to pay anything, to ensure that engines are running. Losses in income are that the great that sum at an invoice is not important.

In the dockings, where a ship arrives to a shipyard for a refurbishment, repair or maintenance, operations are normally well prepared. In these cases Wärtsilä does the critical work with own personnel and other assistance type of work, like hauling, is outsourced. The offering is something that the others are not able to do. In the dockings, a shipyard often has the best capacity in logistic operations and the best tools for this purpose. For example, removing and replacing propeller shafts and gearboxes, only needs to have a supervisor on site.

Logistics

A proper maintenance work might take just a few hours. This is preceded by preparation phase and after subsequent actions, which might take several days to complete.

Logistic efficiency is even more important than improvements of a technician work. Successful logistic in a ship is part of the fluent workflow, especially with heavy parts. Necessary tools are easy to find and carry to location and even the removal of the fitting bolts is fast paced. Often, lack of space causes logistics problems.

Transferring heavy and big objects is challenging in narrow places in the means of work safety and organizing. Certain parts need to be transferred outside engine room. Removed exhaust pipes, which can have almost one meter diameter, are a good example. This needs preparatory preparations in hoisting points, hauling tracks and storage areas. Hoisting point and hauling tracks might be missing. A proper work planning needs to explore the field service venue and check which tools and equipment are needed in practice.

Learning

Learning is a year’s lasting process and continues until a technician leaves for the pension. The work should be possible to conduct with manuals, but that slows the pace. Repetition

per installation type improves the speed and familiarity with personnel on board helps to adapt to conditions.

A field service is much more than tightening of screws. It is also a relation with customer's representatives, logistics and faultless operations in a proper order. Developing routines and collecting experience in challenging jobs improves the speed and confidence.

Development of personal skills and experience are recording into Personal Skills Management (PSM) system. Progression in six level hierarchy is tied to product-based certifications. The goal is that a reasonable amount of skillful technicians among the workers grow up, who have ability to work as a supervisors at the field. Another way is to develop a single product specialist, a black belt, in narrow area. Generally, working with mechanical parts should be common, but some products need more specialization. Automation and electric connection needs specialized training and skills. Among the skills and expertise, personal capabilities consist of suitability for certain jobs and positive chemistry with customers.

Data communication environment

Establishing information networks in marine environment is very challenging. Difficulties arise in both internal wireless communications and in external transmissions. A ship structure is made from metal plates, steel or aluminium. These forms an excellent Faraday-gage that prevents electromagnetic propagation in structures. Internal communication with walkie-talkies functions somehow in a ship although that some electronic appliances may disturb that. Used frequencies in data transmission have less penetration and used transmission power is lower. Practically this means that every single space should be equipped with network transmission repeaters. Still, some process controls equipment and large electric motors can generate unwanted signal noise. External communication has to arrange by wireless communication. This is radio transmission between radio link or satellite and ship antennas. A long distance to radio links forces to use expensive, sometimes slower and weather sensitive satellite communication. Slow connections increase communication latency, which is observed as time delay between the stimulation and response (Wikipedia, 2017).

FS Mobility

Wärtsilä has already taken the first steps towards to digital FSM. FS Mobility is a technician enablement (mobility) application that is tailored for Wärtsilä. It is mobile application for

the field services purposes. The goal is that all technicians will have mobile tablets available on the field operations. All administrative actions could be executed with these devices. FS mobile will provide orders, background information, documents, report templates, hour logs and shop safety analysis in one application. It brings back office features to the engine room environment. At the moment, documents are readable from application but they are not interactive yet.

The work order will be directed to the nominated technician in a digital form. The work order is a kind of basket that carries all information needed. Chatting features are linked to the work order. Chats will be saved in the database. This ensures an easy way to run through work related information change without searching for it in e-mails, text messages or phone logs. Similar information can be used for reporting. Work reports are used for verification and customer approvals.

The application layer is built on using SalesForce and QlikView tools as the user interface on the company ERP on SAP. SAP is the principal database in this solution. QlikView is the tool for service orders for technicians. At this moment, there are three functionalities available for users. FS Mobility is a layered platform that allows adding further functionalities as AR tools in future. Established connections and relations to existing systems ensure expansion easily. There are a lot of ideas for the future.

The basic idea in the platform development has been the ability to use devices of all kind, computers and handhelds. In the large organization, it would be difficult to tie up hands with a certain hardware or operation system. Development is sensitive and challenging. Organization that is not used to digital tools have natural resistance to adapt a new way of working. Selling an idea to technicians has been demanding. In the beginning just a few well working functionalities are introduced. This ensures a lower threshold in the implementation and easier to build trust of use. This helps to win organizational barriers. When these functionalities are adopted to use, more functionalities can be added. It has not been easy for them to understand that this will be "neat thing", although that for implantation need only open the application.

Work orders contain a lot of different information. Application enable for example chatting and assistance in documentation. It is a portal including technical knowledge and manuals, which can be downloaded for off-line use. FS mobility would enable analytical information transfer to maintenance locations. However, this kind of feature is not in use yet. At this moment static information like instruction manuals are available. Manuals could be read also with Head Mounting Displays (HMD). This would not be classified as AR,

because there is no intelligence connection between the subject and manual. HM devices would be excellent instruments reading manuals, because hands release. With dynamic information, HDMs are even a better option. FS mobility and Product Data Management (PDM) would be connected. The PDM model would contain 3D models and customer's product information. This information would be connected to PSM to ensure sending a right technician to the target.

Way of development

Two last parts of this chapter are concentrating on thoughts that arose from the organization. How people see the development and the possibilities.

Challenge in development work is to see the surrounding world. Promoting learning, improvement of knowledge and technology development at increasing speed, customers are not capable of following the progress. Customers have to decide, whether their capability is in operation or in maintenance. Collecting information from the ships increases the volume of data. Customers do not have instruments to collect and analyze information. Big data value is coming from more than one customer source and it is giving good reference knowledge to explain phenomena. New expertise is created by collecting information from service request combined to previous collected data. This can be used to serve more customers.

It is interesting how the company changes. Wärtsilä has made one big cultural change when a product-oriented company has turned to service-oriented. Both orientations are based on the knowledge of mechanical appliances. With the digitalization, new native digital personnel is hired into the house. These new people have a different approach to adapt new methods. During an engine life span easily selling the similar sum of maintenance and spare parts that the original product. With digital features, it is possible to expand the offering even more than the current business model.

People have different backgrounds, all are not necessary digitally aware. How many people are able to utilize extensive information? Although that senior engineers are able to do their analysis with their ears, they also appreciate accurate measured data and use it when available. This moment collected data is in raw format and refined only a little. High skilled professional can use that also for decision making.

It seems that trend in customers' personnel educational and professional background and language is getting worse. Economic and contractual reasons load pressure to hire increasingly work force as called from the pier. The knowledge is mainly on chief and first

engineers. This charge pressure to build new methods to cope with language barriers and increase local skills. Lack of interest and capability to read foreign language leads to the low use of manuals. AR technology would provide a new way of working.
Discussions about developing smart tools have already started.

Ideas

Virtual models are already used in design for testing functionalities. Virtual models could be utilized in the field service work planning. Using scanned virtual engine rooms, could show actually how the location is constructed. This information can be exploited in simulation of hoisting and transfers. Especially when moving large and heavy objects in narrow passages preplanning helps successful execution. Necessary transfer arrangements could be tested in advance. Virtual models could be used later as well. Building or scanning virtual models would be part of a commissioning.

Using checklists, measurement records could be merged together in same document. Checklists would guide to right work order and automate filling of accomplished actions. An exploded view would show necessary installing gaskets and ask whether these are at right places. Verifications can be saved to cloud servers from a mobile device for a later use. Databases have better usability compared with single files that have limited use for queries.

7 Customer perspective and benchmarking

In this section are presented interviews with the selected customer and cross industrial view as a benchmark of the situation between two different big industrial companies in Finland. In the discussions it has been tried to go through the processes where AR could be use within organization. The discussion should lighten what kind of features would be the most interesting and the most profitable.

7.1 Customer case Arctia Oy

Offering AR-services to the customers is one possibility of using of AR. We arranged a meeting with operation and research directors of Arctia for understanding their situation, needs and relationship to AR. This chapter is based on the interviews with the company representatives and on the public information on the company Internet-pages.

Arctia Oy is established 2010 and it is 100% Finnish state owned maritime company. The company main business is to provide assistance icebreaking for commercial ships in Finnish waters and harbours. Secondly, the company has business in international waters as a provider of offshore services. Finnish knowledge in icebreaking and operating in ice-covered water is top in world class.

Arctia operates eight icebreaker and one harbor icebreaker. Their fleet is mainly equipped with Wärtsilä diesels. The newest ship is equipped with the state of the art Wärtsilä LNG compatible diesel power plant. One of the ships is also equipped with the oil recovery equipment. Some of the ships are capable to demanding offshore operations on oil and gas fields. Offshore operations are towing, ice management, cable, pipe and anchor laying and installation and maintenance of underwater structures. The asset of the fleet is the possibility to operate in heavy ice conditions as well in open waters. The assistance in the ice routes is seasonal, the rest of the time the fleet is laying in the pier. For the company, Offshore services are the way extending the season and earn also out of Finnish winter season.

