Servitizing Company X

An assessment on service strategies and service design

Bachelor thesis report
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Preface

This research is my bachelor thesis at Company X to complete my study program Industrial Engineering and Management at the University of Twente. During this research possibilities for servitizing Company X are explored. Afterwards a service strategy for Company X will be developed.

I want to thank first supervisor and second supervisor from Company X for their insights and guidance through this research. I would also like to thank the manager from Digital Business for his support.

From the University I want to especially thank my second supervisor Rogier Harmelink and Jos van Hillgersberg for their support and feedback on the conceptual versions of the bachelor thesis. Furthermore, I would like to thank Jos van Hillegersberg for the opportunity to work on this bachelor thesis within the MARCONI project.

Management summary

This research is performed to find out what Company X's strategy should be in terms of servitization. Here we will summarize the results of the research and give Company X recommendations on how to servitize their business.

Company X knows they need to servitize their business to be less dependent on building ships and to satisfy customer demand. In this process of servitization we saw several problems at Company X. The most important problem is that there is no clear service strategy. Together with a lack of collaboration between Digital Business and Asset Services this led Company X to develop IRIS which did not satisfy customer demand. This is clearly showing because customers do not use the IRIS tool Company X developed. To solve this problem, we developed a service strategy which should help Company X to satisfy customer demand in terms of services and establish a new reoccurring revenue stream.

We started by looking into examples in literature about servitization in industry. Baines et al. (2009) describe how Rolls-Royce servitized their business and why. We used literature which helped us understand what the motivations are for companies to servitize their business and how the process of servitization works.

To find out which different service strategies exist we used theory on service strategies by Ebeling et al. (2014). They identify four different external environments which are connected to different service strategies. One of these service strategies will be chosen based on research within Company X and be modelled.

After evaluating the different service strategies, we chose the service strategy of the after-sales service provider. This service strategy fits well for the Dredger customers and we identified that Company X is not ready to offer complex services to larger customers yet. Also, the higher volume of Dredgers is favourable for scalability. The after-sales service strategy can also be a good stepping-stone towards servitization with larger customers.

The chosen service strategy consists of providing spare parts, basic training, hotline, repairs and inspections. Many of the individual services are integrated with each other which increases the value of the total service offering, this is described in ArchiMate in figure 13.

We advise Company X to install sensors on Dredgers and fix their sensor data storage problems as soon as possible to ensure they have reliable data they can work with. While doing this the core services in the service offering should be set up for commercial use which consist of providing spare parts, basic training, hotline, repairs and inspections. Then Company X could start looking into possibilities of condition-based maintenance and preventive maintenance.

We advise Company X to use the IRIS dashboard tool for internal use at the hotline. There it can be used to do quick remote diagnostics for customers which want to make use of the hotline. In IRIS, visualisations of data regarding common problems can also be viewed and analysed for all kinds of uses like product development or improving training courses.

After implementing the service strategy, Company X has created a new constant revenue stream. This makes Company X more stable during difficult times during which customer order less ships. It also gives Company X the incentive to enable the customers to have high production and focus on their core

business. This is a better incentive than building as many ships as possible against the highest margin. This does not motivate Company X to innovate as much and does not fully satisfy the customer.

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1. Introduction to Company X

Company X is one of the two largest manufacturers of dredging ships. It is based and founded in The Netherlands, has a workforce of more than 3000 employees and a revenue of €800 million in 2017. A predecessor of Company X, shipbuilding company Smit was already active in the 17th century. Back then they were already building dredging ships. Now they are building standardized ships as well as customizable ships which are used for offshore, dredging and wet mining. These ships range from 20,5-meters length standardized Dredgers to 164-meters customizable hoppers.

The ships produced by Company X contain many components that require maintenance in order to keep the ship operational. This maintenance could for example be replacing the blades on the cutter or cleaning the cooling system. If the blades are not changed regularly the dredging efficiency decreases and if the cooling system is not working properly this can cause the engine to overheat and thus the ship needs to stop operating.

Currently there are maintenance schedules for each ship being made based on in-house experience. The customers are advised to execute this planning to ensure the product works properly. This is especially important for the smaller customers because they do not have as much experience using this equipment as the larger customers do.

The most important revenue stream for Company X right now is building the dredging ships. Company X wants to explore what services they could offer with their ships. Offering services with their product would give additional unique value and would create a constant revenue stream. This bachelor thesis will focus on exploring what service strategies are applicable for Company X and provide an enterprise service design for the chosen service strategy. During the research we will primarily be in touch with the asset services which process claims, provide spare parts to customers and do on demand condition-based maintenance (CBM) and digital business which is developing solutions to provide digital services to the customer. A simple organization chart is shown in figure 3. Digital Business is directly under the CEO. A more elaborate organization structure is included in appendix A.

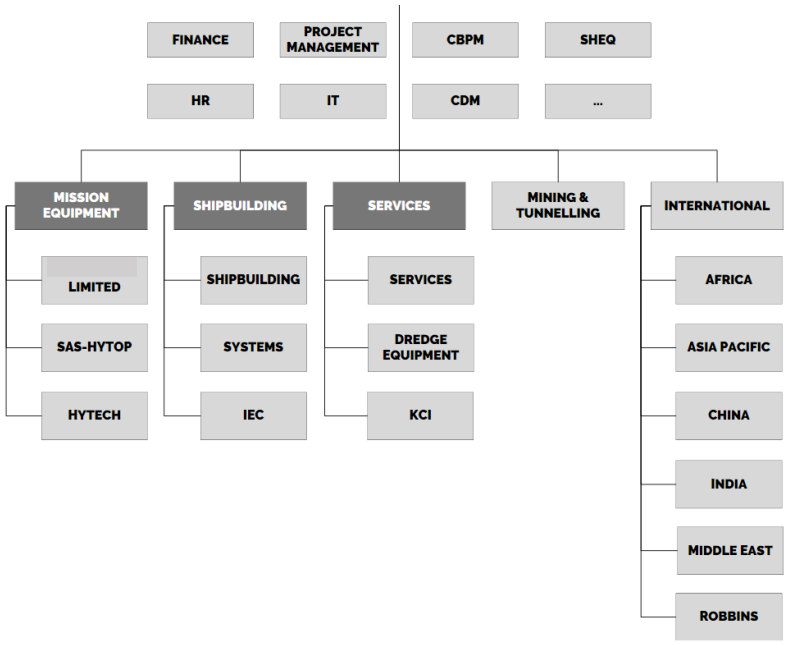

Figure 3. Visual representation of departments at Company X.

1.1 Methodology

In this research we will be following the Managerial Problem-Solving Method (MPSM) from Heerkens and van Winden (2012). This will help us identify the core problem and identify a suitable solution for the found problem. The MPSM consists of seven stages. The stages are listed below.

- Problem identification
- Problem solving approach
- Problem analysis
- Formulate solutions
- Choose a solution
- Implementation
- Evaluation

First, we will identify the problem which will be done in 1.2. From this problem we will define a problem-solving approach in 1.4. Here we will set up a research design which will help us solve the core problem we defined in 1.2. Then we will analyse this core problem. Where does the problem come from? When we know where the problem comes from, we can start formulating solutions based on a literature framework in chapter 2. Afterwards we choose one of these solutions in chapter 3. Normally we would implement the solution however Company X is such a big organisation and this research is part of a bigger picture within Company X we cannot implement our solution. Nevertheless, we will work on a plan to implement the solution we will choose in chapter 3. Because there is no implementation during this thesis, we will not be able to evaluate the results of our solution. But we will constantly evaluate the quality of the solution with the employees at Company X to optimize the solution design.

1.2 Problem identification

Here we will identify what the problem is at Company X by using the MSPM. To do this we use a problem cluster which is shown in figure 4. The following analysis is based on interviews held with employees at Company X. The group of interviewed employees consisted of the manager of Digital Business, senior asset manager and other employees from services.

Customers of Company X want their ships to have a high up-time. Every minute the ship is not operational the customer loses money. To achieve a high up-time, customers need to do regular maintenance on the components. If the customer does not know when a component needs maintenance or needs to be replaced this can cause the ship to suddenly stop working. If the crew quickly knows what is wrong and can do maintenance on location which is not time consuming it is a minor cost but if the crew cannot immediately find out what is wrong and in the end the customer needs to replace the component it can be expensive. There are many components that Company X or the customer does not have in stock, so they need to be ordered. Because these components are quite specific these components can have long lead times. This can end up in very high costs for the customer.

This problem can be solved if Company X would know when a component is about to break. That way the customer can do quicker diagnostics when something breaks and can also order components in advance so that the component can be quickly replaced. The customer could also do more regular maintenance on a component if they see that the component is in a bad state. This would help the customer get higher up-times for their ships.

In order to do predictive maintenance Company X needs data from the ship's components. As previously stated, they already track variables such as fuel consumption and engine speed. This kind of data can help doing diagnostics but might not be enough to do predictive maintenance. Also, the tracking of data on these ships is a new project at Company X and the data is not reliable yet. When the data is not reliable the predictions are not either. If Company X is going to do predictive maintenance in the future they first need to make sure the required data is available and reliable.

However, the problem lies even deeper in the organisation. The data from these vessels is indeed not reliable enough and not always all data is available to do proper predictive maintenance, a further explanation about this is included in appendix B. But this is not only because of technological barriers. There are many different departments which have different goals. The managers of these departments want their own department to perform well. However, this can end up having a negative impact on Company X. It also does not encourage different departments to work together to achieve one common goal. In the case of Digital Business this can be because it is directly placed under the CEO and not underneath for example services. The bad collaborations are also partly caused because Company X does not operate with their vision "Company X aims to be a one-stop shop that provides innovative and integrated solutions for complex wet soil intervention issues." (Mission and vision, n.d.) in mind.

When Company X wants to track their ships by using sensors, the shipbuilding department must install these sensors on the ships. This also means that, either their ship will be more expensive for the customer or the shipbuilding department will make less profit on their ships. Meanwhile the digital department and service department can make more profit because they can offer a service using that data to their customers. So, in this case the ship building department wants to deliver to the customer while having

lowest cost possible, but the digital and service departments want them to spend extra on the ships cutting the profits for the ship building department.

Company X knows they must create services next to their products. Company X needs to be less dependent on building ships and realise extra revenue streams. That way they will be more resistant to bad economic times which they are not at the moment due to their dependability on ship building demand. Also, Company X's customers are demanding services next to the products they buy from Company X. They push Company X to servitize their business.

So Company X started to servitize their business, they started building the dashboard tool called IRIS. However, the dashboards which Company X builds in IRIS are not that popular at the customer yet. They are not sure why these dashboards are not as popular as they expected them to be. They think it might be because they show too much information on the dashboards. At least the customer does not use the service and does not see the added value of it. These services are also individually developed by the digital department without a clear service design, this is partially caused by the desperate need for servitization. This does not enable them to utilize all the available knowledge in their service. This knowledge would have helped them developing a service which come closer to the customer need, this is a missed chance to a better service. This individual development is caused by a bad collaboration between the different departments.

Meanwhile Company X is busy developing different services for different customer segments. This makes it very difficult to focus and prove that the services they are developing are valuable. They are developing different services for different customer segments because they do not know which market they should focus on. While it is already difficult for Company X to develop digital service because they have no experience in this field. The lack of focus on a specific customer segment is because Company X has no clear service strategy which is the core problem at Company X.

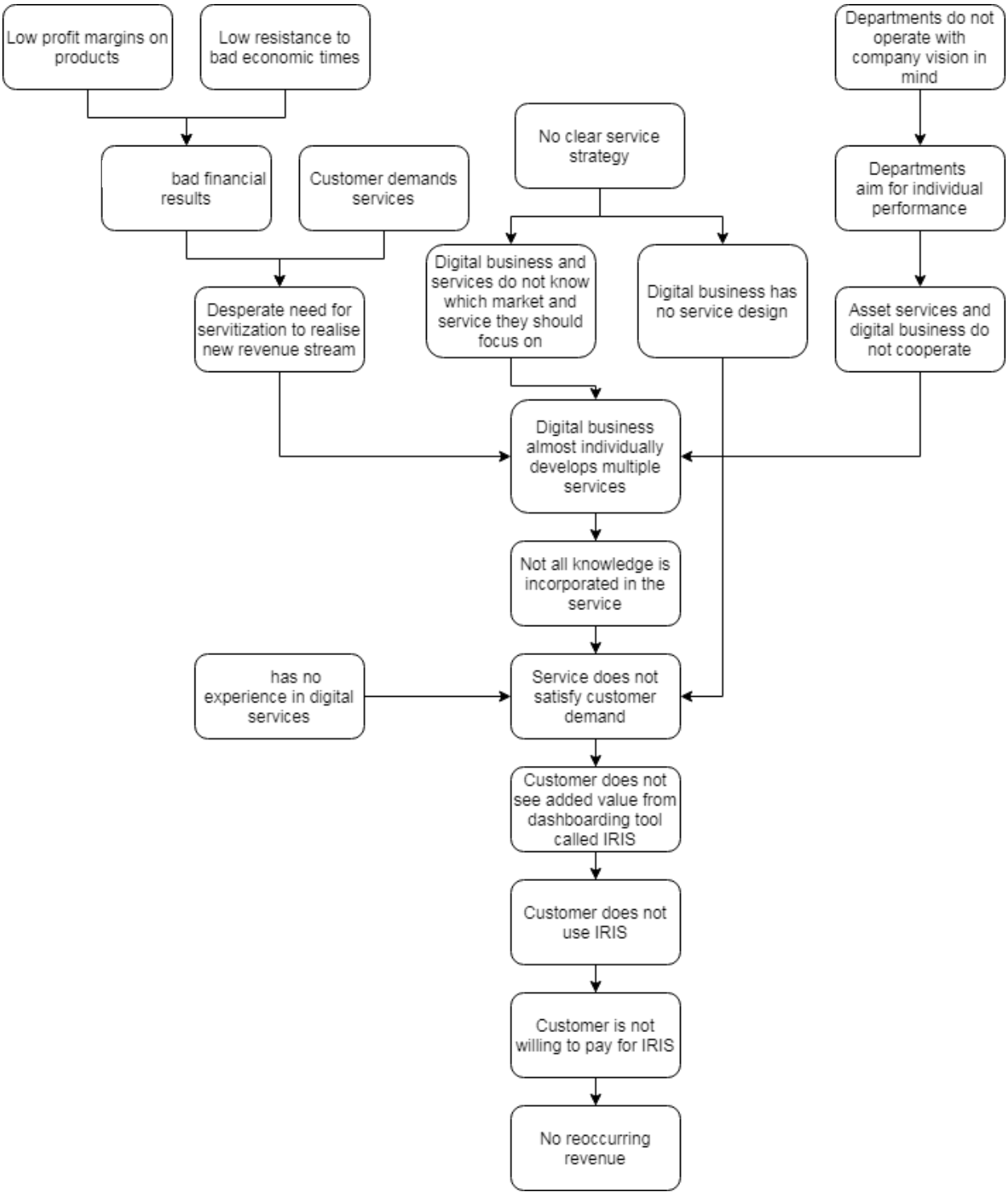

Figure 4, The problem cluster at Company X

1.2.1 Core problem

The core problem at Company X is there is no clear service strategy. Because of this Digital Business (DB) and Asset Services (AS) do not know which market they should focus on. This combined with the desperate need for Company X to servitize their business lead to DB individually developing the IRIS dashboard which did not satisfy customer demand. This tool is developed only by DB and thus not all knowledge from the service department is incorporated in the service. This causes the service to not reach its full potential. As a result, the customer does not see the added value of this dashboard tool and thus does not use it. This leads Company X to not being able to have a steady reoccurring revenue. We chose to solve the core problem "no clear service strategy" because out of the other options as core problem like: service departments do not operate with the company vision in mind, Company X has no experience in digital services, low profit margins on product and low resistance to bad economic times this ended up being the best option. The first option is a managerial problem and will not be the focus of this research. This is because the problem that departments do not collaborate with the company vision in mind needs a culture change which is difficult to achieve in 10 weeks, especially for a company as big as 3000 people.

We could choose to try and optimize the production of the ships to increase the margins on the product. However, implementing a service strategy should be more successful on the long term than higher margins on the ships. This will also be motivated in 2.1.

The low resistance to bad economic times should be better after implementing a good service strategy because of the extra and continuous revenue stream it should create. This makes designing a service strategy the best option.

1.2.2 Scope

This research will focus on choosing a service strategy and making the service design for the strategy. We will also advise Company X how they can make sure that this service strategy will be well implemented. This means it will be investigated if the organisational structure is sufficient and if there are adjustments required to execute and maintain the service. This research is part of the MARCONI project which will be explained in 1.3. The chosen service strategy will be suitable for the control tower MARCONI is developing.

1.3 Relevance of the subject

This research is very relevant for the Company X and their customers as well as for other companies which need to do maintenance on their assets. This research is namely part of the MARCONI research project. MARCONI stands for **Ma**ritime **R**emote **Con**trol Tower for Service Logistics **I**nnovation. The goal of the MARCONI project is to develop a control tower for a supply chain with the objective to have optimal overall performance of the supply chain instead of focussing on individual performance. Company X and her customer Boskalis are also participating in the MARCONI research project. When Boskalis shares their production data with Company X, Company X could possibly predict when something is going to break on their vessel based on Boskalis' data. This can increase the vessel's uptime and the supply chain performance tremendously. With this data Company X can also optimize Boskalis' processes. Because the MARCONI research will in the end also help companies better understand how and when to do maintenance it could result in a longer lifetime of components. When components have a longer lifetime there will be less production of components which is often a polluting process.

If the MARCONI research project can demonstrate such a control tower helps increase overall performance, it can be integrated in many other supply chains in society. This way the companies can

reduce costs, increase production and sustainability which not only can result in more profit for the companies but also in lower prices for consumers and lower environmental impact.

A popular theme in manufacturing at the moment is industry 4.0. This goes hand in hand with internet of things (IoT) which is about connecting machines, products, systems and people (Wegener, 2015). These "things" share data which can be used for different purposes. It can for example be used in supply chains to know in real time where a product is or in services to remotely see in what stage a product is operating and take appropriate action. In this research data will be used to provide services to customers. This can be used as an example for other manufacturing companies which want to servitize their business by using IoT.

1.4 Problem solving approach

In the following part we will discuss how we are going to solve the identified problem. We will do this by stating a research goal and dividing the research in research questions which will guide us through the process.

1.4.1 Research goal

The goal of this research is to plan out what the service design at Company X should look like and if there are organisational changes required to improve and maintain this service. This research should help Company X realise an extra revenue stream by selling a service with their products. The theoretical relevance of this research is that it can be used as a component of the foundation of a control tower in the future.

1.4.2 Research questions

There are multiple research questions which this research aims to answer. These research questions will be the foundation of the research goal in this thesis. Some research questions have sub-questions when it is required to go more in depth into that question. Research questions 1 until 7 will provide a theoretical foundation of the research which will help answer the other research questions and achieve the research goal. First, we will explain what servitization is, which service strategies exist and how companies servitize their business. Then we can answer Company X specific questions with theory from the first few research questions. These Company X specific questions will help us analyse what a good service strategy is for Company X and what the service design should look like. These research questions will also give an indication about what can be achieved and what Company X should aim for in the future.

The main research question is: "How should Company X servitize their business with a service strategy?". Below are 12 research questions which will help us answer the main research question. The answer on the main research question should help Company X to servitize their business and solve the core problem.

1. **What is servitization?**

In order to do proper research on the servitization of Company X it is important to properly understand what servitization is. It is also useful to see an example of a company which went through the process of servitization and what it brought them.

2. **What kind of service strategies exist?**

By answering this research question, it will be clear what kind of service strategies exist. This will contribute to the foundation of the research and will help identifying what service strategy fits for Company X.

3. **Why is a service important and where should services focus on?**

To substantiate why companies should change the way they are operating and increase their focus on services it is important to know why these services are beneficial for their business.

4. **How can a company go through the process of servitization?**

This research question will help us understand what changes and processes a company should go through to achieve the desired service.

5. **What is a control tower?**

In this research question we will elaborate on what a control tower is and what can be achieved through utilizing a control tower.

6. **What is the current situation at Company X?**
    a. *Which services does Company X currently have?*
    b. *Which services are they developing?*
    c. *Which data is being gathered on their customer's ships?*
    d. *Which departments are involved in developing the services?*
    e. *What knowledge is available and what would be achievable service offering within a year?*

This research question will give us an overview of how developed Company X is right now. How far are they in terms of servitization and do they have a proper foundation to set up valuable services? This will help us identify what we can expect from Company X and help us set realistic goals for this research.

7. **Which service strategy is suitable for Company X?**
    a. *What are the environmental configurations at Company X?*
    b. *Does Company X meet the requirements for the different services?*
    c. *What service strategy should Company X execute?*

In this research question we will assess what the best service is to focus on for Company X. By this we will also decide for which service strategy we are going to develop a service design.

8. **What should the service design look like?**

Here we will design the desired services. This will be done in ArchiMate. We will then explain the model to show what the collaborations are there and how the different services can collaborate with each other.

9. **How should the organisation be changed?**

When we have the service design, we will investigate what we will need to accomplish this service in terms of the organisation. We will also validate the service design with the Company X employees.

10. **What can be additions to this service in the future?**
    a. *What are the advantages of this extra functionality?*
    b. *How can these additions be integrated in this service?*

c. *What is required to realise this extra functionality?*

Lastly, we will think of possible additions to this service in the future and what is required to do these additions.

1.4.3 Type of research

For the first five research questions we will do a systematic literature review. This literature will be used as a foundation for the rest of the research. We used backward & forward reference searching in while doing the systematic literature review. Some authors like Baines and Davies had more publications on servitization or other related subjects. Through their papers we also find other relevant research.

For research questions 6 till 10 we will do interviews with multiple people within Company X. These people include the asset manager, manager and employees of the digital department, employees at the CBM department who are specialised in diagnostics and employees who go to the site where the vessels are operating because of their in-depth knowledge about problems on these ships. This gives me a broad view about what is happening internally at Company X and will help me understanding what the customer would expect from Company X.

For research question 6 and 7 we will also do a workshop about servitization. The manager from Digital Business and employees from Asset Management and CBM will attend this workshop. We will go through different strategies with them and assess in what kind of market they are operating, who their users and customers are and where we want to focus on. During this workshop we will also do a SWOT analysis to help us understand what the best service strategy for Company X would be.

For question 8 we will develop the service design for Company X in ArchiMate. This will be the blueprint for Company X to develop their services and how to apply it to their operations.

For research question 10 we will look into different service strategies which are known in literature and see what is possible for Company X. This will be done in combination with interviews with employees from Digital Business, Asset Management and Condition-based Maintenance.

1.5 Problem quantification

To eventually have an indication of how effective this research was it is important to determine the norm and the reality. Ideally the reality and the norm can be expressed in a numeric KPI however, for this research such a KPI is not available and thus the norm and reality will not be as exact as we would like it to be. When discussed with the Company X employees they also did not know how to quantify this research.

Currently Company X does not know which service would be most beneficial to develop and what features this service should have. They also do not have a service design. The goal is that after this research Company X has more insight in how to proceed in terms of servitization, has a clearer strategy about this process and has a service design. Heerkens and van Winden (2012) normally use a norm but because we cannot implement our solution and Company X does not have a quantifiable norm we defined a goal.

Now that we have done the problem identification and the problem-solving approach, we will continue with setting up a literature framework which will help us to analyse the situation at Company X, to develop a solution and to advise Company X on how to implement the solution. We might also come up with

recommendations for the future when there are certain solutions, we cannot implement right now due to restrictions at Company X.

1.6 Structure

This thesis is set up in five chapters. The first chapter is the introduction in which we introduce the reader to Company X and describe why and how we are going to do this research and what we want to achieve. In the second chapter we set up a literature framework which will be used as a foundation in chapter three and four. In chapter three we will analyse the current situation at Company X. This give us the required insights to choose a fitting service strategy for Company X. This strategy will be developed in chapter 4 and be modelled in ArchiMate. Lastly, there is the conclusion, recommendations and limitations.

2. Literature review and methods

Now we have set up the research in chapter 1 we will set up a theoretic framework in this chapter. In this chapter research questions 1 until 7 will be answered by looking into literature. This will be the basis of the research and will help to answer the other research questions. We will introduce the reader to what servitization means for industrial companies after which we will go through different service strategies. In 2.3 we will motivate the importance of services and substantiate where it should focus on. We will introduce control towers and the SWOT analysis which will be used in the chapter 3 to choose a service strategy. Lastly, ArchiMate and enterprise architecture, which is also included which will be used to develop an enterprise service design.

When doing the literature review, we primarily used the FindUT search engine from the University of Twente. This search engine has access to the library of the University of Twente but also multiple databases like WorldCat.org, Wiley Online Library and MEDLINE. Most of the articles in these databases are peer reviewed which makes them very valid.

Relevant search terms in this research were for example “Servitization”, “Needs for servitization”, “ArchiMate” and “SWOT analysis theoretical review”. Some authors like Baines and Lightfoot wrote multiple papers about servitization. Often their papers were based on earlier research which was also done by them. We found their other papers and other literature regarding relevant topics by using backward and forward induction. Also some literature was recommended by the MARCONI project.

2.1 Servitizition in industry

Before starting this research on how Company X can servitize their business it is important to understand what servitization is and why it is important. In order to understand what servitization is, it is important to know what a service is. In Foundations van ITIL V3 it is described as: “a way to deliver value to the customer by helping them achieving the desired goal without them being responsible for specific costs or risks” (Bon, 2007). In other literature servitization is described as the following: “Servitization highlights the trend in which firms seek to gain revenue by offering fuller market packages or bundles of customer-focused combinations of products and services.” (Parry, Tasker, 2014). The definition in Foundations van ITIL V3 is focussed on IT and is a collection of best practises. The definition from Parry and Tasker (2014) does have a better fit to this research and thus we will use that definition.

Many companies are in a transition from just selling a product to a service with their product. They are switching from selling a product to selling a solution. The power by the hour from Rolls-Royce is a good example of servitization (Baines, Lightfoot, Benedettini, Kay, 2009). Due to technological advances in the engines the demand for spare parts decreased (David J. Smith 2013). Rolls-Royce’s profit margins on spare parts were estimated seven times higher than on selling a new engine (The Economist, 2009) so this was a big cut on their profits. A change of business strategy was required. Rolls-Royce aimed to have the largest product portfolio so that they would have the largest number of possible airline customers. In the 1990’s Rolls-Royce competitors started to see the impact of the technological improvements of Rolls-Royce’s engines. At this point Rolls-Royce changed their strategy towards are customer-centric strategy (Davies, 2004). This focussed on extracting more value from their deployed assets, in this case their engines. So, Rolls-Royce started selling service contracts with their products and would guarantee engine availability. At that point Rolls-Royce was not selling a product but a solution.

2.2 Service strategies

There exist different kind of service strategies. There are several factors which influence which service strategy fits best to a company. Ebeling, Friedli, Fleisch, Gebauer, (2014) created four clusters of environmental configurations as seen in figure 5.

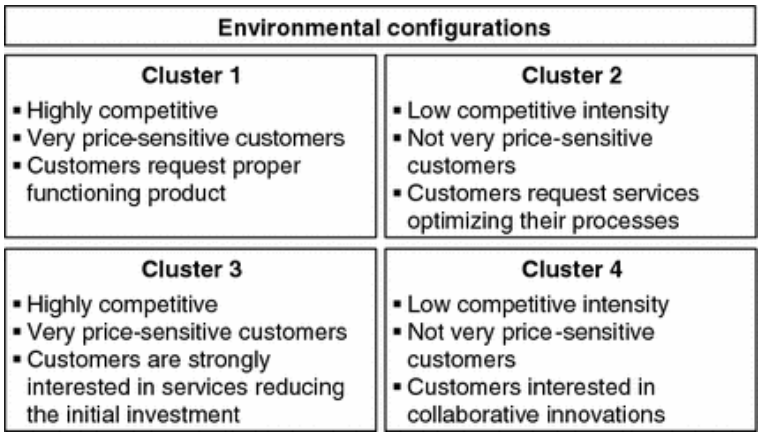

Figure 5. *Note.* Reprinted from Strategies for Developing service Business in Manufacturing Companies, Ebeling et al. (2014). In: *Servitization in industry*, by G. Lay, 2014, Berlin: Springer, Cham.

Ebeling et al. (2014) assigned different services to these clusters. For cluster 1 to 4 respectively he defined the After-sales Service Provider (ASP), Customer Support Provider (CSP), Outsourcing Partner (OP) and Development Partner (DP). These services have different customer requirements, value propositions, service offerings, pricing, et cetera which are explained more in depth in appendix C.

Cluster 1, the After-sales Service Provider focusses on customers who just want their product to properly function for a good price. It is important for these customers to pay as little as possible and are therefore also not interested in very complicated functionality from the services. The service offering from an ASP consists of spare parts, repair, inspection, hotline and basic training. This service offering is not very complex.

Cluster 2, the Customer Support Provider focusses on more developed customers, these customers are interested in optimizing their processes. These customers are also less price sensitive than the customers in cluster 1. However, the customer expectation will also be higher in cluster 2. The service offering of a CSP has much overlap with the service offering of the ASP. The CSP service offering consists of comprehensive preventive maintenance, advanced training, process optimization, repair, inspection, hotline and spare parts. The additional services which a CSP offers compared to an ASP are more complex than the services from the ASP. This makes it harder to execute.

Cluster 3, the Outsourcing Partner focusses on customers which are interested in reducing initial investment. This also makes them very price sensitive. This service is a very different services than the service of the ASP and the CSP. The OP manages takes over the operation of the customer processes.

Cluster 4, Development Partner focusses on customers which are interested in collaborative innovations. Just like in cluster 3, these customers are not very price sensitive either. The value this service brings is that it increases the quality of the product which is being delivered to the customer. This makes it so that both the customer and producer benefit from this collaboration.

2.3 Importance and focus of services

The main motivations for servitization are competitive motivations, demand-based motivations and economic motivations (Oliva and Kallenberg, 2003). A competitive motivation is a motivation that is based on outperforming the competition, a demand-based motivation is based on pressure from the customer to provide services to them and lastly the economic motivation is based on the advantages of a new revenue stream. For each motivation there are different kind of services. For a demand-based motivation there is customer service to improve the customer relationship (Fischer et al. 2012), for competitive motivation there are product service systems which ensure the correct functioning of the product (Mathieu, 2001) and for economic motivations there are for example customer supporting services which support the operational needs of the customer (Mathieu, 2001). Offering customer support is also a good way to gather information from the customer which can be used to improve the product they are offering and can make their service more efficient and cost effective (Goffin and New, 2001).

When looking at demand-based motivations Baines and Lightfoot (2013, 2014) "characterise customer demands for services according to whether: customers undertake operational activities themselves; manufacturers provide some services; or manufacturers undertake the operational activity through an "advanced" service" (Raddats, Baines, Burton, Story, Zolkiewski, 2016). Manufacturers are developing these advanced services so that the customer can focus on their core business and can outsource their other activities (Gebauer et al, 2010; Slack, 2005).

When looking at General Electric they enlarged their service departments in the 1990's. This combined the products, maintenance, service and financing (Slywotzky and Morrison, 1998). This was meant to deliver "integrated combinations of product and/or services that are tailored to create desired outcomes for the customer" (Davies, 2004). So, by heavily investing in their service departments they were able to deliver services tailored with their product which met the customer's expectation.

For manufacturers of complex products, the main motivations were demand-based and economic. Customers required services which would help them reduce costs to decrease cost of ownership. From an economic standpoint the revenue growth was an important driver. Servitization enabled them to grow faster than by selling products alone. The reoccurring revenue was also seen as an important aspect of services. "Manufacturers of complex products have primarily demand-based (cost savings, service quality, risk reduction) and economic (new revenue streams, stabilise revenue, greater profitability) motivations for servitisation" (Raddats et al., 2016).

2.4 The process of servitization

When designing a service, it is very important that the company understands what the customers problem is which the company would like to solve through offering their service (Sawhney, 2006). Brady, Davies, Gann (2005) also state: "Becoming solutions-focused means that providers have to understand how value is created through the eyes of the customer". There needs to be a deep understanding of the customers' business, this can be achieved through a good customer relationship in which the service offering company is seen as a trusted advisor instead of a supplier (Shepherd, Ahmed, 2000). A strong customer orientation results in delivering a solution that fulfils the customer's needs (Brax, Jonsson, 2009). By delivering customer focused solutions, the service will provide the customer with the expected value and experience (Hakanen, Jaakkola, 2012).

We can learn to understand the customer's needs by applying the Kano Model of Customer Satisfaction (Kano, Tsuji, Seraku and Takahashi, 1984). This model identifies three different curves, the bottom curve; the basic needs, the middle curve; the performance needs and the upper curve; the exciting needs. These curves represent customer satisfaction by how much the need is addressed. Respectively these curves get harder to identify. It is often easier to find out what the customer's basic need is than what the exciting need is. The model is visualised in figure 6.

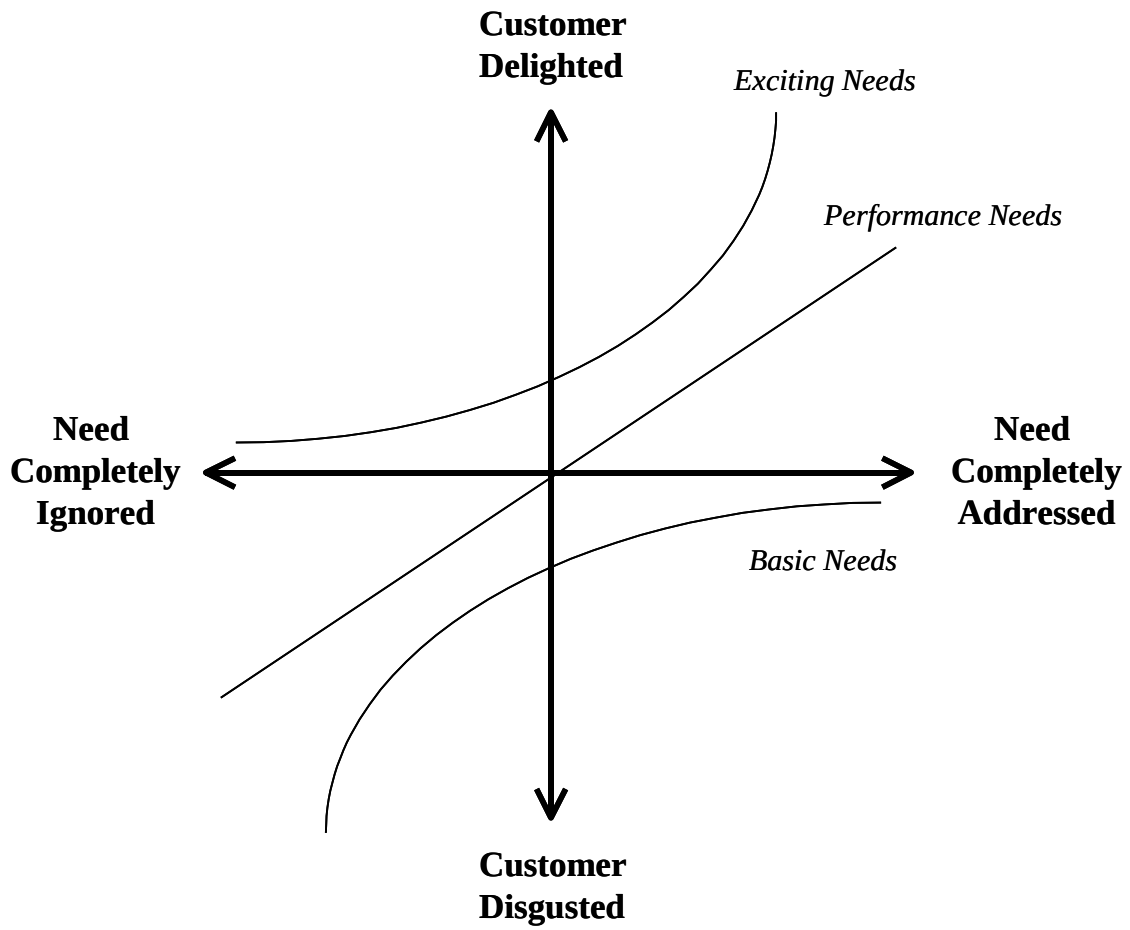

Figure 6, The Kano Model of customer Satisfaction. Note: 28. Kano, N., S. Tsuji, N. Seraku, and F. Takahashi (1984), "Attractive Quality and Must-Be Quality," Hinshitsu: The Journal of Japanese Society for Quality Control, 14 (2), 39-48. In: Bayus, B.L., Shane, S. (Ed.) (2005), "Understanding customer needs" Blackwell Handbook of Technology and Innovation Management, Cambridge, MA: Blackwell Publishers

So, how do we find out what the different needs are? Bayus and Shane (Ed.) (2005) have developed an approach for understanding customer needs which is described in figure 7. The different needs can be found through different ways which can be categorized in two categories; the articulated needs and the unarticulated needs. The articulated needs are the needs which customers tell you they want through market research. The unarticulated needs are harder to investigate. These can be found out through looking at what the customers do by for example doing participant observation. They can also be met by designing products or services in collaboration with the customer as is being done as a Development Partner.