The business is unique in comparison with other ship owners. Icebreaking business is different in comparison with merchant shipping. For the efficient use, ships need to stay in waters for a long period, until they need refueling and supplements for the crew. In merchant shipping vessels travel between ports carrying cargo. On the other hand, this assistance is working on a coastal zone, where services are easily available.

An icebreaker works in extreme conditions. Operating is challenging and icebreaking resources are limited. Due to special conditions and operations, personnel is also specialized.

When an icebreaker is not in active operation, it stays at a pier. When a ship is not operating or it is in standby mode, the crew can be used on the other ships. The ships have different ages, model and even sister ships have differences in spaces and machinery arrangements.

Ships' have a long life span. Decision of buying a new ship takes place with the current fleet replacement cycle is about 50 years. Technical solutions, like the IoT, have quite little impact to the decision-making in acquisition phase. IoT is not the most significant issue when choosing a component supplier.

Knowledge management

Due to Arctia specific field of business, a knowledge management and transfer is important for keeping experience in house. Different tools used for knowledge databases. Experiences of different service operations, risk incidences and malfunction situations are shared in dedicated portals. The currently used portal is passive and it is not having interactive features.

A Master-apprentice configuration is a good learning base to a professional. However, this is an expensive method. AR could be used here by releasing a master for another work while teaching several simultaneous students in assistance.

The need appears in case of new subcontractors. They do not know the places well, but no assistance is necessary available. A checklist type of arrangement would be suitable. For example, while switching a ship from a standby mode to an operational mode, AR could be used for showing the right sequence and adjustment values of the whole process.

Information sharing infrastructure

In old ships, cabling does not exist, those need to rewire and build networks. Thus, acquiring devices are not the critical expense in the investment to digital tools.

Secondly questions are how to arrange communication economically between parties and what is the sufficient needed bandwidth? Arranging external assistance services, a ship location impacts to the costs and quality of communication. Roughly, on a shore area, communication is economical; the data transfer can be arranged using mobile telephone network. At the certain distance from a shoreline, mobile communication possibilities disappear, and data must be sent via satellite. Then it does not matter if the ship is on the Baltic Sea or in the Northwest Passage. Reasonable bandwidth to send video and voice stream is expensive. At this moment, costs are not supporting constant access. Thus, some activities should be arranged as offline services.

Both, the remote control and remote assistance are needed. The arrangement is depending on the case. For example, system alarms remote control is one example and can be monitored remotely with mobile equipment. The company does not have a technical operation center.

Future development

It would be ideal to establish user groups for exchanging experiences . Different users have unique requirements. This information exchange helps to create some sort of a road map for the future. It is obvious that users in a group do not compete with each other.

Similarly, it is important to develop standards for information exchange and security issues. The security issue is already realizing with remote monitoring. In the industry, standards should specify security as in the One-Sea project as well the interfaces how to be defined access rights and who can control the information.

Many kinds of new arrangements are already made. These are not actually based on AR-technologies but using similar installations that are needed in AR setups. Some of the initial prototypes almost fulfil AR definitions. Some parts of the systems like environmental sensors, support long-term capabilities (Robinson, 2016). Test use of QR-codes in technical documentation was already done. The main driver for the use of AR would be cost-effectiveness. Investments can be justified by the saved money and better use of human resources. The company recognizes three major areas where they would benefit the use of AR in the future. Areas and tasks listed in table 2.

Table 2 Main areas where AR-tools should be most beneficials

Area	**Tasks**
Training	Internal training and social support External supporting and training
Maintenance operation	Position Identification Manuals and Checklists
Confirmation	Check that identified tasks are done

New processes will face the resistance and at the same time charm of novelty. Overly complicate arrangements stumble to complexity. Too much planning leads to academic studies without proper practical solutions. Starting from simple with the agile method without waterfall plans, could be a functional approach.

The challenge will be how to get different parties interested and develop a common ecosystem. In a user site, there are different kind of needs, and then there are layered structures of protocols, applications and divides. The existing service contracts have to examine and look how the use of AR will affect to those. There might be a need to add further options on the contract. Small ship-owners like Arctia do not have resources to initiate development projects that lead to the use of AR devices.

7.2 Cross industrial view, Kone Oy

Kone is globally the world leading elevator and escalator provider. The company has their own manufacturing and they are offering maintenance services. Wärtsilä and Kone have similar strategic business structure they have divided equipment and services in different strategic parts. Both companies have managed to build services as a big part of their revenue streams. Both companies are in Business-to-Business markets and are rarely delivering products directly to private customers. Similar businesses have two distinguishing value configuration models. New product deliveries are based on value chain efficiency and services business is value shop type.

Wärtsilä and Kone do not compete with the same products; rather they have the same customers in the marine markets to serve. This gives great opportunity to benchmark companies' business models. The main purpose of this cross industrial comparison is to see similarities and differences that affect to decision making.

According to completion legislation, Kone is required to deliver necessary documentation about their products for maintenance purposes. Similar competitors' maintenance documentation is available for executing the maintenance of installations. Because maintenance service is more than just the work, bundling together different kind of offering, the cheapest maintenance work it is not always the best base of acquisition decision. The maintenance service contract is not one timer rather it is a long time relationship.

Currently, Kone has already digitalized almost all the documentation material. That can be accessed with mobile devices. Producing documentation is an expensive process. That must be scalable to different devices and applications.

Knowledge management

Kone has different level of technicians. They are specialized to different kind of products. The installations and maintaining must follow a local legislation and rules. New technicians learn to the job by the assistance of a senior technician.

The wrong man syndrome does exist - the customer problem is actually something else that is described and expected when ticketing. The wrong kind of expert is sent to location.

Important characteristic with AR-tools is the capability for knowledge transfer. Senior level engineer can give his assistance to junior level by interactive tools, thus junior engineers can train in practice on control. Combining AR- and Social Media-tools might be a good way to share experiences and thus avoid the known problems, by bringing effects of the wisdom of the crowd available. In strictly safety regulated business the acceptance rules must be followed, which is a challenge in maintenance where sometimes improvisation is needed.

Challenges

Organisationally it will be challenge to implement AR enabled new working procedures and accept the use of needed technologies. Discharging old habits is not always the easiest part in learning new.

Easily implement software are available. It is possible that group of experts would establish their own business that is based on AR-tools in certain simpler product segments. Challenge is developing offline guidance. Increasing sensors in technology and artificial intelligence will improve this functionality.

Opportunities

At the moment, AR-technology is a way to improve efficiency and quality. It will give the help desk better to understanding about the existing problem and securing that all necessary operations are performed accordingly. It will reduce time spend on maintenance and will also minimize travelling costs. The current available AR-technology is not yet suitable for field services.

Like Wärtsilä, Kone is collecting huge amount of data from their installed equipment base. This gives an advantage in the markets; knowledge asymmetric is increasing and focusing can be focus on preventive maintenance instead of repairing. This increases operational reliability and customer satisfaction.

8 Discussion and conclusions

This Section combines theoretical background presented in Sections 3, 4 and 5 with existing practical situation within Wärtsilä Service business that was presented in Section 6. This Section concentrates on the issues that were seen clearly important factors implementing AR technology into field service operations of Wärtsilä. These findings could be use the base for decision-making and in further investigations.

In Section 1 there was stated 3 questions, how

1. *AR impacts to the company value configurations*
2. *AR impacts to field service processes*
3. *What limitations are encountered in case of Wärtsilä*

Answers to these questions are presented the in three sections. First, Configuration models represent connection to business and business models. Thus explain strategic positioning. Second, Field Service Management describe how work management and processes are organized efficiently. Third, explains limitations.

Preface

The simplest solution of AR technology is a chat-type conversation between two people with an interactive tool. With a piece of software in a device, it is possible to add information into a picture or a video transferred. This additional information can be used to support decision-making and advising. These kind of setup can be organized to multiple users, thus it is possible to arrange several experts simultaneous to provide information. Additionally, an expert can have several ongoing sessions.

The value creation could be understood in two different perspectives. One is the external view, how customers percept the value, the value capturing. On the other hand, the internal competence and effectiveness improvements increase the possibilities to offer positive perceptions to customers.

Theories that were introduced earlier are independent from each other's. The AR influence on the company value configuration can be to explained with the existing framework of Stabell and Fjeldstad of three different value configuration models. The value configuration model is perfect to explain the customer point of view. However, existing frameworks do not explain AR influence on the field service business value creation which is the internal view of point.

8.1 Augmented reality in value configuration

There is perceivable hypothesis that AR influences each value configuration model. Influence of AR in value configuration models is complex; the effect is not similar, even that value creation might appear similarly in each of the models. AR did not create new business.AR enables developing new modus operandi and business models.

AR devices enable two-way information exchange. This includes collecting, saving, analyzing and computing of data. Two-way communication improves knowledge, increase information asymmetric and develop brand value.

AR in the value chain

In the case of Wärtsilä, the efficient value chain and right strategic positioning in selected customer segments is the foundation for the company. Value creation in the delivery process of diesel engines and power plants can be purely classified according to the value chain configuration. The production is mainly in the provider's manufacturing premises. Selling and delivering marine engines are mainly according to B2B2B model. For an engine supplier, which also offers services, this kind of model is not ideal.