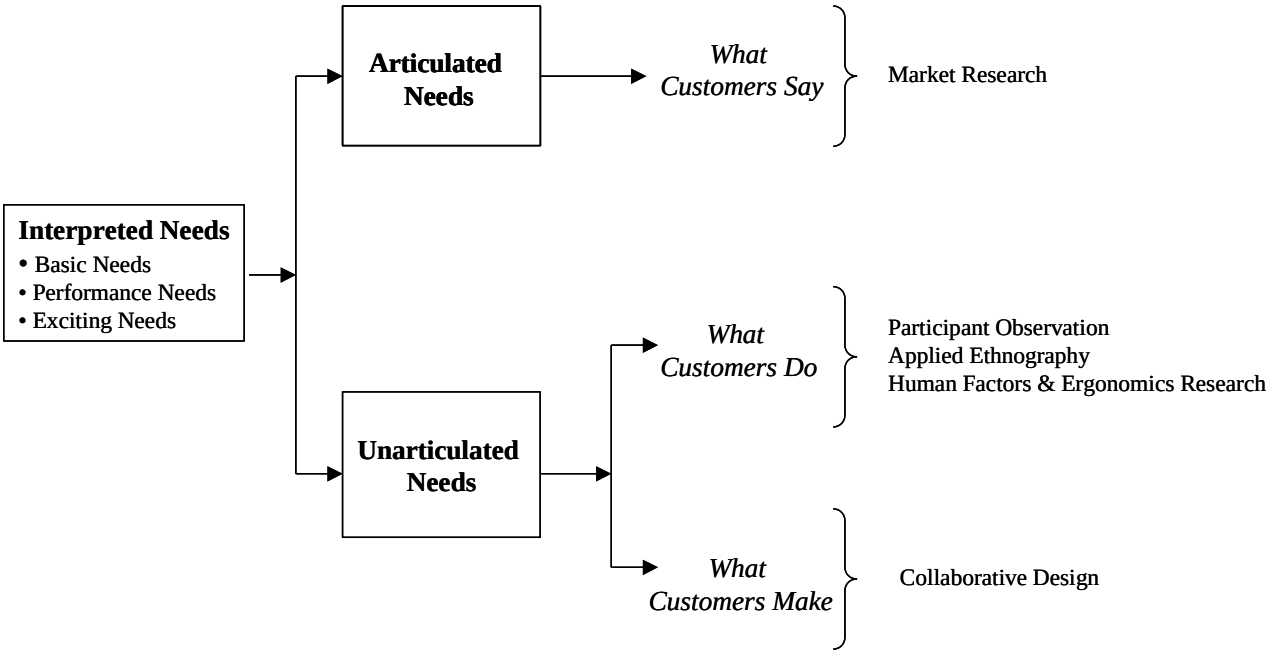

Figure 7, approaches for understanding customer needs. Note: Bayus, B.L. Shane, S. (Ed.) (2005), "Understanding customer needs" Blackwell Handbook of Technology and Innovation Management, Cambridge, MA: Blackwell Publishers

There should be determined which external environment the company wants to operate in (Ebeling et al., 2014). In combination with the customer requirements the company should choose a service strategy. The realisation is different for every strategy. The table in Appendix C can be used as a framework on how to realise one of the following service strategies: ASP, CSP, OP and DP, introduced in 2.2. It goes through different subjects such as service strategy, organizational design elements and several sub aspects regarding these subjects.

2.5 SWOT analysis

To help identify what is a suitable service strategy for Company X we will be using the SWOT analysis. According to Gürel (2017) "SWOT Analysis is a tool used for strategic planning and strategic management in organizations. It can be used effectively to build organizational strategy and competitive strategy". Roelfsema, Aldea, Lankhorst and Franken (2016) state that "about 80% of the organizations that do use strategy techniques use the SWOT analysis to support the development of strategies. The SWOT analysis is one of the most popular methods to analyze the environment of an organization". This has a very good fit to what we are going to do in this research. It also identifies two environments, the internal and the external. This synergises well with the external environments introduced in the service strategies of Ebeling et al. (2014). SWOT stands for strengths, weaknesses, opportunities and threats. SWOT is a powerful method to identify where your business is good at and utilize these strengths, uncover opportunities which your business could exploit, see where your weaknesses are so you can try to supress these or avoid being influenced by these weaknesses and finally to identify threats to your business. When using SWOT, we set up a matrix as shown in figure 8.

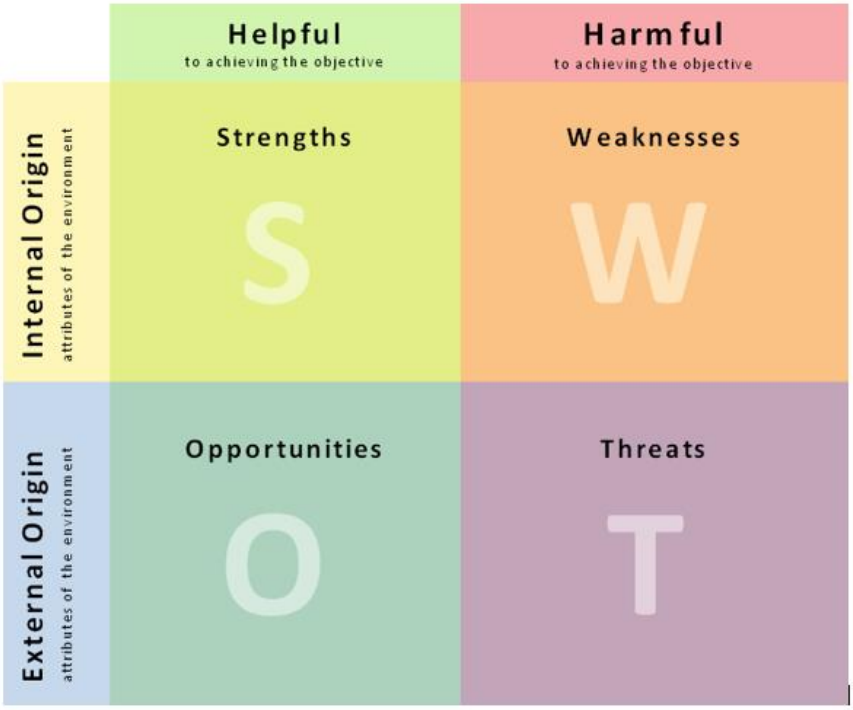

Figure 8, SWOT analysis matrix. Note: Bexon, C. (2015). Risk management for Agile programmes. Retrieved July 7, 2019, from https://sfadigital.blog.gov.uk/2015/02/21/risk-management-for-agile-programmes/

In figure 8 we see the internal and external environments and which parts of the matrix are helpful and which are harmful to achieve the objective we are looking for.

When going through the process of servitization companies change their strategy, just like Rolls-Royce did (Davies, 2004). This is where the SWOT analysis can help. While building the new strategy during the process of servitization the SWOT analysis can help identify where the new strategy should focus on and analyse the environment the organisation is in. This analysis supports the strategy process (Roelfsema, 2016) and therefore the process of servitization.

2.6 Control towers

There are different definitions of a control tower. Capgemini Consulting defines a supply chain control tower as: “Literature describes the main function of a control tower as: “The key function of control towers is to provide enhanced visibility for short and long term decision making that is aligned with strategic objectives” (van Doesburg et al., 2011). This control tower can greatly increase the supply chain performance. Deloitte conveyed a survey among 600 executives at retail and manufacturing companies and found that 63% were highly concerned about the risks within the extended supply chain. These executives cited that there is a “lack of acceptable cross-functional collaboration” (Deloitte Consulting, 2013).

Control towers primarily require data to operate. This data comes from assets. The data gives a representation of what is happening at the asset. When shared with the control tower this can trigger decisions such as sending spare parts through the supply chain or sending technicians to repair parts on the asset.

In a paper from Trzuskawska-Grzesińska (2017) three companies are described. One of the companies, called company 'A' had problems with supply of an electronic component and allocation of supply. This "led the head of the global purchasing office to create a 'global control tower' organization to measure, consolidate and manage demand planning across company's facilities world-wide" (Scholtz, 2014). According to the company the control tower had a positive effect and it provided the expected value.

Blanchard (2007) stated the following about company A which proves that a control tower can very well benefit the business:

> "For example company 'A' after introducing new supply chain management organization, including control tower, it dropped its on-hand inventory from more than $7 billion down to less than $3 billion by 2002, and by 2003 inventory was just shy of $1 billion. It took better control of its cash expenditures, dropping them from $2.2 billion per quarter to $130 million. Over the same period of time, company 'A' reduced its total number of suppliers in half – from roughly 3,000 to less than 1,500".

Such a control tower can also be used when providing services. When customers share data with their service provider, the service provider can start initiating their processes as soon as possible because of the insights it has in the assets.

2.7 Enterprise architecture

There is no accepted definition for enterprise architecture. Van Bommel, Buitenhuis, Stijn, Hoppenbrouwers, Proper (2007) and The Open Group (2009) define enterprise architecture as: "Principles are general rules and guidelines, intended to be enduring and seldom amended, that inform and support the way in which an organization sets about fulfilling its mission.". We will use this definition in this research. The enterprise architecture defines the relations between different elements in the business and their connection to the environment. Minoli, (n.d.) describes the purpose of enterprise architecture "to create a map of IT assets and business processes and a set of governance principles that drive an ongoing discussion about business strategy and how it can be expressed through IT".

2.8 ArchiMate 3.0

To model an enterprise architecture there are several tools we can use. We will be using ArchiMate 3.0 to develop the enterprise architecture. We will use Archimate because it is open-source and both science as business help to develop this standard of enterprise architecture. The ArchiMate 3.0 framework can be seen in figure 9.

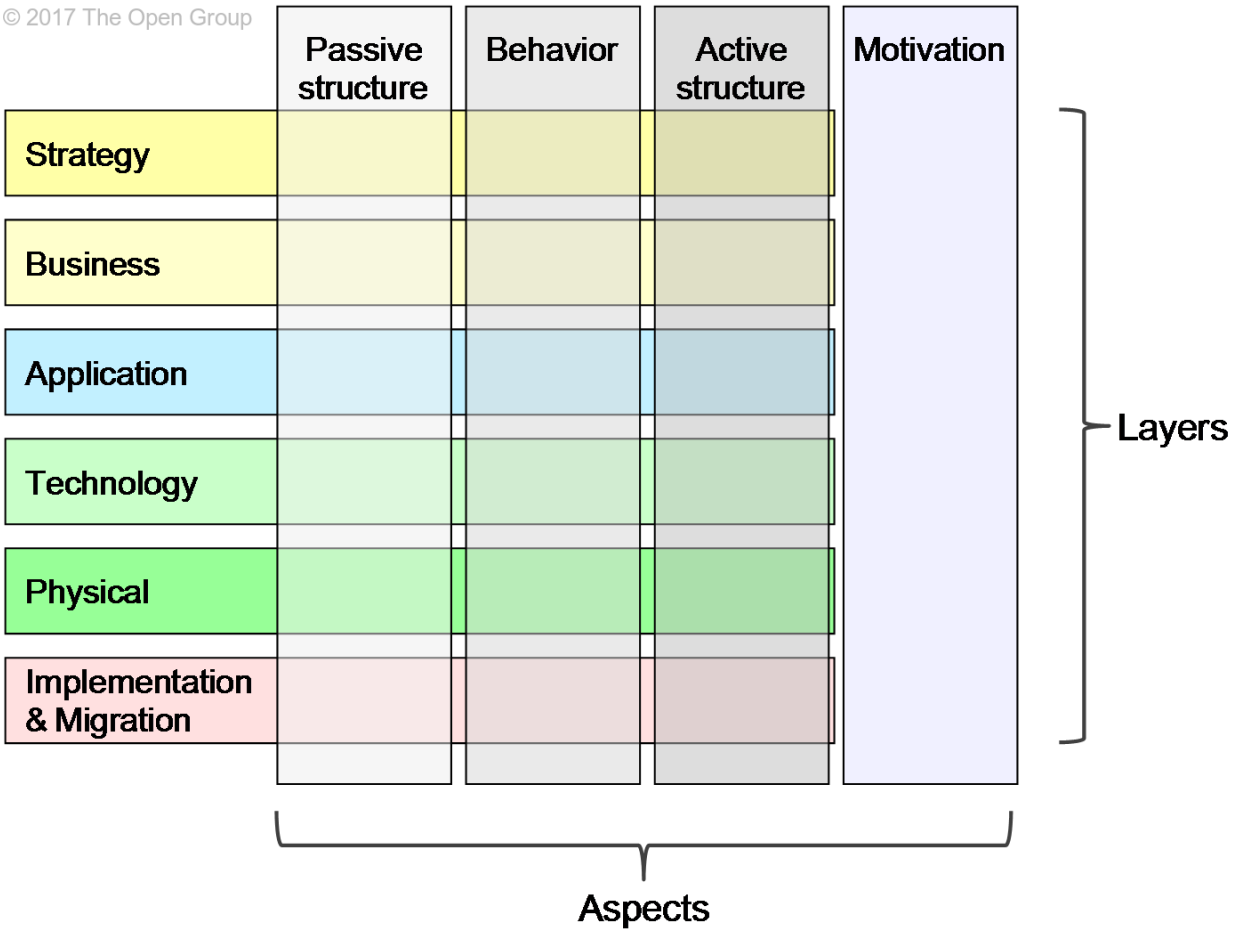

Figure 9. The ArchiMate framework. Note: 3 Language Structure. (n.d.). Retrieved from http://pubs.opengroup.org/architecture/archimate3-doc/chap03.html#_Toc489945969

ArchiMate has several layers, the Technology Layer, Application Layer and Business Layer are the core of the language. The Open Group(n.d.) defines the three layers as follows:

1. The Business Layer depicts business services offered to customers, which are realized in the organization by business processes performed by business actors.

2. The Application Layer depicts application services that support the business, and the applications that realize them.

3. The Technology Layer depicts technology services such as processing, storage, and communication services needed to run the applications, and the computer and communication hardware and system software that realize those services. Physical elements are added for modeling physical equipment, materials, and distribution networks to this layer.

These layers consist of elements with a specific meaning which are included in appendix D. These elements relate to each other through relationships. There are different relations with each their own definition. The different relations are included in appendix D. The layers, elements and relationships allow us to give a good visual representation about what the enterprise architecture looks like or should look like and how business and IT collaborate to achieve a certain goal.

To show how the enterprise architecture fits to the strategy, ArchiMate has a strategy layer which has its own elements. In this layer the strategy can be modelled. This can be done in combination with the motivation extension. “The role of the motivation extension is to allow for the modelling of motivations or reasons that underlie the design or change of some enterprise architecture” (Iacob, Jonkers, Lankhorst, Proper & Quartel, 2012). The motivation elements show what the effects of the strategy should be. The motivation is realized by the strategy layer. This eventually leads up to the mission and vision of the company.

3. Development of the service strategy at Company X

In this chapter we will answer research question 6, 7, 8 and 9. First we will investigate what the current situation is at Company X. Then we will introduce Company X's current incentive, what the incentive should be and how a service strategy can help change this incentive. Afterwards, we will go through a process of assessing what service strategy would be most beneficial for Company X. When the most suitable service strategy is chosen, we will make a service design for that service strategy. Lastly, we will see how this strategy fits into the organisation of Company X and if there are organisational aspects which should be changed and how other requirements regarding the chosen service strategy can be met.

3.1 Current situation at Company X

Here we will assess the current situation at Company X, this will be the starting point of the research. In this part we will answer research question 6. First, we will explain what services Company X is currently developing, how data is gathered from their customers ships and what problems occur regarding data gathering. Then we will discuss which departments are involved in the development of their services and how developed Company X is in terms of more advanced digital business processes like Condition-Based Monitoring or remote diagnostics. This information will help us to assess what a service strategy suits Company X and is feasible for Company X.

3.1.1 Service development

Company X knows that by only producing dredging equipment they will not survive. Therefore, Company X wants to sell services with their products. To do this Company X developed a dashboard tool called IRIS in which they can create all kinds of visualisations from data gathered on their customers' ships. On this dashboard the customer can see if the vessels are operating and other KPI's which Company X thinks would be useful for the customer to see. Company X thinks this dashboard can be provided to the customer as a service next to selling their vessels and thus will be an extra revenue stream.

Company X is also exploring, in collaboration with the MARCONI project, possibilities of developing a control tower. This control tower would aggregate information from different organisations, in case of Company X this would for example be Boskalis, one of the biggest customers of Company X, and enable the supply chain to perform more efficient. If Boskalis would share some of their maintenance and sensor data this could enable Company X to do predictive maintenance on Boskalis' vessels. They would know when some component is likely to break and for example order these components in advance, so they are available before the component breaks. This would reduce downtime and thus provide value for Boskalis.

There are multiple services in development. For the different market segments, so for more developed customers but also the more primitive customers they are developing separate services. This is because these different customer segments have different needs. They have developed the IRIS tool in which they can easily create new visualisations, but according to the manager of DB the customer is not using that product. In IRIS they are building different dashboards for different customer segments which they want to sell as a service. This can also be seen in figure 10 on the far right. There are different services for the customer (not advanced) and the customer (advanced). They are now developing a new version of IRIS. They are developing monitoring, troubleshooting and maintenance services for different customer segments, so for hoppers as well as for dredgers. However, the customer segment with hoppers such as Boskalis are also interested in predictive maintenance and process optimization so Company X also invests in developing these services. Within these customer segments they are also aiming for different users

such as the product owner, super intended and vessel captain. There is not much focus. Meanwhile there is quite some pressure to deliver a product.

3.1.2 Data gathering

Data which is used for this dashboard is generated by sensors installed on the ship. These sensors track variables such as fuel consumption, dredge pump vacuum, engine speed et cetera. Via an extra device installed on the ships, the eWON this data is sent to Company X, if the ship does not have the eWON Company X is not able to log that ship's data. Most Dredgers are not equipped with the device. After the eWON saves it in the eWON cloud it synchronises that data with the IRIS system. After which it is accessible via an Azure Active directory. In appendix E the architecture of how data is gathered and saved is included. In figure 10 there is a visual representation about how data is gathered and saved.

Big hoppers are bought by bigger players such as Boskalis. However, these big players are hesitant in sharing their data. Because of this Company X cannot access their data and use this in their services.