In a product sale, it is possible to sell more additional services and add that to prices. A customer perceives to get more value of the product compared with previous or without added service. Additional services are part of specializing, which can be connected to a product and bundled to the offering. This does not actually create a new business, rather develop and enhance the old one, thus increase value capturing. The purpose of included services is capturing customers. In the value chain model, AR increases fascination for products with quicker services and new features. AR tools are thus essential part of marketing. AR tools replace partly old customer service methods like call centers and personal assistance on-site.

Today fields service for new deliveries consist only commissioning. This means that installed engines are ran up and ensured that these are according to specification values. The acquisition process does not support differentiation with a service, because price competition is in the significant role in the acquisition process. Added services or characteristics for the end customer, which rise a product price are not wise in contract and acquisition situation. A buyer does not take these into account unless these are mentioned in contract vice. One possibility would be to bundle products and services in a novel way. AR would be one good solution for this. Adding feature like AR to service products, this would provide advantage

for Wärtsilä on the markets and may also be positive criteria in the new product acquisition process.

OEM spare part selling is important part of the Wärtsilä Service business. Actual profit accumulates during the lifespan. Spare part selling could be interpreted according to the definition of the value chain configuration. Maintenance and repairing are part of the life span management, those extent a product lifetime and improve performance. AR based services increase the product value, but it is difficult to measure and translate that to additional revenue. This might diversify the company products such a way that enables additional sales or customer are willing to pay more. There could be new the pricing alternatives. In the new feature offering, a provider may be forced to the sponsor role but on the other hand this feature increases the customer commitment to a provider.

In marine business it has been normal to sell a delivery material with low profit. This applies also in Wärtsilä case. Maintenance and spare parts in service business are more profitable. The challenge is keeping the customer loyal and buying service in the long run during engine life span. Especially customers who have ships at the end of the life span are more willing to use other than OEM parts. They acquire parts were cheaply available. Additional services may help customers commit to use the certain supplier. In Wärtsilä case, a customer may continue using of OEM parts for several years. In a ship life span of 30 years, two years extension means 7% more. With some exceptions, this would be directly translating to revenue. Older engines require more spare parts and maintenance than younger ones, so this is excellent opportunity to increase revenue.

In future, the customer behavior may change so that they are increasingly concentrating to their core business cargo operations or hotel and restaurants. This kind of change may lead to service and maintenance contracts of new kind. Also, so-called unmanned ships change the name of the game. Although that some of the navigation and harbor operations would change unmanned, the actual maintenance and repair work will be human operated for a long. A new situation leads to the change the contractual situation with new buildings; a new counterpart arrives to the negotiations. In these cases, an experienced and skillful service operator will express their wishes and visions during the contract process. AR features could be one solution solving service levels in new situations. Combining the product and service delivery blurs further drawn line between the value chain and the value shop models. At least the target customer may change.

AR offers great opportunity to get a customer committed to service programs with the verification features and better service. With AR that is connected to an original product, it

is easier to manage warranty claims and operations. A customer also benefits from faster and accurate trouble shooting and faster problem resolution, these characteristics reduce downtime that further leads to better utilization. With a help of AR, a customer can solve some problems without waiting for a technician arriving and thus minimize down time.

AR in the value shop

In the case of Wärtsilä efficient field service supports the product marketing and creates continuous revenue flow. Wärtsilä has been successful in developing Services their largest strategic business area. As Stabell and Fieldstad (1988) described, services are part of the value chain logic. Occasionally, it is difficult to determine, if services are part of the product delivery or is that independent business. In the case of Wärtsilä, both distinctive features are perceived. Services are strongly supporting the existing installation base. Spare part delivery supports installed product life cycle management, which extends the product life span and as well maintain efficiency. This can be interpreted to belong to the according to value chain definitions. The part of the service activities does fulfil characteristics of the value shop.

The field service activity is according to the value shop model by nature. Thus, benefits of AR in the field service should enforce the effects of this configuration model. In the value shop configuration, resource management is an essential task. Without proper resources, a service business is impossible to run. With complex systems, the training of workers takes time. The perceived trend is that willingness of companies to use time and money for training is decreasing. The information that support employees on decision making and in problem solving, increase a service value to customer.

One of the important characteristic in the value shop configuration is information asymmetry. In the field service operations, information asymmetry is a recognized characteristic. Increased asymmetry and faster cycles enforce the value configuration. With AR and analyzed measurement data, these characteristics could be improved. The internal benefits of AR in the value shop were presented in the Field service management section. Use of AR could increase knowledge asymmetry of Wärtsilä.

In the value shop configuration, some part of the service can be moved to the customer side. This is possible with digitalized platforms. Like private customers, self-service functionalities are increasing for the commercial customers. With standardized questions, a service provider collects information about the customer problem. A problem solving can be automatized to AI-expertise system or to solutions groups, which replay to a customer with a solution. A customer may even execute proposals. A customer pays the right to use

platform. This kind of model can be used if a customer has proper resources. A self-service process is one way to shorten problem resolution time. This would be important aspect for the customers of Wärtsilä.

If spare parts are available, the maintenance work can be to done using local personnel. Because waiting time is removed the downtime decrease. In case that expert has to be sent on site there is better understanding about situation and a right expert is chosen to job ensuring the better success. The reputation is important. Field services must occur fluently, swiftly and with quality. Pricing might be based on other fact than the unit costs of delivery. All procedures that improve resolution rate improve Wärtsilä's reputation.

Self-service features enable the faster and better utilization of resources. The better utilization enables more revenue and/or profit of Wärtsilä. Similar to the consultant services, expertise system pricing can base on the extension of value creation although that expert has been participating remotely. Here a ship owner can utilize a ship in its duties and earn better.

AR in the value network

AR is based on IT platforms. Platforms have been seen as organic parts of networks. This feature is easy to connect to network type of value configuration. As claimed, platforms still may support each of value configuration model separately. In spite of the potential, the current Field service has little or no network effect. We claim that AR enable business opportunities of new kind according to the network value configuration. This will affect the current business strategies of Wärtsilä.

In Wärtsilä's business no network configured business models can be recognized at this moment. Maintenance and repair operations can be arranged in the network model without digital platforms but the management is challenging. Digital platforms provide tools for managing a network. Digital platforms enforce a network structure. Administrative tasks are easier. Due to the platform feature, the AR is easy to utilize in networked environment. AR is one layer in a network.

The AR could open a new opportunity to create completely new kind of thinking in Wärtsilä service business. Services that have been offered according to the value shop configuration can be rearranged to new network service structure.

One solution is using trusted partners network. In the new model, partners use a company providing information for service actions. Wärtsilä still manages information and collect it to databases for quality and warranty use and as well for analysis purposes. This arrangement secure adequate service quality and opportunity to control over the network

members and executions of partners. Wärtsilä earning logic would be based on fees for be the network partners and right to use the required platforms.

AR characteristics are supporting learning and guiding the in work. AR could break the traditional barriers of expertise. That is not the primary goal but enables the better utilization of resources. In the networked model, especially in a multi-sided network a service provider could co-operate with several partners. Several service calls can be executing during the same visit. This would be addition to Wärtsilä's current business model.

Network enables specialized network service providers. Their task would be the process to collect data for different purposes and deliver that to others. Digitalization will add in marine equipment as has already done onshore products like Kone elevators. In the networked models, a company is not necessarily a network owner who administrate and manage it. A company position could be a partner, which creates additional value to network and participates in development or just a user. This leads to ecosystems of new kind. The network structure is not anymore simple between a company, a partner and a client. It is co-operation between different service providers and customers. The ecosystem, similar in Figure 18, is excellent opportunity to gather and combine information for diagnostics and analysis purposes.

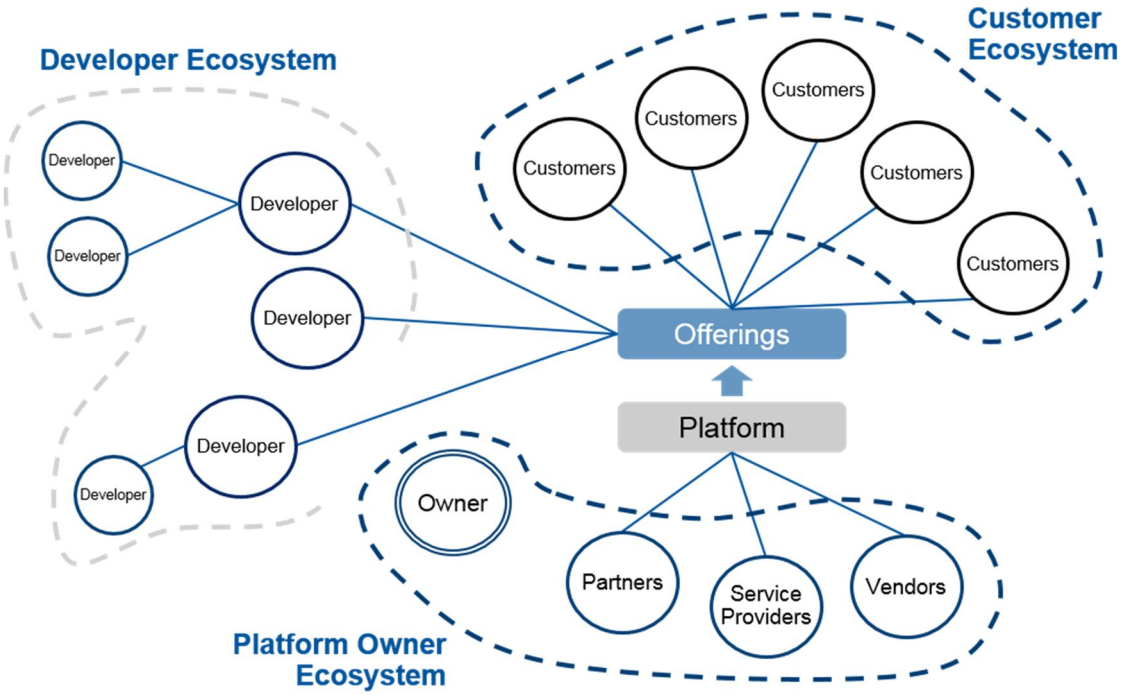

Figure 18 Platform ecosystem. Gartner (February 2016)

AR connection to Platforms

Wärtsilä field services needs applications that manage data collection, manuals, verification duties and tool integration. User interface applications execute user recognition, data transferring and saving. AR is one of the user interfaces. Platform application are easily design on mobile devices. AR tools are one type of mobile solution.