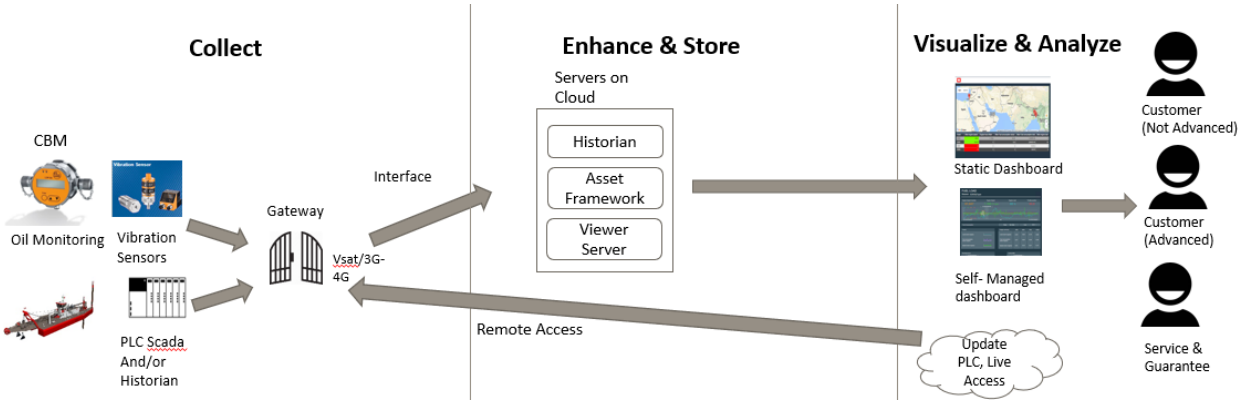

Figure 10, visual representation of how data is collected, enhanced & stored and presented to the customer. Note: Presentation from Company X in MARCONI project.

3.1.3 Involved departments in service development

Because of Company X's size they have many different departments which are responsible for their own tasks. About one and a half year ago a new department was created: Digital Business. This department was set up to servitize Company X's business, they are responsible for this task. DB also processes and analyses data gathered from the ships. Because of the desperate need for servitization they quickly started developing IRIS which would help them servitize.

During the development of IRIS DB did not involve the other departments often. For example, AS and CBM were not involved in the development of the services while they have quite some knowledge on customer problems and demand. AS and CBM are also the departments which in the end should provide these services to the customer. They should have a better understanding about customer needs which can then be implemented into the service design.

3.1.4 Available knowledge and readiness

There is quite some knowledge about different aspects of dredging available at Company X. First, there is the CBM department. Their knowledge and operations are the first step to predictive maintenance. Company X is not able to do predictive maintenance within a year because they do not have the required data quality from the ships and do not have the historic data which can help them find the 'fingerprints' of failure in order to do predictive maintenance. However, they can assess certain intervals in which measurements from the ship should be in order to work properly. If the measurements go out of the range of this interval, they could advise the customer on how to prevent this in the future. This could be a form of a remote-control service.

The knowledge from CBM combined with employees with on board experience can be used to do remote diagnostics. Company X should be able to properly do this within a year. The main bottleneck for this is the data quality.

The remote diagnostics combined with the remote-control could help Company X with supplying their customers with spare parts. When something goes wrong on the ship and it turns out that there are spare parts required the remote diagnostics department can offer the customer to send spare parts. This is basically the same for remote-control. When they see a certain measurement is out of the advised interval and this is caused by a worn-out component, they can offer the customer to buy spare parts from them.

The data which is gathered to do remote diagnostics and remote-control can later be used to find patterns and develop other services. These services could be predictive maintenance and process optimization.

Company X has some revenue from services, however this is not substantial. This revenue comes from commercial claims, delivering of spare parts and CBM. The commercial claims, which are claims outside of the warranty period, do not come close to €1 million, this is insignificant for Company X with a revenue of 800 million in 2017. Company X has some more revenue coming from spare parts which is modelled in a Bizagi like structure, in appendix F the process of purchase to order is included. This process is executed when the customer is ordering parts which are not in stock at Company X. The last service which generates some revenue for Company X is CBM. This service is mainly requested by large, developed customers.

3.2 Changing Company X's incentive

Currently the main driver of Company X is building ships. They want to build as many ships against the highest possible margin. This does not give Company X a lot of incentive to innovate and build ships which lasts for a long time, because it would take longer for Company X until they can sell new ships. This reminds us of the situation Rolls Royce was in with their engines (David J. Smith 2013). Due to technological advances the demand in spare parts declined which was a large contributor to Rolls Royce's revenue. At that time, it would have been better for Rolls Royce to build an inferior engine because they would sell more spare parts where they had large margins on, unless they would change strategy. That is exactly what they did and thus introduced power by the hour (Baines et al., 2009), this gave them the incentive to keep innovating the engines and enable the customer to focus on their core business.

The service strategy we will choose in chapter 3 should help Company X change their incentive from "building as many ships as possible" to "enable the customers to have high production and focus on their core business". By doing this Company X will be less dependent on building ships and will get more advantages from service- and product innovation. When Company X would build a very reliable and efficient ship which lasts for a long time this would not fit in the current strategy of selling as many ships

as possible. It might increase Company X's market share because they have a competitive advantage in terms of product quality, but it would also make the product much more expensive because Company X would be building less ships as a consequence of the longer lifetime of the ships.

When Company X would build a very efficient ship which lasts for a long time which comes with services that would help the customer to improve its business this would fit into the strategy of "enabling the customer to have high production and focus on their core business". This would increase market share due to a competitive in terms of service to the customer and would help Company X to gain higher margin through the services even though the lifetime of the ships is much longer than before. When Company X can provide services for such a ship for the entire lifetime of the ship it benefits both the customer as Company X.

3.3 Company X's service strategy

To assess which service strategy is suitable for Company X we will first define the environmental configurations at Company X and what Company X can do at this moment and if this fits the requirements for the service strategies. We will compare the different service strategies with each other in the situation of Company X and list the pros and cons of these service strategies. Eventually we will evaluate which service Company X should implement, this will then be used as basis for chapter 4. This chapter will also give more insight in what might be interesting service strategies for Company X in the future.

3.3.1 Environmental configurations

We discussed the environmental configurations with a research consultant which is now helping Company X to servitize their business. She visualised the experience flows of Dredger and hopper customers. This is not finalised yet, but it gives an impression of the difference in complexity between the two. The experience flows can be found in appendix G. When we look at the environmental clusters and the accompanying service strategies designed by Ebeling et al. (2014), we see that Company X's customers are primarily in clusters 1, 2 and 3. In cluster 1 are the smaller dredge companies which are not that experienced in dredging and mainly have Dredgers. These customers just want their ships to properly function for a cheap price, they are not necessarily interested in being as efficient as possible. These requirements match with cluster 1. These customers are Company X's highest volume market. Company X is trying to become an ASP to satisfy this market segment.

In cluster 2 and 4 are Company X's biggest customers such as Boskalis. Boskalis' fleet consists of large hoppers and they want these hoppers to function as efficient as possible and thus have low downtime and well-planned maintenance. So, they are interested in optimizing their processes. They also are not that price sensitive as the smaller customers are. These characteristics match cluster 2. This suits the CSP which Company X is trying to become to satisfy companies such as Boskalis. Also, Company X is trying to develop a smart pump together with Boskalis, this fits into cluster 4 as a DP. However, this is not easy to execute because Boskalis is hesitant with sharing any data with Company X.

Cluster 3 is about customers that are primarily interested in outsourcing their operations. In this case that would be operating the dredging ships. However, Company X's customers are specialised in operating dredging ships. That is their main business. These companies are not interested in outsourcing these operations because they are looking to do that operation themselves and therefore is not interesting for Company X. This is why we will not further include this service strategy in this research.

Thus, Company X is currently trying to be an after-sales service provider, customer support provider and development partner to generate additional revenue and satisfy customer needs in different market segments.

3.3.2 Service offering requirements

For the three service strategies which are left we will list the required service offering and explain if they are ready to execute these services or need more time to develop them.

3.3.2.1 The after-sales service provider

First, we will assess if Company X meets the requirement to be an ASP. According to Ebeling et al. (2014) to be an ASP a company needs to be able to provide the customer with spare parts, repairs, inspection, hotline and basic training.

Spare parts

Currently Company X provides customers with spare parts but does not have very good grip on that market. Inspection schedules are often also provided to the customer, this depends on the contract between the customer and Company X. However, larger players tend to make their own maintenance schedules because they have a lot of knowledge about their vessels.

The offering of spare parts is done by AS. The processes of ordering spare parts are modelled internally. This is done for different variations like purchase to order which is included in appendix F but also for example purchase from stock. Most of the time when a part is not in stock the part is delivered to Company X first, then they send the part to the customer. This can be greatly improved by directly sending it to the customer. This can be done by making use of third-party logistics providers

Basic training

Company X trains their customers' operators on demand, this is being done by the Company X training institute. They do this using simulation and giving lectures. In some cases, they also go to the ship with the customer to show them how they should use their equipment. These trainings are especially used by smaller customers.

Hotline

Company X does not have a hotline service right now. However, they are setting up the hotline through which Company X could remotely support their customer whenever something goes wrong or when the customer has any questions about the product. The development is done by DB. They would use the gathered data to give them additional insights in the customer's situation. They also need to present this data in such a way that it is useful for the Company X service employee. Company X has employees with the required field knowledge to be hotline employees. Yet, they might need to create new training programs for internal use to educate their hotline employees.

Repairs

The customer primarily has its own technicians to do repairs. However, Company X is looking to do provide maintenance on the dredging equipment aboard their customer's vessels. Van Oord is willing to outsource the maintenance on the dredging equipment aboard their ships. This would then be somewhat like power by the hour from Rolls Royce (Davies, 2004) but it would be payed per cubic meter instead of flight hours. Company X has the required knowledge to do repairs on the dredging equipment on the ships. They are

not collaborating with service agents now to do these repairs. When a repair is requested, they fly in Company X personnel to do the repair. This service is also executed by AS.

Inspections

Currently Company X only does inspections whenever the customer files a claim and Company X needs to check whether the claim should be paid by Company X or is not Company X's fault. This claim handling is done by AS, this also applies to the inspections. If Company X wants to do inspections, they will need to work with service agents.

3.3.2.2 The customer support provider

According to Ebeling et al. (2014) to be a customer support provider a company needs to be able to provide comprehensive preventive maintenance, advanced training, process optimization, repair, inspection, hotline and spare parts. Repair, inspection, hotline and spare parts is already discussed in the part about the ASP so we will elaborate on comprehensive preventive maintenance, advanced training and process optimization.

Comprehensive preventive maintenance

Company X is not ready for the development to provide comprehensive preventive maintenance. First Company X should work on their data gathering and other services. This is already discussed in section 1.2 and in appendix B.

Process optimization

They can do some remote process optimization, but this is not very developed yet. They do have analysis on optimization curves on for example flow and density. In which the flow is the m^3/L and the density is kg/L. However, there is still much to do on this front. The bottleneck in this development is also the lack of complete and reliable data sets logged at the ships. This process optimization is done by CBM.

3.3.2.3 The development partner

Ebeling et al. (2014) states that one who wants to be a development partner should be able to offer design and construction services. Company X is already doing construction and design for a very long time so this knowledge is available. They are also in talks with Boskalis to develop a smart pump. However, this is not going smoothly due to Boskalis being hesitant to share their data.

3.3.2.4 Conclusion

The only service strategy for which all service offering requirements are met is for the DP. For the ASP Company X is close to offer all services. The delivering of spare parts is already possible but should be optimized. They have the required knowledge to do repairs and inspections, but they just need service agents to partner with to be able to quickly provide these services. The basic training is already in place. But the hotline will be the most difficult to realize.

The extra services which are part of the service offering of a CSP are not in Company X's reach right now. They are not ready to do comprehensive preventive maintenance due to data problems and this would also require extra time to develop. The process optimization also still needs to be developed further until it can be offered as a valuable service.

Based on only the service offering requirements in mind the DP and ASP seem most feasible right now.

3.3.3 Company X's service strategy

The environmental configurations and the requirements for different service strategies will be used as a foundation to choose a suitable service strategy for Company X. Other influences on which service strategy to choose will also be discussed in this sub question.

Currently Company X is trying to execute three different service strategies. Firstly, the after-sales service provider for small customers like dredging companies in Turkmenistan or India through offering them custom made dashboards, spare parts, repairs, inspections and training.

Secondly, the customer support provider by offering them the possibility to use IRIS and create their own dashboards in combination with CBM, spare parts and repairs.

Thirdly the development partner by trying to develop a smart pump with Boskalis but this project is being brought to a halt because of bad communication and distrust between Company X and Boskalis.

This is very broad, especially considering that Company X only started the digitalisation of their services one and a half years ago. The IRIS tool which they have developed are not used by the customer either. Company X wants to offer services to every customer segment which seems to be too ambitious for a traditional company like Company X. Therefore, we are going to focus on one single service strategy out of the three strategies Company X is currently trying to get into.

3.3.3.1 The development partner

The DP is an opportunity for Company X. According to Bayus and Shane (Ed.) (2005) it helps Company X with identifying what the customer's unarticulated needs are which leads to producing a better product which fits the customer need. The DP also increases the customer relationship. The combination of a product co-developed by the customer and the good customer relationship results in higher customer retention. However, this is difficult to execute. This is primarily because the bigger players which are interested in Company X as a DP are hesitant with sharing their data which is essential to do proper development. There could also arise problems with intellectual property. Moreover, having more stakeholders can sometimes make the development more complex because different stakeholders can have different needs which they want to see in the product.

3.3.3.2 The customer support provider

The customer support provider would also be interesting for the bigger players. Currently some big dredge companies are doing much of the data analysis on their equipment in house. However, Company X has more potential in doing useful data analysis on vessels. This is because Company X potentially has more data available to them than a single dredge company does due to the higher volume of ships where Company X could get access to. This way they have more situations to compare and to learn from than the individual customers have. However, the service offering from a customer support provider is quite advanced. Company X is able to do some of the service offering on a short term such as a hotline and spare parts but is not nearly ready to do predictive maintenance or process optimization. Moreover, in this case it is again very difficult to provide these services when these companies do not want to share their data.

The bigger customers also have a larger variety of users and processes which makes the service design very complex.

3.3.3.3 The after-sales service provider

The after-sales service provider would fit to Company X's smaller customers. The customers which primarily have Dredgers. These customers are less developed in the dredging business and thus have different needs from a service than the more developed players. They are willing to pay less than the big players, but their needs are also way less ambitious and their processes are way less complex. Also, these customers are much more primitive and therefore, it is easier to provide value for these customers than for a bigger customer which has optimised its processes to a higher extent. These dredgers which are most commonly sold to smaller customers are also the highest volume market for Company X. This also means that the number of ships which gather similar data is largest for the small customers. This makes it so that Company X can potentially learn to optimize processes, do predictive maintenance etc. quicker than with the larger ships.

3.3.3.4 Choosing the service strategy

To choose a suitable strategy for Company X we also did a workshop on servitization with employees from DB and AS. In this session we filled in a SWOT analysis to assess the current situation of Company X which helps us understand where Company X should focus on and what strategy supresses the weaknesses and utilizes the strengths and opportunities. The SWOT analysis is based on the question: "What is our current position with regard to servitization".

To do the SWOT analysis we organised a workshop. Employees from different departments like the manager of Digital Business and employees from Asset Services attended this workshop. We first discussed a few slides to introduce servitization. We also introduced some basic questions like:

- who will be the customer?
- who is the user?
- what will be the services we are offering?

We already listed some options as answers for these questions, these were quickly introduced. We did this to make them aware of some of the topics which influence the service strategy. Then we started to fill in the SWOT analysis which is presented in table 1. During the filling in of the SWOT analysis we encouraged the attendees to have a discussion and to hear different points of view. This was important because we wanted to increase the collaboration between the departments and see where they can help each other.

STRENGTHS	WEAKNESSES
Iris dashboard tool	Collaboration between departments
Knowledge on CBM	Company X is not an IT company
Large Dredger fleet, a lot of data	Data is not complete and reliable enough

OPPORTUNITIES	THREATS
Understand added value for the customer	Big customers have their own systems and analytics
Operating more demand driven	Difficult to make standardized solutions for custom made ships
Learn how to provide a digital service from deploying services at smaller customers	Small customer base of big customers

	Big customers are not sharing their data

Table 1. SWOT analysis as a result of servitization workshop

This SWOT analysis gives a general overview of what Company X has to deal with. These strengths, weaknesses, opportunities and threats will be considered when choosing a suitable service strategy for Company X.

Below we included a table in which we list the pros and cons of the three service strategies.

After-sales service provider		**Customer support provider**		**Development partner**	
Pros	**Cons**	**Pros**	**Cons**	**Pros**	**Cons**
High volume market so potentially a lot of data available	Customer is price-sensitive	Large, important customers value this service	Service offering cannot be met in the short term	Helps Company X produce a better product	Can be complicated with intellectual property
Relatively easy added value because of inexperienced customers	Customer needs to be convinced of the added value of the service	Data is being logged and stored on the large ships and can be transmitted to Company X when there is an agreement	High expectations from customers due to own analytics	Increases customer relationship	Development process can be more difficult because of more stakeholders
Expectations of service are lower	Most dredgers cannot transmit data to Company X yet	Customer is less price-sensitive	Customer does not want to share data	Higher customer retention	Customer does not want to share data
Relationship between customer and Company X is less crucial			Can negatively influence important relationship		
Service offering should be achievable within one year			Requires larger investment		
Can act as foundation of a CSP					
Requires lower investment					

Table 2. Pros and cons of different service strategies

The ASP has a very big advantage in terms of availability of data compared to all other strategies, this is essential to the feasibility of the strategy. The Dredgers' data which would be used is currently being

tracked but the Dredger does not have a device to save and send that data. However, this is not a very complex problem. Compared to the accessibility of data from larger ships like hoppers from Boskalis it is much easier for Company X to access the Dredger's data because Boskalis does not want to share their data at this moment.

The Dredgers are sold in higher volume than the hoppers. This makes it so that Company X potentially has more data available about the Dredgers than about the hoppers and thus more data to learn from. Based on this Company X can increase the added value of their services.

The service offering from a CSP completely overlaps with the ASP. This is very beneficial because when Company X would develop the service offering for the ASP they would indirectly also develop the CSP service portfolio. Once the ASP service portfolio is operational this can be shown to the customers interested in CSP as a minimal viable product.

If Company X wants to be a CSP in the future the foundation of systems and knowledge developed for the ASP will ensure that there is a smoother service roll out than there would be when Company X has no experience in offering digital services. When choosing to be a CSP it is very important for Company X to have a smooth roll out of their services. Considering Company X has barely any experience in digital services they have much to learn about providing valuable digital services. At the same time, they only have a few big customers to deploy their new services. It is likely that when Company X can convince their big customers to use their service but fails to meet the customer's expectations that they will not get another chance in the next few years to deploy a service there. This is quite a big risk because Company X has never done this before. Especially because the service which Company X wants to offer should be better than the in-house analysis these companies are already doing.