Operation Optimization and Assets Performance products are mixed service products. These products consist of three distinguishing components: data collection and motoring, Data analyses and improvement proposals and procedures. This is according to different phases of the value shop model. AR tools can be used in data collection for further analyses.

A platform can be internal, external or public. Mobile solutions could be the base for the client end systems. Following are listed some benefits using AR platforms.

Internal user	External user
· increase expertise · improve quality · information exchange · support learning · verification of duties	· Check lists · Trusted partner services · Own enterprise · Spare part order management · Self-service trouble shooting · Service calls

External and public platforms are similar, because in both cases a strong user identification is needed. External users may have similar user rights than internal users using platform services.

In case of Wärtsilä Services, AR in internal platforms of service business are supporting the value shop configuration. Use of AR within external customers divides according to all value configuration models.

8.2 Augmented Reality in Field Service process

Field service is according to the value shop configuration model. This part explains how AR will affect in different areas of FSM. The claim is that the AR provides possibilities to improve field service quality and customer satisfaction by innovative technology.

Field Service Managing Process

In the theory part, the field service management is divided into six different sections. Here we have regrouped these six categories into three distinguishing phases according to AR contributions. This classification is based on the effects of the characteristics. In the classification, takes into account the customer value capture that changes over the classes. Following introduces the field service management categories and how AR interact with different functions. These phases are

1) Preparatory tasks, 2) Actual actions on customer site and 3) indirect effects after completed maintenance work. The following Figure 19 explains how the field service process, management theory and the new deviation are intertwined.

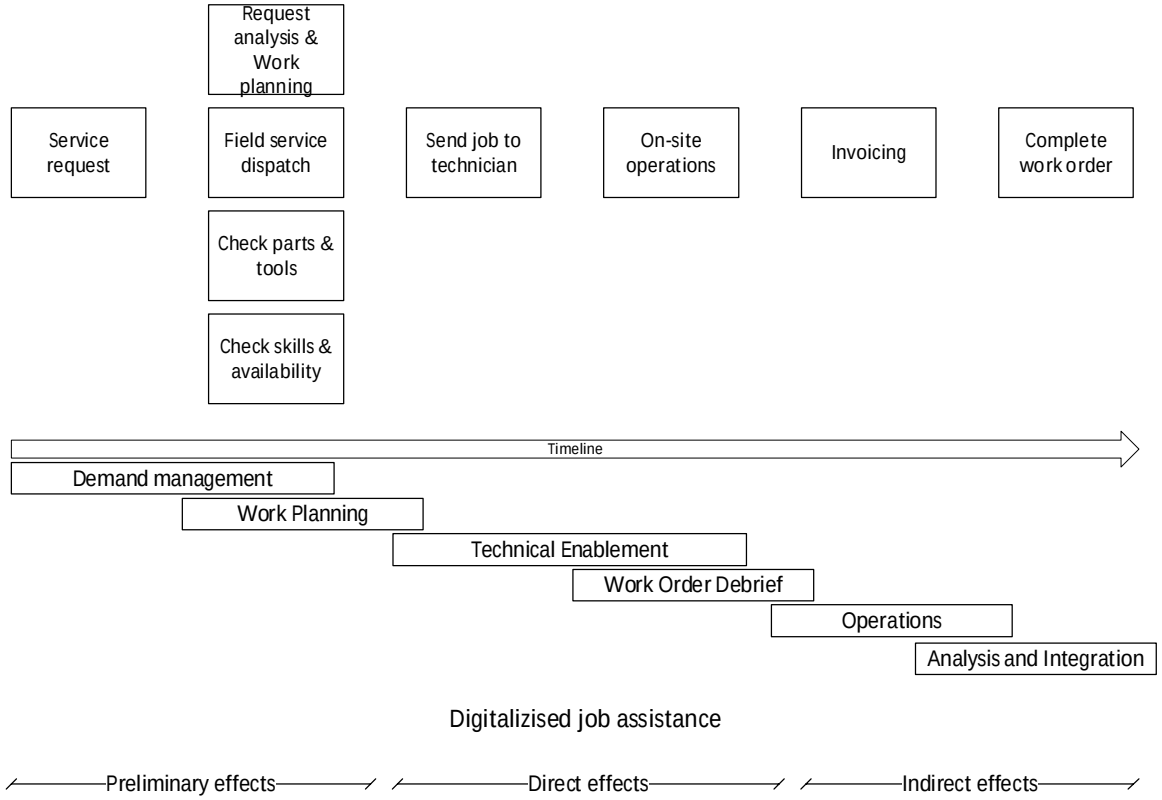

Figure 19 FSM categories related to process and effects to work

Preparatory actions

Preparatory actions are needed to enabling actual work on the field. Preparatory tasks cover Demand Management and Work planning that are introduced in the Section 5 with FSM. This phase has a significant role in a total success of the process. It is planning and collecting the necessary information and material of execution. Preparatory tasks have significant impact on the efficient use of AR tools in practice. Use of AR is not similar than in the actual work.

In marine business, maintenance and repairs can be organized a) during dockings, b) on call of ports or c) at sea. Dockings are preferable advanced planned operations and thus have sufficient time to be prepared well. Excluding regular maintenance, Field service is ad hoc type of on ports or at sea. However, field service operations need good planning and require reserve resources to nominated jobs. Preparation for all possible scenarios is impossible. Presented technicians are the educated guess of needed skills; all possible specialists cannot be nominated to a job. If the time give in, a technician can perform other duties than specified.

AR helps in resource planning and availability. The correct troubleshooting leads to the best solution in work planning. This ensures right resources, correct spare parts and tool sets. It is possible to use AR tools as a communication equipment during problem analyzing. Smart analyst tools can be used in client sites and in service centers. The collected sensor data can be harness to faulty analysis and guiding the decision-making. The actual work planning is done according to collected information.

The current process, defining the needed service work and spare parts is long and multilevel. The information contorts easily in the chain. Would AR tools help straightforward this process? The minimum requirement would be that participants use similar equipment. When AR is available on a client site, ticket request can be clarify more easily.

The logistic planning would be easier with 3D models and virtual environment. With similar tools, it is possible to practice the actual work in advance. If the real environment and the 3D model matching each other, the 3D could be connected as a part of the AR environment. The information stored into 3D model is valuable also on site. This open possibility to execute step-by-step instruction in critical points. Advance simulation speeds up actual work procedures. These actions shorten work time and improves resolution times. This is the good example of merge reality, the blurring line between AR and VR.

On the planning phase, the common tools with the customer and the provider increase the customer commitment to use proposed spare parts. Best of all, with the use of AR could be solve a customer's problem without a service call. These will increase customer satisfaction and willingness to use OEM parts.

Direct actions (Actual field service)

Direct effects indicate that made actions contribute directly with a customer's problem. Here AR impact directly to FS work performance. In FSM theory, this covers Technical Enablement and Work Order Debriefing phases. Use of AR influence directly to Technical Enablement and Work Order Debrief phases.

AR benefits are directly recognized in field service maintenance and repairs work. Furthermore that AR tools improve effectiveness in workflow it also streamlines processes, thus it has LEAN effects (Hines and Rich, 1997). Use of AR can remove useless phases and unnecessary waiting. Improved effectivity and streamlining strengthen and speed up the cycle of primary process according to value shop configuration. With the AR, existing resources can be utilizable better and effectively, which is as well according to value shop objectives.

AR influences to supplementary times that are described in LEAN method thinking. AR tools help in reading and following instructions and manuals and as well, make saving the work related recordings more easier. These executions can be merge part of the normal work procedures.

Absolutely troubleshooting is not able to made in advantage, because of complicate causes and available preparation time, a final troubleshooting may stay on the technician shoulders. A present technician skills and experience are not always reasonable alone to find problems. A technician should get help immediately to proceeding. AR supports collaborative working and problem solving methods. A more experienced colleague can help and give "hand-held" advice in work. Similarly, collaborative features can be used in the troubleshooting.