It is difficult to develop a standardized solution for custom made ships. This makes it less scalable and more complicated to roll out. This combined with the absence of digital business experience at Company X makes it something important to consider.

The different services within the service offering that are expected from an ASP seem to be achievable within a year according to experts at Company X. They are already offering spare parts, doing repairs, inspections and training. Although, the offering of spare parts, repairs and inspections should be optimized. The only extra service which should be included for an ASP is the hotline. However, the developed IRIS dashboard can help them setting up a well-functioning hotline. This makes the service offering from the Asp the most feasible from the three service strategies.

The entire service offering from an ASP is included in the service offering of an CSP. So, while Company X is developing the ASP service offering they are indirectly also developing the CSP service offering. The ASP service strategy can be the foundation of the CSP strategy. All gathered knowledge and developed systems for the ASP strategy can in the future be used to execute the CSP strategy.

The relation between the smaller customers and Company X is also less vulnerable than with the bigger customers, this makes it less risky to deploy a service at the smaller customers. The ASP also does not have to be as highly reliable as with the CSP (Ebeling, et al., 2014).

The most important difference between the service strategies in terms of feasibility is that the customers interested in a CSP or a DP are hesitant in sharing their data. This makes the execution of these strategies very difficult at this moment. In table 2 there is a comparison between the three services.

Thus, we choose to develop an ASP strategy. At this moment this strategy fits best to Company X. The CSP and DP strategies are also interesting for Company X but are not feasible now, primarily because of the absence of data sharing between customers and Company X. However, it is important to think about how Company X can ensure that it will be feasible. The ASP strategy is a good steppingstone towards the more sophisticated CSP and DP in the future.

4. Implementing the service strategy

In chapter 4 we are deciding what the service design is going to look like. This service design will be made in ArchiMate. First, we will see what service will be included in the service offering and what is needed to realise these features. When we know what services will be included in the service offering, we can use that to design the service. Processes like request for spare parts which are already modelled by Company X will also be inserted. We will also advise Company X on what changes need to be made to implement this service strategy.

4.1 Service offering

The in 3.3.3.4 chosen service strategy is that of an After-sales Service Provider. According to Ebeling et al. (2014) the service offering of such a service provider consists of offering spare parts, doing repair and inspections, hotline and basic training. We will go through all services within the service offering and list what is required to realise these individual services.

4.1.1 Spare parts

When offering spare parts, the logistics to quickly deliver these spare parts can be very complicated. Currently spare parts are sold from stock or are first ordered and then sent to the customer. This is very time consuming. Especially for Company X because their customers' ships are all over the world. Therefore, ASPs often collaborate with third-party logistic providers. A third-party logistics provider for Company X could for example be ShipServ or Shipsupport which is basically the Amazon of maritime spare parts. This way they can get the required spare parts on location quicker. Company X could choose to also have spare parts in stock with third-party local service agents. This third-party logistics partner can then get to the location quickly to deliver the spare parts. The by Company X modelled process of the purchase to order for spare parts is included in F.

4.1.2 Repairs

Company X is currently in talks with Van Oord because Van Oord wants to completely outsource all maintenance on the dredging equipment at Company X. Van Oord is one of the bigger players in the industry and has other needs than the market segment the ASP aims for. However, this shows that Company X is looking to increase their repair services. For the smaller customers this probably needs to be done differently than with the big customers. To be on site quickly and do repairs Company X has to collaborate with the third-party service providers.

4.1.3 Inspections

Company X is providing some of their customers, mostly smaller customers with inspection schedules. This means that Company X knows when and how you should do maintenance on the equipment. This can also be executed by a third-party service provider.

4.1.4 Hotline

A good hotline might be complicated for Company X to realise. This is because the service quality of the hotline increases when Company X has reliable and complete access to data from the ship. Now we will only investigate what is required to realise the hotline, in 4.2 we will elaborate on how to integrate the hotline with other services which Company X has to offer. If Company X has no data from these ships they must completely rely on the customers' explanation. The people from Company X which are doing the hotline service need to deeply understand how Company X's ships work. Also, they need to be able to

analyse the gathered data from the ships to help identify what is wrong. When Company X is rolling out the services the hotline can be the service which should pick up the phone whenever the customer has any questions about the ship. They can forward the customer to the needed service within the service offering. This way the customer has one point of contact at Company X which makes the service customer friendly. We choose to let the hotline do the forwarding of the customer because it will increase the utilization which drives profits which is needed when the customer demand is not reliable due to a small customer base. When there is a larger customer base this should be changed so that there is a central gateway which the customer calls which forwards it to the required service, then the hotline won't have the burden of forwarding customers through the system.

4.1.5 Basic training

Company X is currently training the customers' employees in Company X's training institute. They have developed their own training program which they update as the equipment changes. Sometimes they go to their customers ship to see what is happening on site, this will influence their training program together with reports they get from other Company X employees who have been on site. We might say that the education which the training institute is offering through simulation and lectures could be classified as advanced training. This means that the way Company X is currently educating these employees is enough for an ASP.

4.2 Organisation

The most important thing that should change within Company X is that there should be more collaboration between different departments or services. Moving DB closer to AS in the organization chart in appendix A might be a smart move to increase their collaboration. A better collaboration would increase the product market fit because the different departments and services have different insight in customer demand. When developing new services, the communication with the customer should also be improved. This would decrease development costs which would also have saved development cost with the development of the IRIS dashboard because it clearly is not being used by the customer at this moment. This shows that Company X developed software which does not meet the customer's expectation.

A good collaboration between the services would increase the functionality of the ASP through the functionalities we described in 4.2. This would also mean that if there is a possibility to create new business that it should be possible to create a multidisciplinary team which will investigate if this should further be developed and how it can be implemented.

The employees at Company X should be aware of the common goal they have instead of only executing their own service. For example, the hotline should not only want to help the customer on the phone and solve their problem, but they should also document this problem which can then help other services or ship building to increase their value. To encourage this there should be sessions in which individual services explain and show other services what has been achieved and how other services did indirectly contribute to these achievements. This should help the employees of the individual services realise that for example they are not documenting everything because they just have to but because it adds value. In these sessions there should also be an opportunity to give feedback, this way more perspectives are considered in the development of new services or products.

The demand of an ASP is very unpredictable, especially when the number of customers which the ASP is serving is low. While "Having fixed costs for the required service personnel, the main driver for profitability

becomes capacity utilization" (Ebeling et al. 2014), this makes it very difficult to estimate the required capacity. It is easier to predict customer demand when there are many customers than when there are only a few. It would be beneficial for Company X if they could quickly scale their services to serve higher volume customers to achieve high utilization. This also means they have to get either some small customers with many Dredgers or many smaller customers with some Dredgers aboard.

According to Ebeling et al. (2014) "ASPs bundle the various after-sales service activities such as repair, inspection, and spare-parts management in a cost-centre within the product unit.". At Company X this should be done for everything claim related because this is part of the product, in this case the product unit is ship building. However, the spare parts, repair and inspection costs can be accounted on the service department. The costs of installation of the sensors should be paid by the customer. Even though Company X could choose to pay the sensors to lower the threshold to use their service and through this get the customer enthusiastic about their service.

4.3 Service design

In this part we will design the service in ArchiMate which consists of five layers, the strategy layer, motivation layer, technology layer, application layer and business layer. We will also elaborate on what is happening between and within these layers. CBM is included in this service design, however this should not be focussed on for the first few iterations of the service. In the future the CMB could be substituted by predictive maintenance. We will elaborate on CBM and predictive maintenance in 4.4. The entire architecture is presented in figure 11, 12 and 13. The meaning of the elements in the architecture can be found in appendix D.

4.3.1 Strategy layer and motivation layer

The strategy layer and motivation layer are both visually described in ArchiMate in figure 11. The strategy layer starts with the service department which makes use of CBM software and IRIS, sensor data and IFS service management resources. This is assigned to the IT management and service operations which realises the course of action to become an after-sales service provider. Becoming an after-sales service provider is the most important part of the strategy layer. This flows to multiple other course of actions which will in the end realise the end goal to "servitize business and be less dependent on building ships". By becoming the after sales provider Company X will be able to optimize their ships blueprints, this will eventually lead to less technical claims because of superior product design. It will also contribute to less operational claims because the product will be able to cope with more operational failures than it did before. The service Company X will offer will also increase the customers' operational efficiency which leads to less claims because of better use of the product. All services included in the service offering together will lead the customer to have a high production for a low price. This should result in an increase in competitive advantage. This should increase Company X's market share.

By deploying digital services Company X will increase their knowledge on digital business which will help them servitize their market segment which consists of bigger customers in the future. Both the servitization of the market segment with big customers as becoming an after-sales service provider for smaller customers will create additional revenue streams.

The additional revenue stream combined with the increase in market share should result in a higher revenue. In combination with the decrease in costs through less claims, both technical and operational this will result in higher margin. Higher profits follow because of this which in the end realises the goal to:

“Servitize business and be less dependent on building ships”. This leads to the mission and vision of Company X (n.d.): “Company X provides reliable and innovative equipment, vessels and services that enable its customers to outperform in the dredging, offshore and mining industries. Our products and services add value to our customers’ activities, maximising uptime and performance, and minimising operational costs.” and “Company X aims to be a one-stop shop that provides innovative and integrated solutions for complex wet soil intervention issues.”.

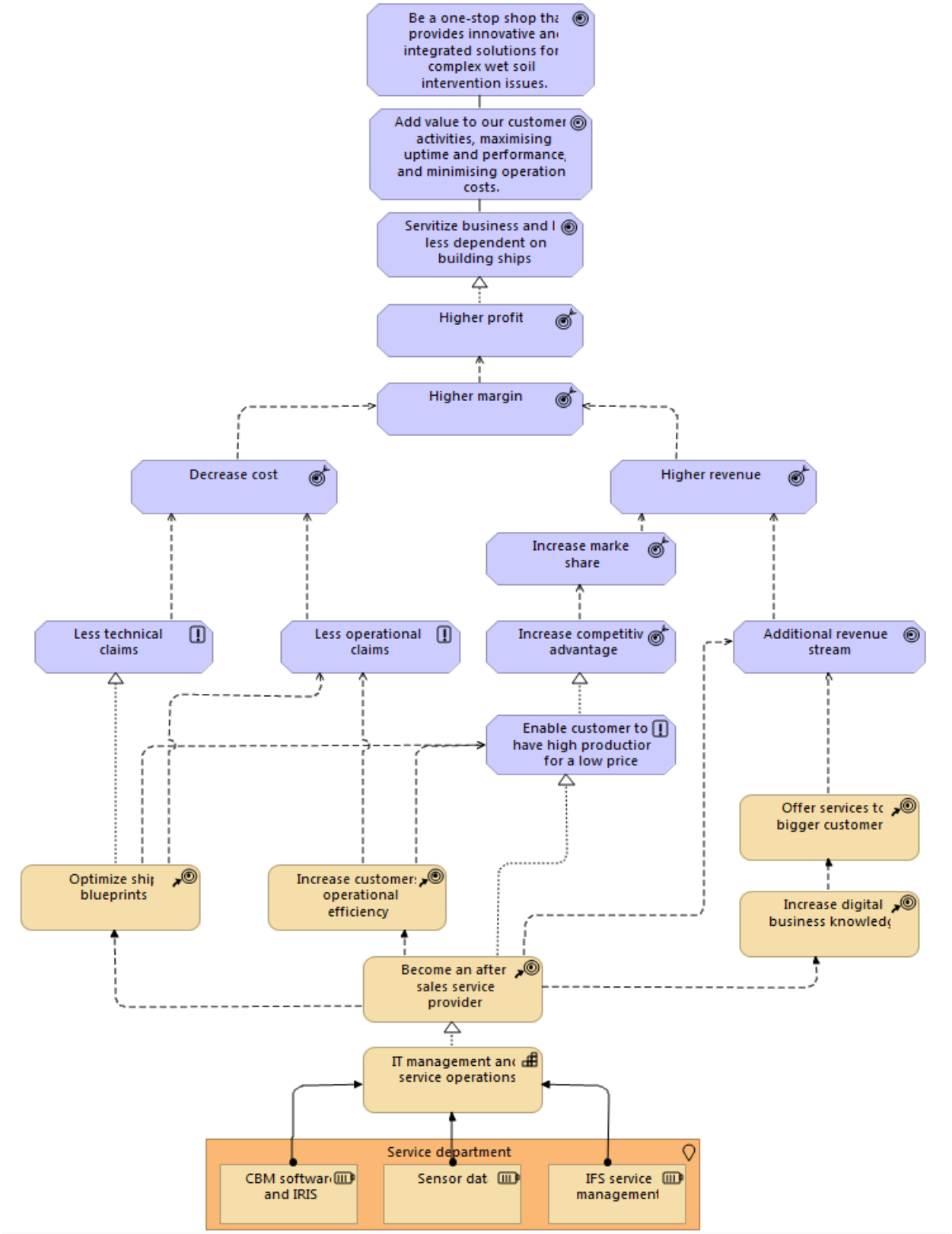

Figure 11. ArchiMate structure of the strategy layer and motivation layer.

4.3.2 Current service architecture

In figure 12 the current situation of Company X's services regarding Dredgers is modelled. There are several differences between the current situation Company X is in and the desired future situation. Currently there is a smaller service offering than is expected from an ASP. Also, the services which are in place are not fully optimized. There is no hotline, condition-based maintenance and third-party agent but Company X is handling claims, organizing training, executing physical services like repairs inspection and delivering spare parts. This overlaps with the ASP service offering. However, the claims and physical services which Company X is offering are mostly warranty related instead of commercial even though Company X would like to do more commercial claims. Company X then also sends employees to the customer to repair the vessel instead of collaborating with service agents.

The claim handlers and physical services do document the problems they run into. This is used to improve the blueprints and training program. However, there is no sensor data available to analyse these problems. This makes it more difficult to improve the blueprints and makes it harder to prematurely identify problems on the ship.

In the technology layer and application layer in figure 12 the elements which support the services an ASP offers which are not present in the current situation at Company X are left out. The elements which do support the currently offered services will be explained in 4.3.3 and 4.3.4.

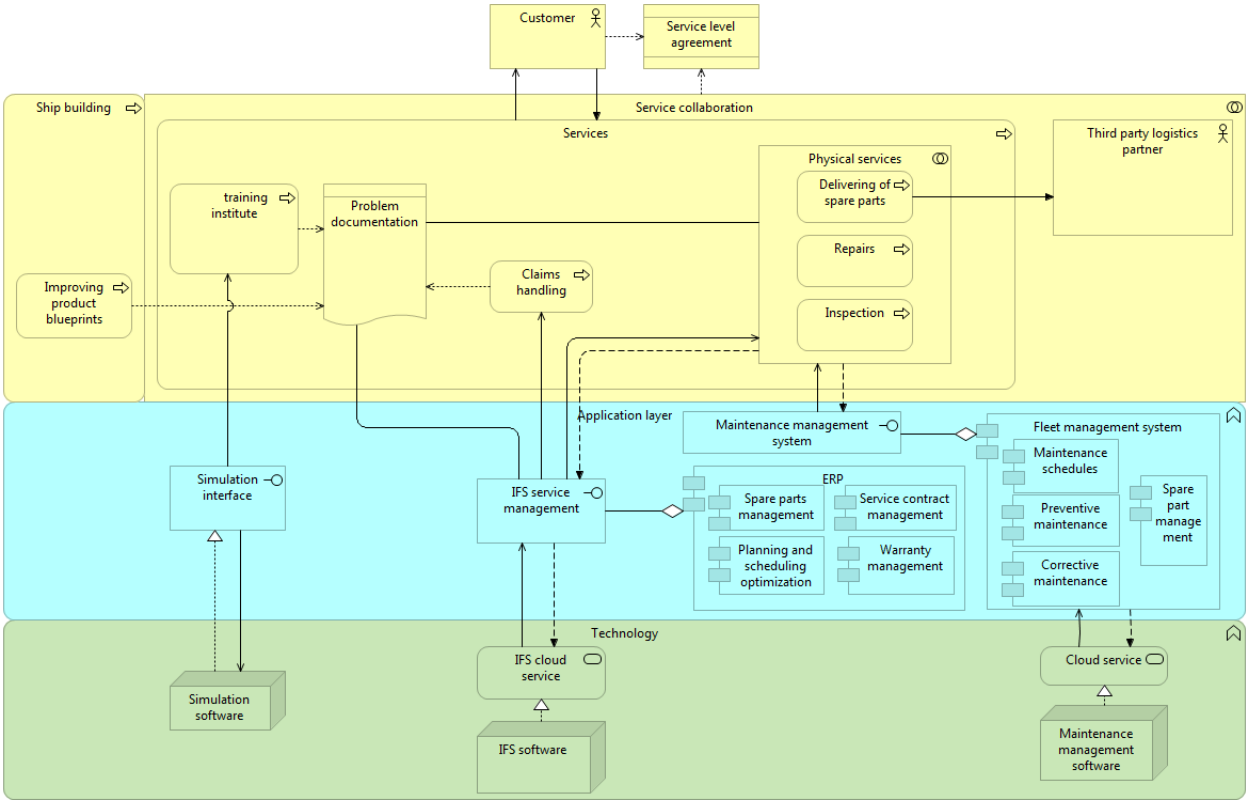

Figure 12. ArchiMate structure of current situation regarding Dredgers at Company X.