Executing services in the field is opportunity to learn in practice. Junior technicians have to practice in a field for collecting experience and increase expertise. In the marine engine field service, a customer invoicing fundamentally based on the skillful logistic arrangements and, in the last, the technicians' skills. Currently, learning happens with the assistance of senior technicians by working as assistance. Thus, the efficient use of resources is not arranged the most profitable way. With the quality, preparation of work and

troubleshooting even less experienced junior technicians would be used in routine operations. If work instructions did not cover all things, the assistance of a senior technician would be available on request with AR equipment.

Indirect effects (Post service operations)

In Indirect effects phase, actions contribute indirectly to an actual customer problem solving. AR is not used in the post operations. AR has indirect effects on the total performance, positive impact on productivity and quality. Some of those can also archive with other methods. Indirect effects are improvements in process quality in actual work and in merged routines. Collected information can be used to spare parts management, analysis and billing.

The most significant impact will be to quality of invoicing material to the customer. Necessary information is easier to collect in the following reasons: a) material is in digital format and b) the process “forces” technicians to delivery all necessary information. Thus, a needed information to an invoice is not postponed by a mailing of necessary data. The waiting of information postpones invoicing and income of receivables. According to Wärtsilä balance sheet information (2016), a one-day receivables cash effect is about 1,7M€ (Appendix F) in Services business.

There have to notice also that use of resources in post operations are the same that are needed in the preparatory phase. Releasing time from the post operation can reinforce preparatory actions that have positive effect on the success of actual operations.

The collected information enables automatizing the spare part sale. Installation information combined with sensor data is more systematic. The customer service history and the user behavior can be added to supplement the customer profile information. A customer can benefit from analyzed information, this increase value capture that returns by increased revenue and/or customer loyalty.

8.3 AR Framework in case of Wärtsilä

In Section 8.1 were discussed AR impact to the value configuration models. Observations and assumptions from are collected into Table 3 according to different value configuration models. This table summarizes impacts on the company value configuration that was the first research question: How AR impacts to the company value configurations?

Table 3 AR impacts to value configurations

Engines	Field services	Digital services Service networks
§ Digital features to offering § Increase desire to products § Increase engine base § Increase customer satisfaction § Bundle warranties to life cycle management § Prolong use of OEM parts § Increase OEM selling	§ Support learning § Reinforce knowledge and skills § Increase asymmetric § Speed up problem solving cycle § Self-service possibilities § Additional services	§ Enable new business models § Field service licensing § Ties Trusted partners to network § Service ecosystems with other providers § Connect analysis platform and diagnostics § Base for client end systems
Augmented Reality Platform		

Analyzing the previous table we make following conclusions: Because AR is a digital platform tool, it can be present in all value configuration models

Value chain	Increase a product value directly or indirectly
Value shop	Strengthen asymmetry and speed up problem solving
Value network	Open new way to arrange business and revenue possibilities

The findings of Section 8.2 are collected into Table 4. It shows how different phases impact on improvement of value stream of the field service process and explains AR impacts to improvement of FS business in different phases. This answers to second research question; How AR impacts to field service processes? It is closely connected with the Value Shop configuration model.

Table 4 AR impacts on Field service process

Preparatory	Direct	Indirect
§ Easier problem analysis and resolution § Possible customer made resolutions § Reduce advance visits § Speed up resolution process § Easier resource managemant	§ Modularize service procedures § On-Site assistance § Enlarge work possibilities § Additional works § Verifications	§ Speed up billing process § Improve document handling § Better data from processes § Preferable analysis

In Chapter 1 we introduced the framework for developing the theory. The theory was built on the assumption that using AR technology in Wärtsilä diesel engine field services has larger impact to business than just single improvements in work performance.

In the Figure 20 is explained complimented framework, where AR impacts to value configurations are presented as a business advantages and AR impacts to field service process are presented as a novelty classification of effects.

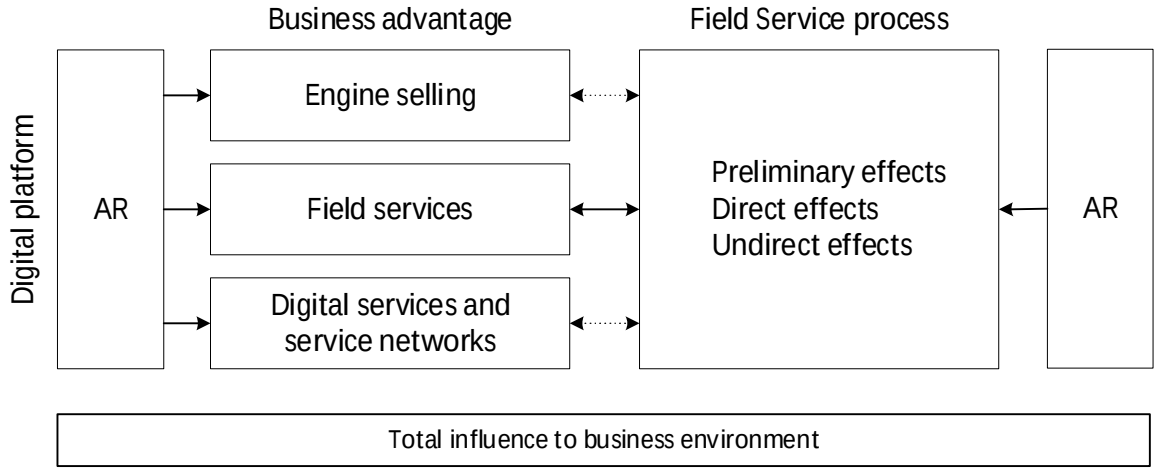

Figure 20 Framework: AR in Wärtsilä field service

8.4 Limitations in case of Wärtsilä

The third research question concern limitations to implement AR to practice. Here is listed some of issues that rise up from the practice and from the theories.

At this moment, exist a few shelf available AR applications for field service purposes. To get the best advantages of AR, these applications needs integrations to other applications.

Marine environment is challenging in properly working digital information communication. Smoothly operating AR needs reasonable swift connections for short latency time. Especially with HMD, the augmentation should be almost real time and stay with the movements of the user's movements. New digital working methods and related applications have challenge to win the user confidence and a positive first experience.

Encountering non-working functionalities, among the existing resistance to change arise negative experiences and unwillingness to use equipment. Equipment should operate properly independently in offline mode. Data transfer between servers and equipment could be organized such a way that it is not disturbing working. In marine environment, there are two challenges in data transferring, proper functionally internal networks and sufficiently speedy connections between a ship and outside world. In the TV example, the theory part the communication is not interactive, few seconds delay in a moving picture between camera recording and augmented content in broadcast is not a problem.

When selecting technologies into practice, the security issues have to take into account. In evaluation, with the benefits, also the risks and treads have to take into account and these should be manageable. Similar to users' acceptance, a wearable and mobile technology implementation can fail to functionalities, social and physiologic reasons (Taylor and McInture, 2017). Information security, especially camera recordings in industry secrecy and privacy protection are crucial. The user identification has to arrange reliability, especially when saving data to records.

In common, HMD release hands to work on both hands and thus improve work safety, it is not clear how HMD and prescription lenses can use together and how well these work in variable environment conditions. Can HMD substitute protective goggles, when needed?

Improperly working technology can not be reason to abandon works. Alternative methods and procedures have to define although that working would be slower. Solving this problem, could be benefit for the total process flow and procedures.

Implementation of a new technology is not trouble-free. Perhaps, the implementation of new technology to organization is one of the biggest managerial problems for solve. One

of the biggest problems is human resistance to change. Resistance of change is encountered when technologies change and new ones emerging (Venkatraman, 1994). Unwillingness even to try new technologies, especially if the current workload is challenging to execute existing duties properly according to schedules. This phenomenon exists already with the FS mobility application. Lack of conformity to internal and external platforms exists, if the platform is not ready and do not work properly while introducing, a threshold to abandon it reduces to low, instead of eagerness participating to develop and improve it to a working tool. Wärtsilä Services are already introduced FS Mobile application to the use of technicians. It would be better to implement new methods gradually than in giant leaps. Adding AR to FS Mobility functionalities step vice could be a proper procedure.

Finally, There exiting the general IT worries. FSM projects are complex and changes happens in software, administration reporting, roles, hardware and processes. This needs visible support of the senior management in the visions and justification (Robinson, 2016). FSM covers also other disciplines than IT and service. Although that FSM project targets are in specific improvements, there is lack of understanding in an organization that improvements have also the positive impact of their metrics. Financial, supply chain, sales and customer teams have to engage in projects and goals. (Robinson, 2016)

8.5 Estimating potential

When preparing decision making and choosing proper development areas, business decisions should base on facts. In this research have arisen two different areas a) internal benefit and b) external business opportunities.

Measuring internal benefits

A new technology implementation can be justifying with economic measures or with an increasing revenue and/or profit expectation. This thesis has objective to study possible positive impacts on company business. The following Figure 21 shows how Nguyen et al (2017) see how to define measures for AR deployment.