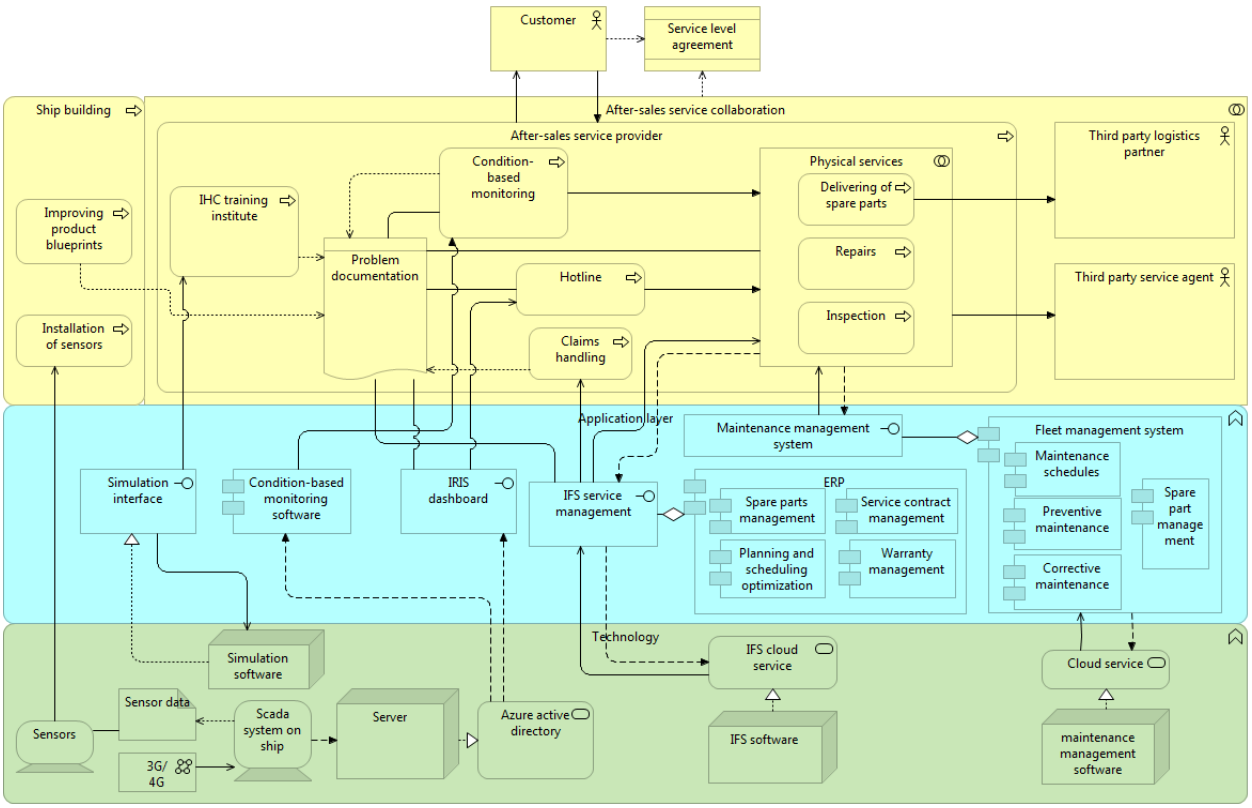

Figure 13. ArchiMate structure of desired future situation regarding services for Dredgers at Company X.

4.3.3 Technology layer

The technology layer visualises how the business and application layer are supported by technology. In this case the technology layer is used to model how data is gathered on the customers' ship and how different software packages and cloud services are used to support applications.

To gather data from the customers' ships sensors are installed. These sensors gather data on the ship which is then sent to the Scada system on the ship where the generated data is processed into usable data. Using the 3G or 4G network this data is sent to a server after which it is sent to the Azure Active Directory cloud solution.

The IFS software is hosted via the IFS cloud service. This cloud server saves all updates in the IFS. The same applies to the Marad software which is hosted by the Marad cloud.

The simulation software is developed by the systems department of Company X. It simulates a ship and an environment in which a trainee can practise how to dredge. According to the Company X training institute employees there are different parameters which they can change to change the scenarios.

4.3.4 Application layer

The application layer shows how the technology layer is used in the applications and how these applications support the business. Applications like simulation, CBM software, IRIS dashboards, IFS service management and maintenance management systems are presented in this layer with their accompanying components.

In the application layer the data in the Azure Active Directory should be accessible through the IRIS dashboard and the CBM software. The IRIS dashboard should be used for the hotline employees. Through the IRIS dashboard they have more insight in what is happening on the ship and what might be the problem the customer is dealing with at that moment.

There is also an ERP system which consists of spare parts management, warranty management, service contract management and planning and scheduling optimization. This is aggregated by the IFS service management interface. This ERP system is used by claim handling and the physical services.

The simulation interface is also in the application layer to realise the Company X training institute. They use these simulations to educate their customers on how their equipment should be operated.

The fleet management system consists of maintenance schedules, preventive maintenance, corrective maintenance and spare part management. This is hosted and served by the Marad cloud service and aggregated in the Marad maintenance management system. This system is used by the physical services.

4.3.5 Business layer

The business layer is the most complex layer of them all. This is because there are several services which should collaborate with each other. All modelled services are included in the service offering in 4.1.

The hotline can be highly valued by customers but also by Company X. This is because it can bring in a lot of information for Company X about how the users use their product and what problems occur in their operations. This is why the hotline should have many indirect connections through the business layer. With indirect connections we mean that the hotline service does not necessarily has to collaborate directly with for example the CBM service, however the CBM service should use the information gathered by the hotline. The hotline gets direct information from the customer what are common problems on the ships. The data gathered during the period of failure and the diagnosed problem should be documented in IFS. These documents can then be used for different purposes.

The Company X training institute can use the documents to improve their training programs. This would improve the quality of the training service and at the same time reduce claims from the customer. The reduction on claims would lead to a smaller workload for the Company X employees who process these claims and also reduce the claim costs. The documented claims can also be used to improve the training programs by looking at often occurring claims.

The CBM can use these documents combined with the ship's sensor data to identify fingerprints in this data. These fingerprints are certain patterns which can be identified leading up to the problem on the ship. Fingerprints can in the future be used to warn customers before certain problem occurs. By using this data, they can also identify what is going wrong on these ships both for operational failure as technical failure. The time interval of the failure should be documented so the data can be trace back in the azure directive server where the original data comes from. The operational failures can then again be used in the training institute and the technical failures can be used by the ship building department.

The shipbuilding department can use the problem documentation to improve the ship's blueprints. This will eventually lead up to less technical claims and a competitive advantage in terms of product quality. Shipbuilding will also need to install the sensors on the ships which will be used for data gathering.

Claim handling should also use the problem documentation. If the customer's ship is still in the warranty period, the diagnostics being done by the hotline and the documentation of data can help them to easier identify with higher accuracy whether a claim is caused by operational failure and thus will not be compensated or if it is caused by technical failure and thus should be compensated.

The hotline and CBM should directly collaborate with the physical services like delivering spare parts, repairs and inspection. Whenever the customer calls the hotline and repairs, spare parts or inspection is required the hotline can directly notify these services on the customer's request. They can then take the necessary steps to provide the necessary services to the customer. This should increase Company X's market share in the delivering of spare parts.

CBM should directly work with the physical services when they get a notification that something is wrong on the ship. Inspection might be required to assess what is wrong on the ship or when they can already see from the data what is wrong, they might need to immediately send technicians and spare parts to the customer. Because the CBM can prematurely find defects Company X also has a larger time window to deliver the spare parts and do the repair.

The spare parts, repair and inspection are modelled in a physical services business collaboration because they should constantly collaborate with each other. When spare parts are delivered there should also technicians be present to immediately do the repairs. Also, whenever inspections are being done and there are repairs required this should be communicated so that spare parts will be delivered. These spare parts should be delivered by a third-party logistics provider. The repairs and inspections should be done by a third-party service agent. In some cases, these two services might be provided by a single third party. These services should be provided by third parties because Company X does not always have employees available globally at every location the customer is operating, this would be too costly. This collaboration allows Company X to quickly serve their customers while having lower costs than doing everything on its own.

According to Ebeling et al. (2014) the employees should continuously be educated and have both formal classroom training as on the job training. The Company X training institute should take this responsibility.

4.4 Pricing and value creation

Currently at Company X building ships is their main revenue stream. However, when servitizing the business, Company X should be looking to make the revenue stream from services more dominant than it is at the moment. Ebeling et al. (2014) state that the product, in case of Company X the Dredger dredging ships, should be sold for an attractive price. This should encourage customers to buy Company X's ships. Proper functionality of the product should be guaranteed through the after-sales services Company X is offering with their product. To do this the offering of services for the customers should be seen as an essential part of the total value creation, both within Company X and by the customer.

Changing the strategy to increase revenue from services instead of building ships might be difficult at Company X. This is because different departments within Company X are different legal entities, this already divides the company. Shipbuilding is part another private limited liability company than the

services department. If Company X would decrease margins on the ships this would mean that the shipbuilding department will have less margin. This might be a point of friction due to the individual way of thinking within Company X, which is further stimulated by the separate legal entities. On the other hand, could the lower margin and the service offering lead to higher demand which eventually could lead to higher profits despite the lower margin.

According to Ebeling et al. (2014) the services offered next to the product should be unbundled. This means that the customer should get to choose which services they want access to. The customer should be able to choose individual services. To encourage the customer to take extra services, Company X should make use of discounting. The more services the customer incudes in the service package the cheaper the individual services should get. For example, the customer should be able to choose the hotline and basic training services without also having to pay for the spare parts and repair services. However, the pricing of these services should then be relatively more expensive to choosing the entire service offering.

4.5 Implementation

We advise Company X to focus on installing sensors on the Dredgers and to fix problems with regard to saving this sensor data as soon as possible. While Company X is doing this, they should use "The Kano Model of customer Satisfaction" (Kano, 1984) and "approaches for understanding customer needs" (Bayus, Shane (Ed.), 2005) to understand what the customer wants from Company X, so they know what to offer to their customer. This should be done by DB in collaboration with AS. AS should be responsible for the entire service offering but DB should provide the required information and infrastructure to execute these services. This collaboration can be increased by moving DB closer to AS within the organization chart as well as physically. Currently there is no collaboration between these two departments, it would be easier to collaborate when they are in the same building or even office. AS is now located in an office which is half empty, therefore we advise Company X to move DB to this office as well.

Company X should also start conversations with third-party agents which can do on demand repairs and inspections, this should also be done with service agents which can provide spare parts like ShipServ. Agreements should be made about what these service agents do for Company X and for which price. They should also discuss how this can be executed logistically.

Future hotline employees should be educated on how to use the IRIS tool to do remote diagnostics. During this process dashboards should be developed which can be used for the hotline service. The development of these dashboards should be done in collaboration with employees which have on-site experience and thus know what common problems are at the Dredgers. This way dashboards can be built which optimally support the hotline employee in finding the problem on the ship.

The documentation of often occurring problems should be made accessible for CBM, Company X training institute, hotline and claim processing employees. There should also be governance in the documenting of the problems which keeps it clear and prevents errors.

According to experts Company X should be able to develop the core services of the service strategy which consists of spare parts, repair, inspections, hotline and basic training within a year. Only when the core service offering is set up Company X can start exploring possibilities of CBM or preventive maintenance. This should be discussed with the customers to find out of the customer is willing to pay for this service. When Company X starts exploring this service they can look to collaborate with Boskalis.

Because there are multiple services Company X has to develop they might want to prioritize because of capacity issues. We advise Company X to work on servitization in the following order:

1. Install sensors on Dredgers and fix data storage problems.
2. Relocate DB and AS physically closer to each other.
3. Find out the customer needs.
4. Educate hotline employees and build dashboards for them.
5. Start conversations with third-party agents.
6. Set up often occurring problem documentation.
7. Set up a collaboration between hotline and physical services.
8. Find out if there is interest in CBM at the customer.
9. Start looking into possibilities for servitization with big players like Boskalis.

To get full benefit from the service strategy there are several crucial requirements. The data logged on the ships is processed and stored correctly. When this is not the case it is difficult for hotline employees to do good diagnosis on the ships and eventually CBM and ship building can not use the data logged on the ships. The hotline employees need to be well educated to be able to extract the right information from the data and be able to link this to certain failures. This should be well communicated to the physical services which requires a good collaboration between the different service providers. Lastly, the communication between Company X and the third-party agents should be good and agreements they made should be met. There have to be third-party agents on different locations to quickly provide spare parts or do maintenance.

4.6 Future additions to the service

There are additional options to implement in the service offering. These options could lead to an even more present competitive advantage and a larger revenue stream from providing services. In this part we are going to look at possible options to add to the service in the future. We will also elaborate on CBM and predictive maintenance which is introduced in chapter 4. To clarify the difference between CBM and predictive maintenance we will introduce the two. CBM measures certain parameters and at the moment that these parameters exceed acceptance levels maintenance will be done. When doing predictive maintenance, we analyse sensor measurements using algorithms and formulas, based on this we schedule maintenance predictively to prevent breakdowns.

4.6.1 Condition-based monitoring

Company X has employees which are specialised in CBM. This service is on demand and basically only used for big ships. However, Company X is looking to implement this for the Dredgers. They are already gathering data from the ships for the hotline. This data can be used to do CBM even though it needs to be more reliable than it is right now and might need to track other variables on the ship. Company X can then also learn from doing this CBM on a bigger scale and how they can implement this for larger customers in the future.

At this moment spare parts are manually requested by the customer. When spare parts are requested the lead time depends on whether Company X has the spare parts in stock or not. When these parts are not in stock it can take a while until the part arrives. This is a motivation for the customer to decide to buy the part somewhere else.

Using CBM, Company X has some more insight in when spare parts are needed at one of its customers' vessels. This would increase the time window Company X has to deliver the spare parts. It will also reduce safety stock levels at Company X or/and at the customer and even Company X's supplier because Company X knows when the parts are needed before they actually break. Who reduces the safety stock depends on who normally holds the safety stock for spare parts, this can be Company X or the customer.

Company X would acquire a unique value proposition in the spare part market through the use of CBM. There are no other spare part vendors which know in advance that spare parts will be required at a specific customer in the dredging market. This will increase Company X's market share in the selling of spare parts.

CBM could also trigger inspections and repairs. Whenever CBM sees something is going wrong on the vessel they can send technicians to the customer to do inspections on the vessel or do maintenance if needed. This would increase uptime of the customer's ship, reduce costs on maintenance and gives Company X a larger time window to get the technicians on location compared to a situation in which the vessel already has vital damage and the technicians should be on location as fast as possible.

If Company X chooses to implement this service for the customer segment where the ASP aims for it should be discussed very carefully with these customers. They should be aware of the financial implications but also of the advantages it brings. This way the customer can also be involved in the development of this service. This would minimize the risk that Company X develops CBM services but that the customer does not want to pay for it like what happened with IRIS.

4.6.2 Predictive maintenance

When the services are up and running Company X could also choose to implement predictive maintenance if this is not too expensive and the data quality from the ships has been improved. This service cannot be too expensive because the customer segment where the ASP is focussed on is very price competitive and might not want to pay for this service.

Predictive maintenance would even give Company X more insight on when spare parts are needed. This would further emphasize the advantages which are previously discussed for CBM. It gives Company X a larger time window to deliver spare parts, do maintenance and do inspections which does increase the vessel's uptime and reduce costs. Additionally, it would further reduce safety stock and increase the competitive advantage in the spare part market. If Company X looks to implement this for the ASP customer segment it should be discussed with the customer, the same way as with the implementation of CBM.

Company X would also learn from developing their predictive maintenance algorithms for the smaller customers which in the future can be implemented for the bigger customers. Experience with the smaller customers with regard to predictive maintenance can influence a smoother roll out on this part of the service offering of an CSP.

The unique value proposition Company X can create by using predictive maintenance or CBM in the spare part market is very important. When Company X is collaborating with for example ShipServ it does not only give access to a customer base, which could normally also buy spare parts at ShipServ but it does also predict demand. ShipServ cannot do this because they will not have predictive algorithms. This is an advantage for both ShipServ as for the customer. ShipServ knows when to order their spare parts which need to be delivered to Company X's customer which reduces costs while Company X's customer will have

less downtime because of the predictive algorithms. This reinforces Company X's position in this collaboration.

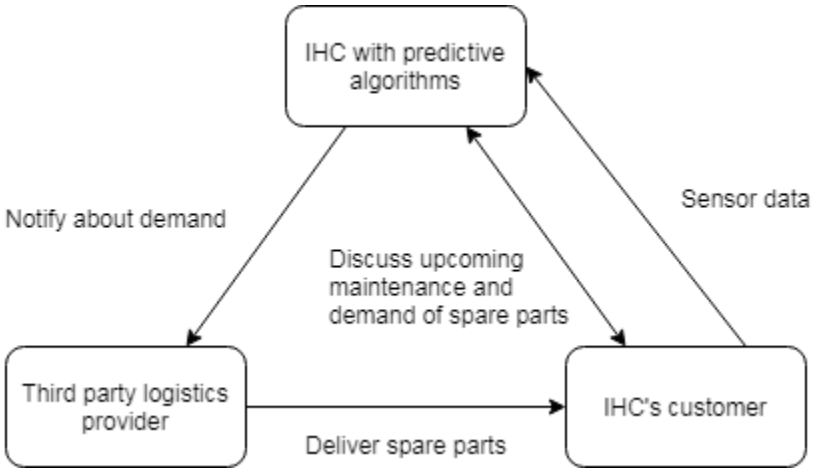

Figure 14. A visual representation of the collaboration between a third-party logistics provider, Company X and Company X's customer.

4.7 Boskalis and Company X control tower

Company X and Boskalis are both participating in the MARCONI project. As Boskalis is an important customer for Company X it is very interesting for both parties to collaborate within the MARCONI project. Through MARCONI they could develop a practical solution which can improve their business processes.

Company X and Boskalis want to develop a control tower to enhance their spare part logistics. Boskalis' asset data gathered by sensors would be used in predictive algorithms. These algorithms would predict when spare parts will be required. This information will be pushed to the predictive maintenance application which triggers the maintenance management system. This system will advise Boskalis' on when to order spare parts. This information will directly be forwarded to the spare parts supply chain at Company X. Company X can then order spare parts via IFS. In figure 15 the control tower between Boskalis and Company X is modelled in ArchiMate.

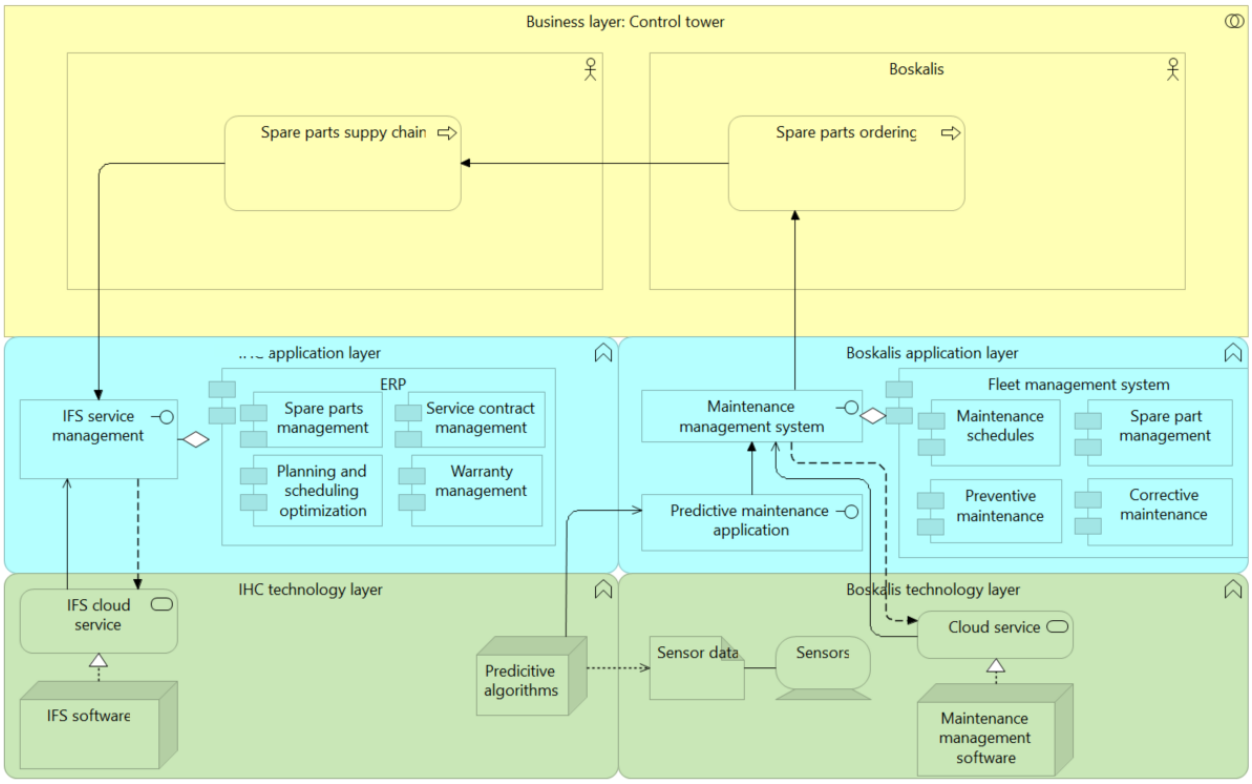

Figure 15. A control tower for Company X and Boskalis

This control tower would reduce inventory costs because Company X can predict when spare parts are needed and thus will need less safety stock. It will also reduce downtime for Boskalis' vessels. This is very helpful for Boskalis because high utilization is a big driver for profitability at Boskalis.

Sharing asset data is an issue in this control tower. The asset data would be used for the predictive algorithms to forecast spare part demand. We can imagine that Boskalis can run these algorithms internally and only share the results of these algorithms with Company X. This way Boskalis stays owner of their data and never has to share this data with Company X. Meanwhile Company X gets the results of the data and can use this to optimize their supply chain. The algorithms should be running in a separate application and feed the results into the maintenance management system.

Company X will probably develop these algorithms in the future to be deployed at multiple customers. If Boskalis would develop these algorithms as well the financial implications of these algorithms would be much higher. It would be beneficial to find some collaboration between the two companies by which not both have to develop predictive algorithms. Company X will stay owner of these algorithms when offering it as a service.

This type of a control tower can also be developed for Company X's smaller customers. The predictive algorithms would probably not be as complex because the processes on the Dredgers are not as complicated as on the bigger ships. The algorithms can also be deployed at more ships in the case of smaller customers than with bigger customers. Developing algorithms for the Dredger customers would make more sense than starting with more complex algorithms for big customers. The algorithms developed for Dredger customers can be used as a foundation for the algorithms for large vessels.

5. Conclusions, recommendations and limitations

In this chapter we will elaborate on the conclusions of this research and give further recommendations for Company X. The goal of this research was to solve the core problem: “No clear service strategy”. This is what the main reason why Company X cannot get their advanced services off the ground and does not meet the customer’s expectation. This holds them back from creating an extra, stable revenue stream which they desperately need.

To solve this, we mainly focussed on finding a suitable service strategy for Company X and investigating how this service strategy can be implemented at Company X.

5.1 Conclusion

The goal of this research was to make sure that Company X has more insight in how to proceed in terms of servitization, has a clear strategy about this process and has a service design. We explained what servitization is and what should be focussed on during this process. We compared different service strategies and chose which strategy would be best for Company X to implement right now. After choosing the strategy we modelled this service in ArchiMate and elaborated on how this service should be implemented.

After realising this service Company X should have multiple advantages compared to the current situation. These advantages will be listed below.

- Company X should have more information about ship performance which can be used for product improvement.
- Company X could improve their programs at the Company X training institute.
- Company X should acquire more knowledge on digital service which can be used for future implementation of digital services for bigger customers such as Boskalis.
- Company X should have better customer retention and larger market share in the supply of spare parts.
- Company X would have to assess and compensate for less claims because of operational and product improvement.
- Through these advantages Company X should increase their competitive advantage over other dredging ship producers.
- Company X would have a more scalable business model instead of just selling ships.
- Company X should increase maintenance and inspection services.
- This strategy incentivises Company X to build ships which are low in maintenance.
- These advantages combined would increase revenue.

We think implementing a service strategy such as the ASP at Company X is crucial for the future success of the company. Company X is about 380 years old with 3000 employees which brings advantages such as a lot of experience in building ships but also disadvantages of being less flexible and sometimes less innovative. For example, in terms of IT Company X is not very developed. They seem to have identified this, if Company X would invest in IT developments and lead the way in that field it could be a significant competitive advantage.

Also, one of the problems we identified is that the Company X employees don’t operate with the company vision in mind. This is very important in my opinion but very hard to solve. This contributes to several

problems, for example that different departments do not collaborate properly and products which do not bring value to the customer are developed.

5.2 Recommendations

This research started by looking into how Company X can do predictive maintenance and how this could be implemented. However, as described in appendix B there were data problems which made it impossible to do good analysis on this data. When Company X is properly logging data from their customers' ships we recommend Company X to research possibilities in the field of standardized predictive and condition-based maintenance. That research should give an indication of costs, advantages, disadvantages and limitations as a result of standardized predictive and condition-based maintenance. The research could also go in depth in how the data logged on the ship can be used as an input for algorithms which would automatically identify patterns in this data leading up to the failure. By identifying these failures prematurely, appropriate action can be taken to prevent it from failing or it can help to quickly identify what the problem is.

By doing this research before the ASP service strategy is implemented it enables Company X to implement improvements or extra services as soon as possible. However, there is a need for more reliable data logged from the dredger dredgers before this research can be done.

Further research should be done on how Company X can implement a service strategy for the larger customers like Boskalis. What is the demanded service offering? The CSP service strategy from Ebeling et al (2014) might fit to the bigger customers but this needs to be further evaluated in the research. Also, how developed should the services be in order to be attractive to the large customers because they already do analysis in house. In order to compete with the customer's own in-house services, they need to be on another level. Finally, the research should clarify what Company X needs to do to realise these services for large customers.

5.3 Limitations

There were several limitations during this research. These limitations influence the results of the research. In this section we will elaborate on these limitations.

Developing a service strategy requires knowledge about the customers which will be using these services and the business the company is operating in. Before coming to Company X for this research we had no knowledge about dredging and shipbuilding. We got familiar with different aspects of dredging and how the business works but we do not have years of experience in the business like the employees at Company X have. Because of this we constantly asked feedback and discussed what we were doing with employees at Company X.

Many employees at Company X are working in the maritime sector for a long time. They have not seen many other industries and might therefore be biased. Sometimes employees would say that there is no way that it would be feasible for Company X to have good margins by offering services like CBM and predictive maintenance. The opinions from employees on servitization varied a lot within Company X.

As we said before, when developing the service strategy, it is important to understand the customer. There are different ways to find out what the customers want, one of these is talking to the customer. During the time we had we did not get the chance to talk to customers to listen to their needs. This might have influenced the service strategy.

Company X is a large company of about 3000 employees. This makes it difficult to get an entire overview of what is happening at Company X. Especially during the short time period, we had to do this research. Also, the financial structure of Company X with several limited liability companies makes it difficult to oversee where costs should be allocated and where profits should flow to.

A strategy concerns a large part of the company. Due to this it is time consuming to elaborate the implications and how it should be implemented for the different departments in the company. Especially because Company X is also a large company with many different departments.

When starting this research, we expected Company X to have the required data to do research on predictive maintenance. However, this seemed not the be the case. Due to this we had to change the scope of this research which lead to me having less time and was quite a big setback.

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Appendix

Appendix A Visual representation of Company X departments

Note: Retrieved from Company X intranet.

Appendix B Possibility of predictive maintenance

We investigated if it was possible to do predictive maintenance with the currently available data at Company X. Digital Business extracted the logged data in csv files. We chose to look at the dredging pump vacuum because there often occurred problems on this component and there were multiple variables logged on the ships. Data was supposed to be logged every second for different variables. The variables which were related to the breakdown of the dredging pump was the density of the mixture, power, engine load and glandwaterpressure. However, there were big gaps in the data. With gaps we mean that for example data is logged every second but suddenly there are gaps from a few seconds or minutes between the last data point and the next data point which made us wonder if the data was reliable.

Then we used a claim report in combination with the logged data to see if the data matched what was reportedly going wrong. Together with an expert we figured that we were sure that the slip detection alarm went off. However, in the entire data set did not log that this alarm went off. According to the data the alarm never activated. This showed that the data logged from the ship was not reliable nor complete and thus not suitable to do predictive maintenance.

This case on the dredging pump was the only case Company X thought was solvable at this moment with the current systems and data in mind. After this case did not succeed the results of research on predictive maintenance were extremely uncertain. And thus, we stopped focusing the research on predictive maintenance.

Appendix C Service strategies

	After-sales service provider	**Customer support provider**	**Development partner**	**Outsourcing partner**
External environment	Cluster 1	Cluster 2	Cluster 4	Cluster 3
Customer requirements	Proper functioning of the product	Main purchasing attributes are product performance and reliability; efficiency and effectiveness of the product in the customer processes	Innovative solutions for their operating processes	Reducing the initial investment; high level of operational services

	After-sales service provider	Customer support provider	Development partner	Outsourcing partner
Competitive intensity	Competitive equality with products, erosion of product margins	Technical superiority creates part of the differentiation	Competitive equality with products; and after-sales service; erosion of product and service margins; sustainable competitive advantages come from designing individual solutions for customer process	High price competition
Service strategy				
Service offering	Spare parts, repair, inspection, hotline, basic training	Comprehensive preventive maintenance, advanced training, process optimization, repair, inspection, hotline and spare parts	Design and construction services	Mainly operational services; other kinds of services are not important; customized service are not important

	After-sales service provider	**Customer support provider**	**Development partner**	**Outsourcing partner**
Value proposition	Provide products at attractive prices; guarantee proper product functioning through after-sales services	Provide highly reliable products and increase customer efficiency and effectiveness through services; tailored services to satisfy the individual customers; guarantee a fixed price for individual service package	Customers benefit directly from supplier development competencies; Co-production of competencies between customer and supplier	Combining cost leadership, medium degree of product and service differentiation; value proposition is based on reducing the customer's capital employed and managing the corresponding risks
Pricing	Unbundling pricing approach enables customer to choose service; use of discounting	Low intensity of price discounting	Price bundling of product and service	High price competition, price discounting is regularly used
Organizational design elements				
Human resource management				

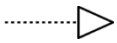
	After-sales service provider	**Customer support provider**	**Development partner**	**Outsourcing partner**
Personnel recruitment	Strong foundation of technical expertise; ability and motivation to learn continuously	Strong foundation of technical expertise; behavioural competencies and customer-focused attitude; risk-assessment skills	Strong foundation of research and development expertise; graduate engineers from technical universities; managing engineers from professional engineering consultancies or other manufacturing companies	Frontline employees with good expertise in operating processes recruit customers' employees when taking over the operation of customer processes
Personnel training	Formal classroom training; on-the-job training	Initial training program, on-the-job training; mentoring program	Trainee program for graduate engineers; on-the-job training	Do not incur great costs of intensive training of the frontline staff in advanced operational skills; on-the-job training
Corporate culture				
Values with respect to providing services	Services as an essential part of total value creation	Customization and flexibility are the enabler of value creation	Being service provider for customers; Co-innovating solutions is main source of value creation	Convincing frontline staff to be a "pure service provider" that delivers the output of the operating

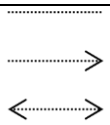
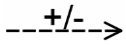
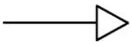
	After-sales service provider	Customer support provider	Development partner	Outsourcing partner
				process to the customer; focus on standardized services
Role of employees	Serve a reliable trouble-shooter; deliver standardized service	Deliver highly customized services; serve as performance enabler	Serve as a trusted advisor, develop a learning relationship; lead collaborative innovation performance	Reliable operators and boundary spanners between standardized services and complex service delivery
Organizational structure				
Integration of business unit responsibility	After-sales services as a cost centre within the product unit	Creation of a separate service division	Separate R&D team	Separate service organization which is often legally independent
Inter-firm collaboration	Initial internal resource flow from production function, shared resources between service and production function	Initial internal resource from the product unit, no shared resources on an on-going basis	Initial resources from the R&D function, internal expert knowledge network	Close collaboration with banks and insurance companies

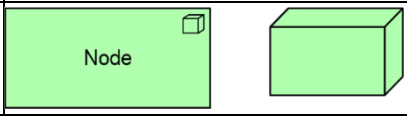
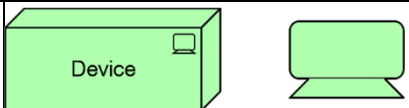
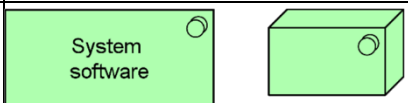
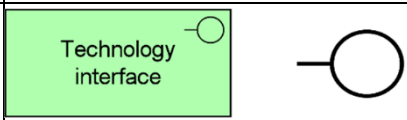
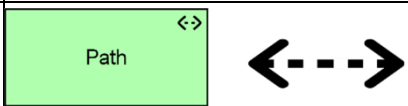
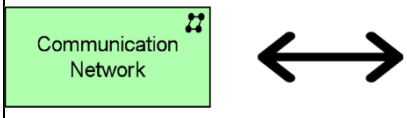
	After-sales service provider	Customer support provider	Development partner	Outsourcing partner
Global service infrastructure	Service agents	Infrastructure of local service organizations; essential investment that will not generate revenues immediately; diffuse knowledge across the local service organizations; explicit decision on standardization of services	Centralized service infrastructure because R&D team for external customers is located at headquarters	Great emphasize on customer-proximity; decentralized decision making

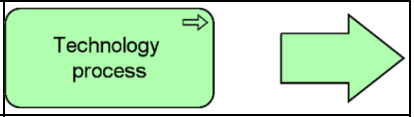
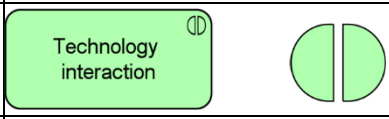
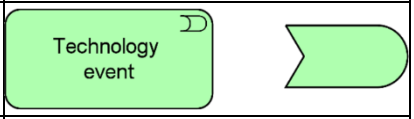
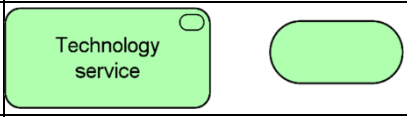
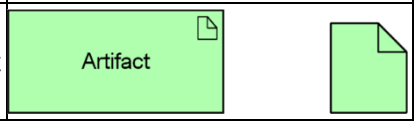
Note. Reprinted from Strategies for Developing service Business in Manufacturing Companies, Ebeling et al. (2014). In: *Servitization in industry*, by G. Lay, 2014, Berlin: Springer, Cham.

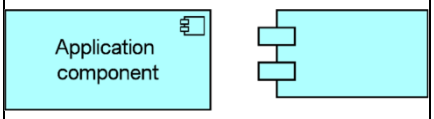
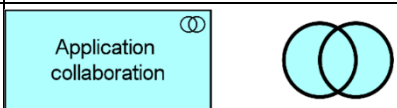
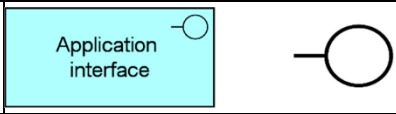
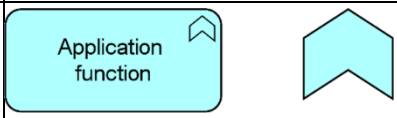
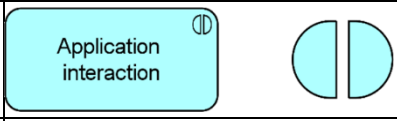
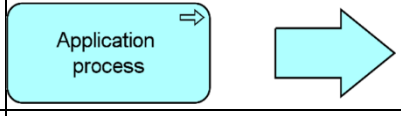
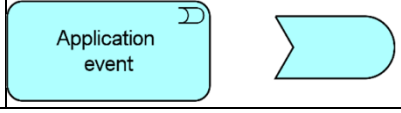
Appendix D ArchiMate 3.0 documentation

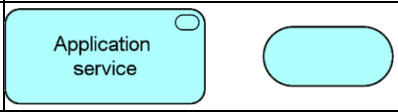
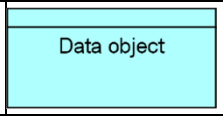
Structural Relationships		**Notation**
Composition	Indicates that an element consists of one or more other concepts.	
Aggregation	indicates that an element groups a number of other concepts.	
Assignment	Expresses the allocation of responsibility, performance of behavior, or execution.	
Realization	Indicates that an entity plays a critical role in the creation, achievement, sustenance, or operation of a more abstract entity.	
Dependency Relationships		**Notation**
Serving	Models that an element provides its functionality to another element.	

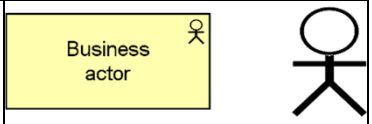
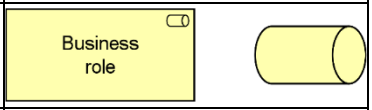
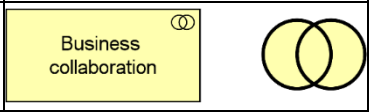
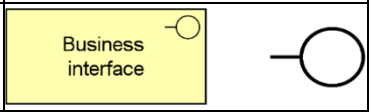
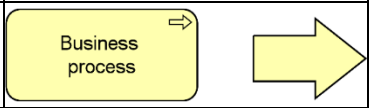
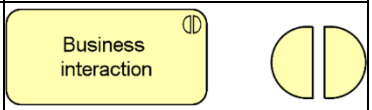
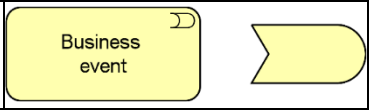
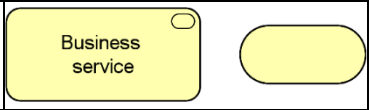
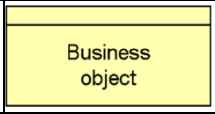
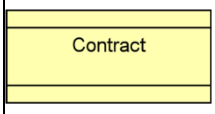
Access	Models the ability of behavior and active structure elements to observe or act upon passive structure elements.	
Influence	Models that an element affects the implementation or achievement of some motivation element.	
Dynamic Relationships		**Notation**
Triggering	Describes a temporal or causal relationship between elements.	
Flow	Transfer from one element to another.	
Other Relationships		**Notation**
Specialization	Indicates that an element is a particular kind of another element.	
Association	Models an unspecified relationship, or one that is not represented by another ArchiMate relationship.	
Junction	Used to connect relationships of the same type.	