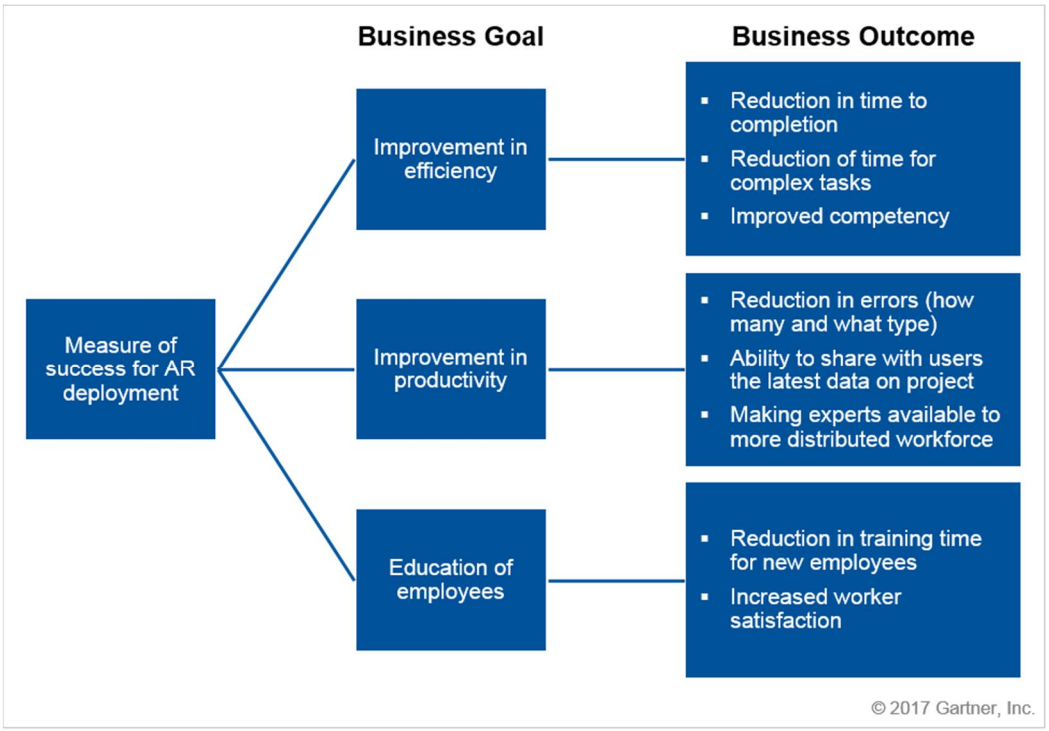

Figure 21 Successful AR deployment measurures. Gartner (September 2017)

With measures can evaluate areas where the best improvement potentials are. Here are listed measures, which should take into considerations to follow

List of measures to follow:

- Problem resolution rate
- Technician to customer time
- Billing time
- Customer satisfaction
- First technician rate

- Working time
- Extra billing work
- OEM parts selling to work
- Re-repairing rate
- Work quality measures
- Average receivable turnaround
- Solving at first time
- Logistic side times
- Work accident rate on-site (ext. impropriate accidents)

Business potential

When AR based services are offering to customers this also brings the question; what kind of an earning model should be? At the initial phase, interest about new technology implementation is high; this is not necessary lead to investments or buying decisions. A service or product provider often end up a sponsoring role for attracting join users. This kind of phenomenon appears especially with network solutions. After a reasonable user base, a critical mass has been reach for profitable business. Then also other service providers became interesting in new business opportunities.

List of potential business areas:

- Offer new features for customers (value add)
- Adding digital features to offering (hook customers to DS)
- Field service licensing (service concept)
- Platform provider for trusted partners
- Data analysis and visualization
- Connecting Field service operation documentation to warranties

A new type of models are challenging. Similar, the technology development is fast and new innovations come to the market at rapid speed. Models that based on digital technology platforms, a company's own resources and knowledge are not necessary sufficient to execute a change project. The risk is that a final result of a long lasting project is outdated. To avoid this pitfall, the project is divided with technological partners to speed up entry to markets. Speed up the development process, in the literature is presented use the open business model (Chesbrough, 2007). Digital platform business models have essential characteristic of layered structure and co-creation with open business models (Eisenmann et al, 2008). This

arrangement also possible new business opportunities; licensing, new products and divest income. Figure 22 explains how the company could benefit when it use open business models.

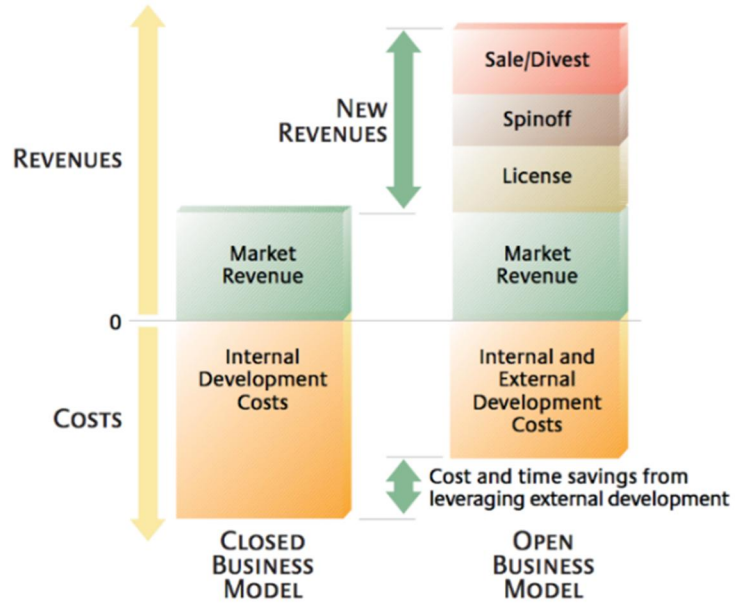

Figure 22 Open Business model advantages, Chesbrough (2007)

Rules and procedures have to be streamline. Grover and Kohli (2012) have presented four different layers in a multi-firm IT initiatives.

- Relation specific asset (Common platform)
- Complementary resources and capabilities (Dividing skills)
- Knowhow-sharing routines (information exchange)
- Effective governance (common policies)

Vast organizations based on the old structures have difficulties to change according to multi-firm environment. This supports a start-up thinking with new business models.

LeHong (2016) describes six ways to that company can create digital based revenue. Following Figure 23 shows, what these possibilities are and how these situated to each other's. Each option present separate transformation intensity level. Less transformative digitalization is easier to adapt to existing business model.

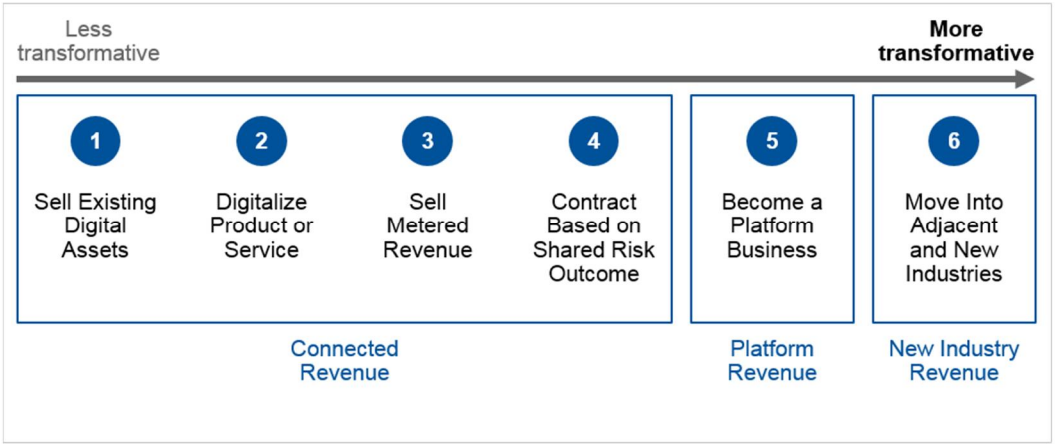

Figure 23 Change of business with platforms. Gartner (2017)

In chapter, where Wärtsilä's existing business and services are described, can be found easily similarities to first box alternatives. This assert interpretation that platform type of business model would be next step in continuum.

8.6 Implementation

Define roadmap

A full-scale deployment of AR might be difficult for several reasons. The main reasons are the organizational resistance of change, integration to other platforms and technological barriers. After building the vision of the goals, the management have to create a roadmap how different parts are depending on each other's and how to follow the progress. Instead of one project, the progress could be continuous processes of the small phases of constant development. Focus first on pilot projects that facilitate learning, then later technology integration and testing and finally deployment (Balu et al (2017).

Ecosystems

Platform network forms an ecosystem of different players. In the network, there are many different roles. Each of participating company has to decide what kind of role they take. In the case of Augmented Reality, the main user is a dominant player. As an early adaptor, the role might be more centric, but after the maturation stage, ownership could change more towards to a partnership role. The way of co-operative development and actions need to be determined.

Establish internal start-ups

The new method of working may be difficult to be merged to the traditional business and organization. In AR, particularly revenue models that based on licensing might be difficult. The new business still needs old business for support and perhaps the old business should be rewarded from a success of the new business. Because of the novel thinking, a new business should be organized in a manner that resembles a start-up company. This kind of arrangement would ensure sufficient fresh thinking. Later these start-ups could be merged together with other organization or spin-off.

When implementing new business models into a company, one possible approach would be to build an internal start-up. These start-ups could exploit the existing knowhow and contacts of a company. A start-up needs reasonable amount or resources to survive.

8.7 Conclusions

Merge Reality (MR) solutions, what AR present, will rise up in following five to ten years. Digitalization in blue-collar work will increase. Digitalization has an advantage, it provide possibilities to streamline and swift processes easier than many other improvements methods. AR enables many benefits to be realized simultaneously. The effects are not only improvements in internal processes; furthermore, there are several possibilities to extend existing business to new paths.

AR has a lot of potential. In the field of a field service, this potential maybe bigger than any other source of development. The main advantages, interactivity and capability to increase consciousness, rise AR to a podium position.

Augmented reality provides possibilities to improve field service quality and customer satisfaction by innovative technology. Even if it does not provide possibilities for new businesses, it will be in an important role in future to improve existing maintenance and repairing functions and make it more desirable and efficient.

Evidences show that AR could streamline field service operations. This release resources to work preparation and to actual field service with the result that efficiency increase. Improved invoicing routines speed up billing and shorten receivable turnover. Money release to into to cash.

The company has already introduced the mobile tool of the field service management, FS Mobile. This is a good base for further development. All AR features will not function on current FS Mobile environment. The main reason is that some AR solutions needs high computing power and available memory. On the other hand, development is fast and OS providers Apple, Google and Microsoft have been launching new development tools for AR, which would indicate that in future more development is anticipated.

AR technology is not competing with the company is other digital platform offering. Rather AR supplements the current functionalities of platforms and vice versa. Especially this linkage exists with Guaranteed Asset Performance and the Optimised Maintenance Services. Linking AR to these platforms could increase the value capture.

AR will open new business opportunities especially in networked service practices. This is a network of trusted partners and service co-operation with the other marine equipment manufactures. As well, customer interest to use interactive manuals and checklists.

8.8 Future research

Important research area is to estimate numeric values of benefits. One of the most difficult measures will be valuating customer satisfaction and the impact on sales and revenue. A correlation of the other indications to customer satisfaction should be estimated in another research.

This research does not perceive different available technologies and differences between those. It is clear that some technologies suit better to certain tasks than the others. One technology might be suitable for the specific business objectives than the others. Further research would be calculating a set of applications where the economic impacts are the highest.

An excellent area for further examination would be new network configured business models. There are so many ways to organize the business and define the business model. This type of a study would support managerial implementation.

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Appendix A: Near and Long Term Initiatives

Near term Initiatives

Capacity	Description, benefit and challenges
Remote technical assistance and oversight via telepresence	A senior technician, supervisor or other support person in a different physical location guides a less-qualified technician, subcontractor or customer resource through appropriate repair steps, and visually confirms the results. **Benefits:** New technicians can be in the field alone sooner; fewer trips require a technician to be physically on-site and quality improves through inspection. **Challenge:** Remote technician workflows using HMDs are ill-defined — businesses will need to work independently or with advanced solution providers to best determine those workflows and user experiences, or learn by doing.
Photo and video capture – job recording	Technicians capture photos and video of the site and equipment conditions using the head-worn camera at arrival and again at completion, without removing hand protection or carrying additional devices. **Benefits:** In industries such as utilities and healthcare, among others, video reporting supports compliance and reduces billing questions while also improving transparency and efficiency. **Challenges:** Indexing for fast search and secure cloud storage carries additional costs, even when the software handles the transfer. Privacy and security constraints for certain customers will require training on specific protocols.
Photo and video capture training	Technicians capture video while making repairs. Video clips are edited and reused for training others in classroom or computer-based training modes. **Benefits:** Training with real-world examples is more effective and speeds up comprehension. **Challenges:** Editing and curating the video will require resources. Some companies may achieve only minimal benefit over handheld recording options.
Read QR codes automatically	The HMD automatically recognizes a QR code or bar code using a built-in camera, and uses it to retrieve or capture information about equipment or parts. **Benefits:** Technicians no longer need a handheld scanner or camera phone to access information, and can automate authentication with secure QR login (SQRL). **Challenges:** Accuracy can depend on lighting, angle and so on.

Contextual handsfree work instructions and check list	Technicians receive visual, step-by-step instructions and can complete checklists using voice commands as they work through a repair. They follow a semitransparent visual overlay usually toward one side of their field of view. This overlay directs them to where their next physical activity should occur and provides animation that depicts what will happen as they perform the task. **Benefits:** Technicians can get instruction while using both hands without leaving the work area to consult a manual or handheld device. This improves efficiency, safety and learning. **Challenges:** Transparent HMDs have relatively small screens, limited pixel counts and narrow fields of view.
Speech-to-text and voice commands	Technicians use voice control to fill in forms they see via the HMDs or to access proprietary knowledge base articles, training and repair history, as well as public or manufacturer-supplied operations and maintenance videos. **Benefits:** Avoids the need to remove hand protection or other safety equipment, which improves efficiency. **Challenges:** Speech recognition may be inaccurate depending on language, accent, ambient noise and so on. Editing may be required.

Long term initiatives

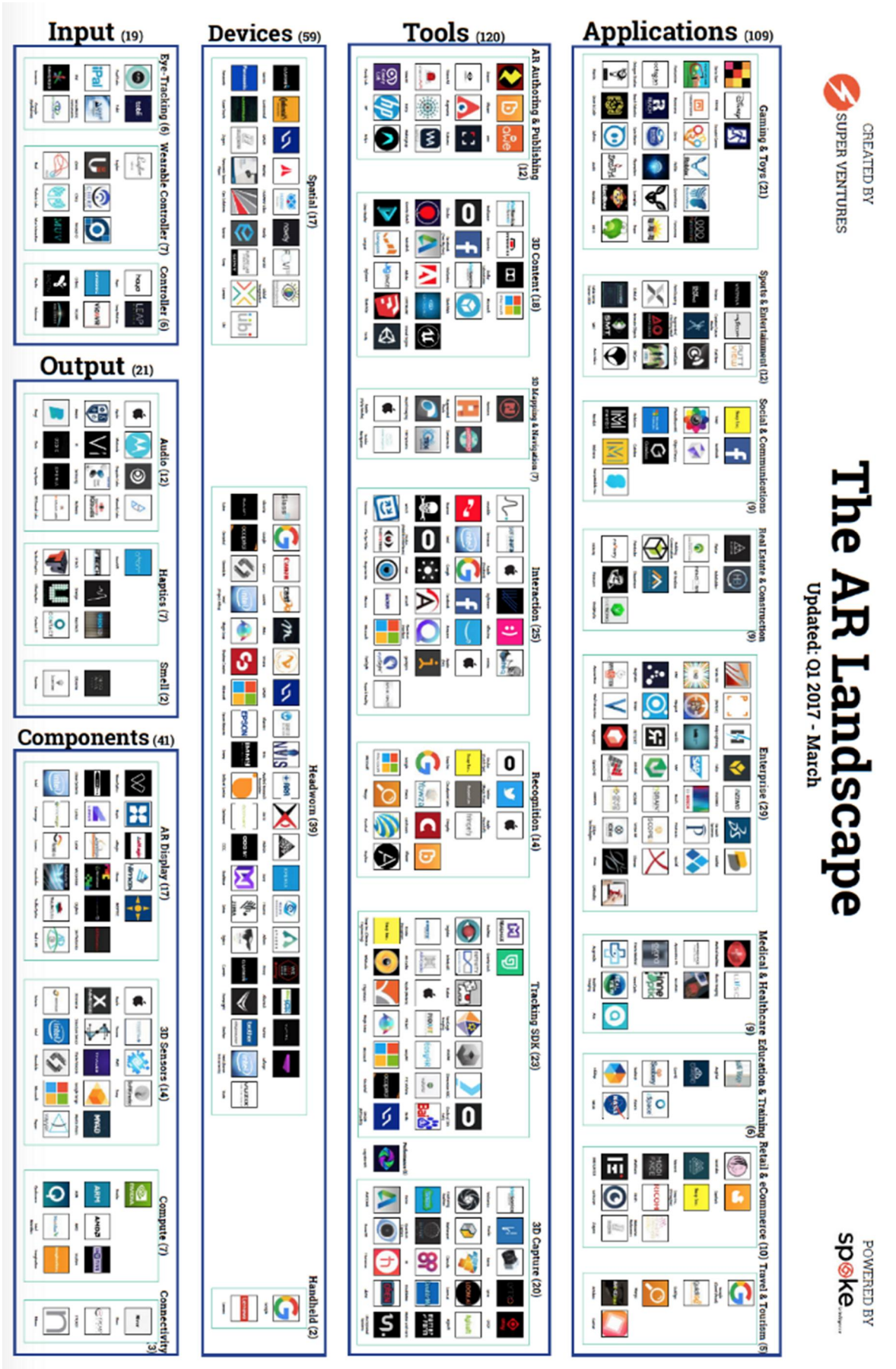
Capacity	Description, benefit
Environmental sensors in the HMD	A technician can see a visual map of temperature gradients through an HMD. Additional sensors, such as for carbon monoxide, can also be integrated into glasses. **Benefits:** Can warn of hazards such as excessive temperature behind walls or cowling.
AR-Hidden structures	With integration to GIS, technicians can "see through walls" to visualize the infrastructure hidden inside them. The visual overlay may be sized and docked to the physical equipment they see, and informs them via arrows, transparent schematics or animations. **Benefits:** Technicians can quickly assess the best path forward and level of effort without shutting down the equipment.
AR-telemetry data	Technicians can see values being logged by sensors in real time through the power of the Internet of Things, even if gauges or fault codes are either hidden from view or retrievable only with specialized tools. **Benefits:** Technicians get a better picture of the current situation and effectiveness of their repair with fewer tools.
Object recognition	Technicians retrieve information about equipment or the location of parts by using the camera on the HMDs to match an image of an object with photos of it in a database. Inventory database automatically updated. **Benefits:** QR code or bar code not needed on object in order to access information
Simultaneous localization and mapping	Technicians arriving on-site are directed to the exact location of the task via HMDs. With technology such as Google Tango, the camera and activity sensors on the HMDs measure the distance between objects at a job site, creating a virtual map of the facility. **Benefits:** Technicians can be self-guided through facilities, and their location monitored with alerts and timers when in a confined space or exposed to a hazard.

Appendix B: Measures for Augmented Reality in Field Service

- First time fix rate
- Mean time to repair
- Total repair time
- Speed to repair (based on best-practice methods)
- Employee training time
- Customer satisfaction
- SLA achievement rate
- Remote resolution rate for repairs not requiring parts
- Compliance audit success
- Quality
- Mean time between failures
- Billing complaints
- Day sales outstanding
- Employee satisfaction
- Tracking of parts inventory
- Safety
- Improved process (qualitative measure)
- Time to diagnose
- Cost of diagnosis
- Outage duration
- remote resolution rate for work orders without parts required

Source: Gartner (2016)

Appendix C: AR Landscape



Appendix D: Field service scheduling rules and business goals

Schedulling rules

Technical Rule	Description	Consequences If Broken
Currently on shift	Work must be scheduled during the technician's normal day.	Overtime costs Breaking regulatory rules for rest requirements Technician could miss normal hours
Certified on equipment	Only send technicians with appropriate skills, licenses and certifications for the work.	A law could be broken Potential injuries on-site
Technician or site has the required parts available	If the required parts are known, validate that they are available before dispatching a technician.	Technician may have to leave the site to retrieve parts or the work may have to be rescheduled, decreasing the first-time fix rate
Avoid overbooking/double-booking	Technician cannot be in two places at once (there are some use cases that intentionally violate this rule).	One or many jobs will not get completed
Only book technicians who are assigned to the service area	Technicians are assigned to geographical areas close to their starting point in order to align to expected demand and minimize return-trip travel.	Long travel times for return trip
Do not send technicians without a helper technician	Work is only assigned at a time when the lead technician, as well as a crew or helper technician, are available.	Job may not get completed Technician may get injured trying to perform work without assistance from crew or helper

Source: Gartner, 2017

Business Goals

Business Goal	Description	Consequences If Ignored
Achieve SLA commitments	Give priority to work for which the organization has guaranteed arrival times	Penalties for missed SLA guarantee More difficult to sell SLA contracts that are not met Lower customer satisfaction rate
Use soonest-available technician for task	Use the technician that can complete the current job and become available soonest	If only proximity is considered, then current jobs might be left incomplete unnecessarily
Use closest technician	Minimize travel by using the technician that is geographically closer (all other attributes being equal)	Long, unnecessary travel times
Minimize equipment out-of-service time	Start with work where equipment is currently not operating	Longer equipment outage time and potential penalties if uptime is a contract entitlement
Minimize overtime (before or after shift)	Do not assign a job when it is improbable that the technician will be able to complete it before the end of their shift	Increased cost due to higher hourly rates, which cannot be passed on to the customer
Preferred or nonpreferred technician	Send technicians to work with customers with whom they have had a positive experience	Customer may be scheduled with a technician that they are biased against Lower satisfaction scores
Avoid long gaps in schedules	Either allow technicians time off or fill their schedules with low-priority work when there is unscheduled time between work	Increased unproductive time Lost revenue Missed training opportunities
Perform nearby planned work	Seek other work in the area when technician travels to a remote location	Increased average travel time
Allow/disallow overbooking	If cancellation rate is high then overbook; if added unplanned work is high then underbook	Missed committed jobs due to lack of schedule flexibility
High-profile customers first	Customers are prioritized based on, for example, the revenue generated or strategic nature of the relationship	Visible failure Bad press
Balance workload across all technicians	Consider underutilized technicians that may not be the best fit but that may have more availability	Missed learning opportunities and on-site experience Senior technicians already committed elsewhere when critical work arrives in the queue

Source: Gartner, 2017

Appendix E: Questions related to Wärtsilä Marine deliveries and service business

Services are relating to diesel-motor delivery according to the value chain model adding value as the part of the chain. The product service functions are maintenance or upgrading.

- Which kind of services provide to customers. What is the purpose in this context?
- How the services relate part of the project marketing
- Which kind of marketing activities to the services are addressed
- Are there possibilities to charge from services separately or bundled to delivery?
- What kind of partnerships is used in offering
- What other companies participate in the value chain
- How the interfaces manage
- How Wärtsilä's position in the services compared to other engine manufacturers within different customer and product segments
- How important are production costs and economy of scale related to offering

How Wärtsilä has been developed Services into strategic business?
How long the process has been taken? What are the biggest challenges in this process?
Are Services part of the product value creation or rather customer's problem solving service?

According to the value shop model, the most recognizable characteristics are problem solving to custom, reducing total costs of use and improving customer's operational effectiveness.

- which kind of
- How customers can collect additional value from Wärtsilä Services activities
- The characteristic of the configuration model is information asymmetry, what are the recognizable parts
- How the services are prices?
- Is the modus operandi different from the competitors
- How the problem solving is coordinated internally and externally?
- How the solution value relates to costs?
- How the continuous learning supports with previous solutions and information asymmetry reasserts?
- How in Service is observed specializing
- How are the key employees?

Adding digital services to current services can lead to value creation according to the value network configuration model. Value creation bases on connection and use of similar networks between the customers. In this model, basic idea is join in a club, where approved members supplement each other's. A company is part of the network or it is the network owner. A network would be group of virtual expertise services, common product management tools.

- how this kind of services could possible materialized as a service?
- who will be the possible network operators
- What thoughts this kind of model arise?

Prepared questions for Field services

What kind of services are offered to customers with new installations
Service's deal from an entity and pricing
possibilities to charge services in an installation
Relative value of diesel installation from a ship value

Field service role in a new installation, bundled or independent service
Compared to competitors

Improving knowledge and technicians training
How important is improving productivity
AR-tools in training

Field Service Management
Overlapping service calls
Preparation to service calls. Demand and work planning

Monitoring services impact on field services
How you will see possible common platform

AR as a resource balance tool
Assistance in improving learning
Billing
Quality assurance and verification

Prepared question to platform development

Internal/external customer
Creating roadmaps
Building digital technology platforms
challenges
Status of FS mobility

Value network model
primary activities
promoting networks and contract management (marketing and contracts)
Service offering (connection establishing, maintenance and cancellation)
network infrastructure operations (service operation)
Secondary activities
development of technology and definition of new services

Access right, connections to company architecture

decision to join public network as a service provider

Prepared questions for Arctia

How IoT contributes to product selection?
How do see importance of difference between own and external remote controlling?
What kind of benefits are possible to find from AR-tools

- in training
- in service processes
- in verification

How much activities are this moment in other suppliers
What would you think about common platform tools with other actors?
“Social maintenance support”?
How the Internet access function on board?
Are the available wide bands enough for proper connections or should equipment operate in off-line mode?

Appendix F: Calculation of day based Cash effect

Used values from financial statement of Wärtsilä 2016 in M€

Total revenue	4801
Services revenue	2190
Receivables from sales	1220
Equity (E)	2321
Debt (D)	520+108=628
Interest and other financial expenses	31
Wärtsilä β, (Reuters, 12.12.2017)	0,66

$$Avg\ receivables = \frac{Receivables}{Total\ Revenue} = \frac{1220}{4801} = 0{,}2541$$

$$WACC = \frac{E}{E+D}R_E + \frac{D}{E+D}R_D(1-T_C)$$

US treasure 10Y = 2,38 % (12.12.17)

S&P 500 (2016) = 11,9 %

$$R_E = RiskFreeRate + \beta * RiskPremium = 2{,}38 + 0{,}66 * (11{,}9 - 2{,}38) = 8{,}66\%$$

$$R_D = (1 - TaxRate) * MarketInterest = (1 - 0{,}20) * \frac{31}{628} = 3{,}95\%$$

$$WACC = 6{,}82\% + 0{,}84\% = 7{,}66\%$$

One day cash effect

$$= One\ day\ interest\ effect + one\ day\ receivables$$

$$= \frac{WACC}{365} * Revenue * Avg\ receivable\ ratio + Revenue * Avg\ receivableratio\frac{1}{365}$$

$$= \frac{1 + WACC}{365} * Revenue * Avg\ receivable\ ratio$$

$$= \frac{1{,}077}{365} * 2190 * 0{,}2541 = 1{,}64 M€/d$$