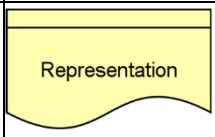
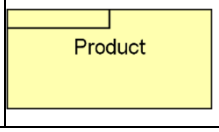
Element	**Definition**	**Notation**
Node	A computational or physical resource that hosts, manipulates, or interacts with other computational or physical resources.	
Device	A physical IT resource upon which system software and artifacts may be stored or deployed for execution.	
System software	Software that provides or contributes to an environment for storing, executing, and using software or data deployed within it.	
Technology collaboration	An aggregate of two or more nodes that work together to perform collective technology behavior.	
Technology interface	A point of access where technology services offered by a node can be accessed.	
Path	A link between two or more nodes, through which these nodes can exchange data or material.	
Communication network	A set of structures that connects computer systems or other electronic devices for transmission, routing, and reception of data or data-based communications such as voice and video.	

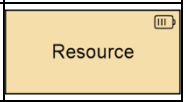
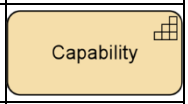
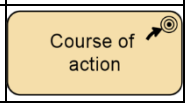
Element	Definition	Notation
Technology function	A collection of technology behavior that can be performed by a node.	
Technology process	A sequence of technology behaviors that achieves a specific outcome.	
Technology interaction	A unit of collective technology behavior performed by (a collaboration of) two or more nodes.	
Technology event	A technology behavior element that denotes a state change.	
Technology service	An explicitly defined exposed technology behavior.	
Artifact	A piece of data that is used or produced in a software development process, or by deployment and operation of a system.	

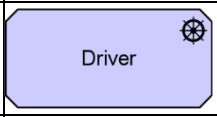
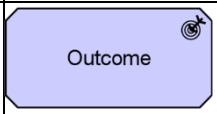
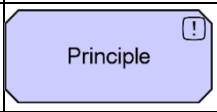
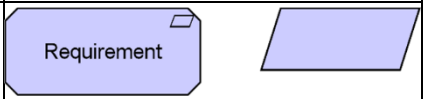
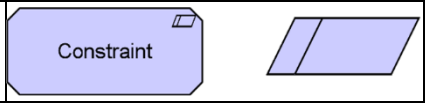
Element	Definition	Notation
Application component	An encapsulation of application functionality aligned to implementation structure, which is modular and replaceable. It encapsulates its behavior and data, exposes services, and makes them available through interfaces.	
Application collaboration	An aggregate of two or more application components that work together to perform collective application behavior.	
Application interface	A point of access where application services are made available to a user, another application component, or a node.	
Application function	Automated behavior that can be performed by an application component.	
Application interaction	A unit of collective application behavior performed by (a collaboration of) two or more application components.	
Application process	A sequence of application behaviors that achieves a specific outcome.	
Application event	An application behavior element that denotes a state change.	

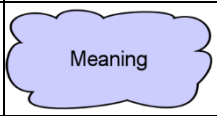
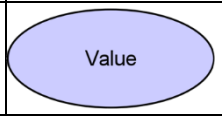
Element	Definition	Notation
Application service	An explicitly defined exposed application behavior.	
Data object	Data structured for automated processing.	

Element	Description	Notation
Business actor	A business entity that is capable of performing behavior.	
Business role	The responsibility for performing specific behavior, to which an actor can be assigned, or the part an actor plays in a particular action or event.	
Business collaboration	An aggregate of two or more business internal active structure elements that work together to perform collective behavior.	
Business interface	A point of access where a business service is made available to the environment.	
Business process	A sequence of business behaviors that achieves a specific outcome such as a defined set of products or business services.	
Business function	A collection of business behavior based on a chosen set of criteria (typically required business resources and/or competencies), closely aligned to an organization, but not necessarily explicitly governed by the organization.	
Business interaction	A unit of collective business behavior performed by (a collaboration of) two or more business roles.	
Business event	A business behavior element that denotes an organizational state change. It may originate from and be resolved inside or outside the organization.	
Business service	An explicitly defined exposed business behavior.	
Business object	A concept used within a particular business domain.	
Contract	A formal or informal specification of an agreement between a provider and a consumer that specifies the rights and obligations associated with a product and establishes functional and non-functional parameters for interaction.	

Element	Description	Notation
Representation	A perceptible form of the information carried by a business object.	
Product	A coherent collection of services and/or passive structure elements, accompanied by a contract/set of agreements, which is offered as a whole to (internal or external) customers.	

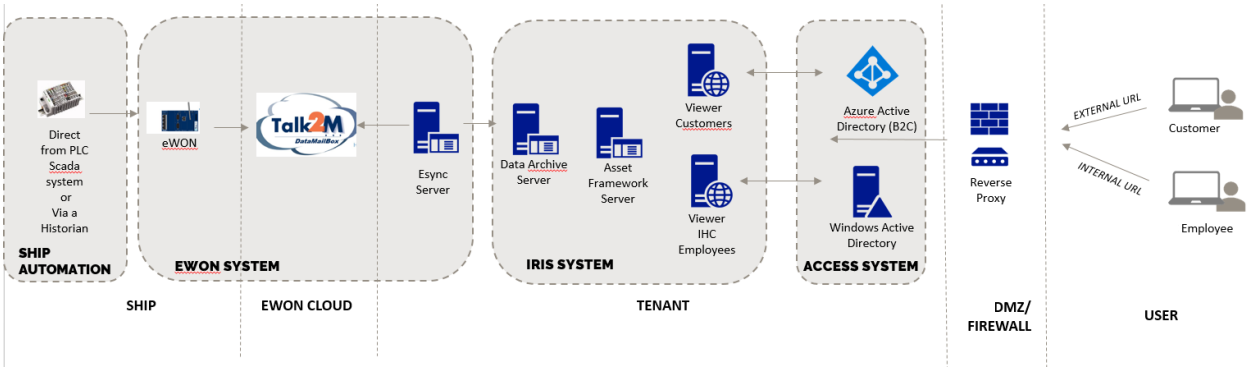
Element	Description	Notation
Resource	An asset owned or controlled by an individual or organization.	
Capability	An ability that an active structure element, such as an organization, person, or system, possesses.	
Course of action	An approach or plan for configuring some capabilities and resources of the enterprise, undertaken to achieve a goal.	

Element	Definition	Notation
Stakeholder	The role of an individual, team, or organization (or classes thereof) that represents their interests in the outcome of the architecture.	
Driver	An external or internal condition that motivates an organization to define its goals and implement the changes necessary to achieve them.	
Assessment	The result of an analysis of the state of affairs of the enterprise with respect to some driver.	
Goal	A high-level statement of intent, direction, or desired end state for an organization and its stakeholders.	
Outcome	An end result that has been achieved.	
Principle	A qualitative statement of intent that should be met by the architecture.	
Requirement	A statement of need that must be met by the architecture.	
Constraint	A factor that prevents or obstructs the realization of goals.	

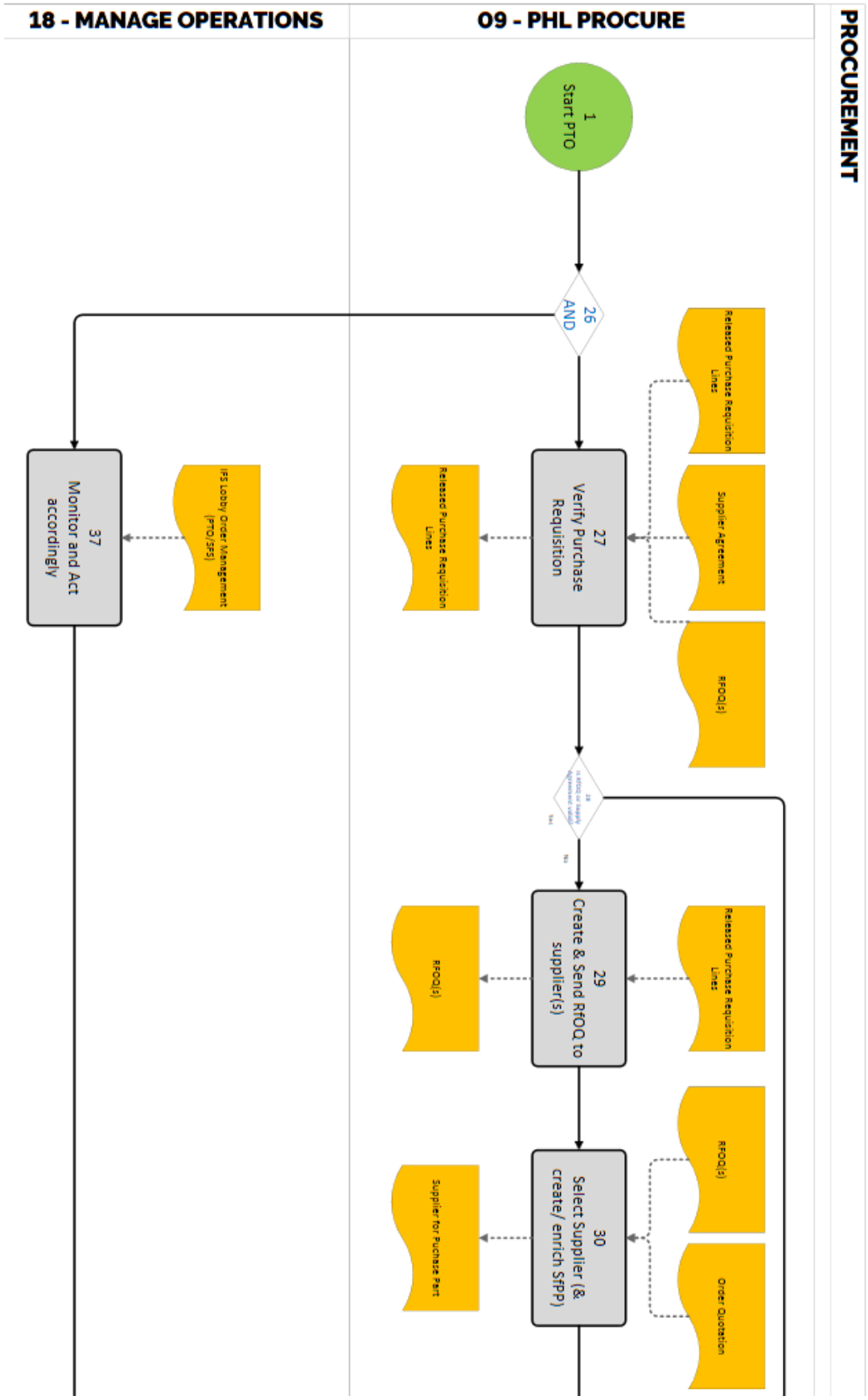
Element	Definition	Notation
Meaning	The knowledge or expertise present in, or the interpretation given to, a core element in a particular context.	
Value	The relative worth, utility, or importance of a core element or an outcome.	

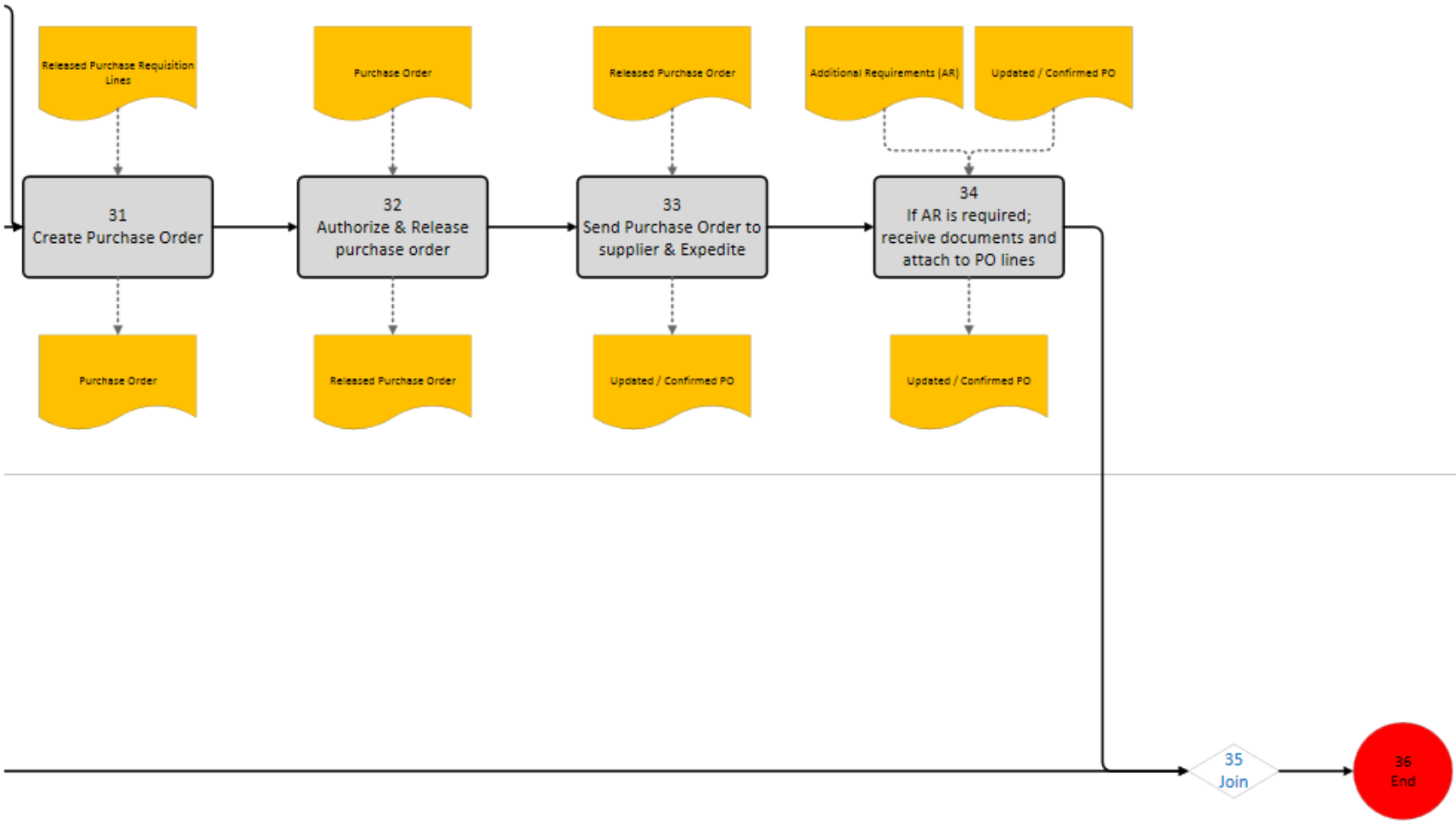
Note: The Open Group. he ArchiMate® 3.0.1 Specification, an Open Group Standard. Retrieved July 9, 2019, from http://pubs.opengroup.org/architecture/archimate3-doc/toc.html

Appendix E The data gathering architecture at Company X

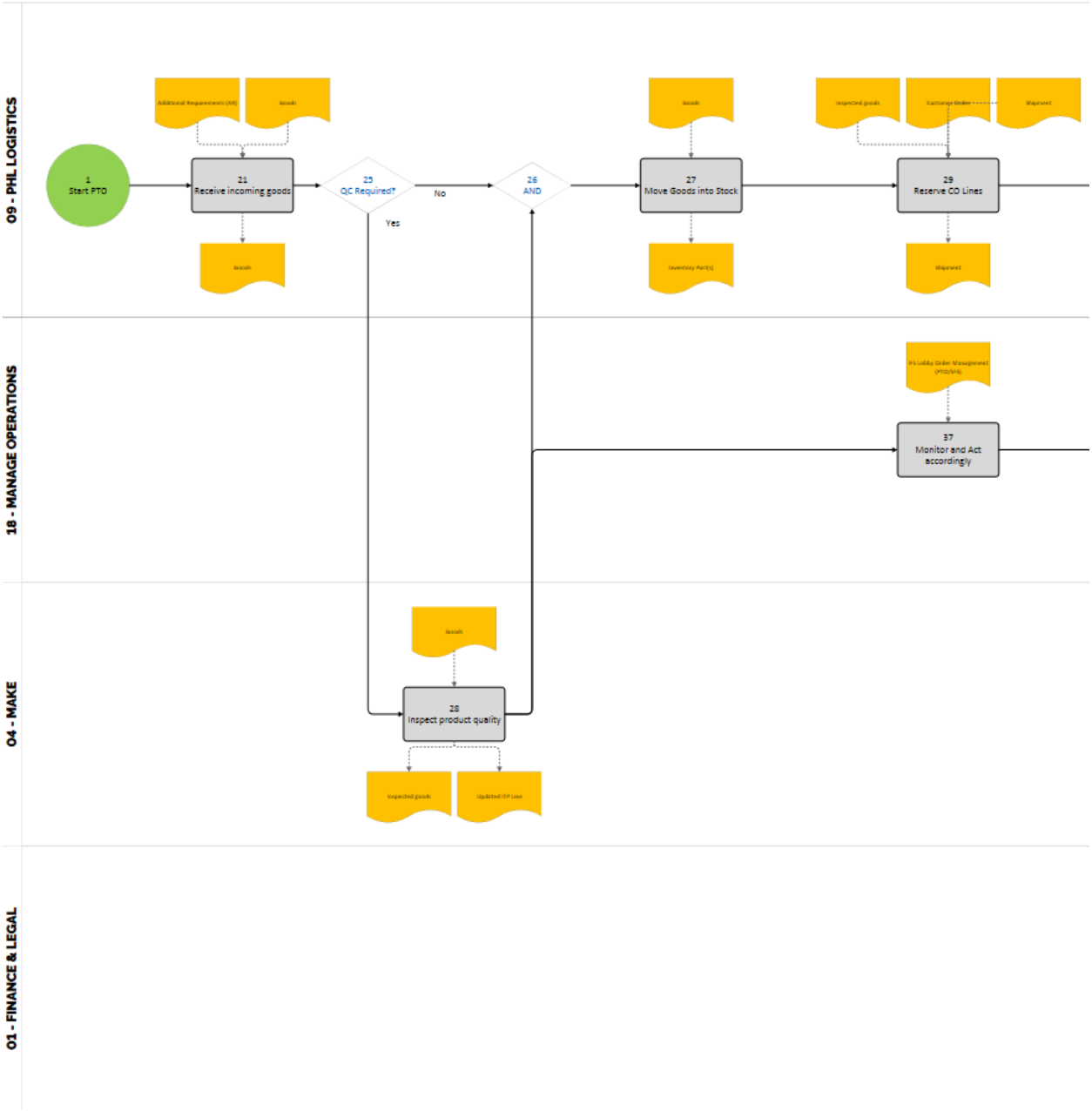


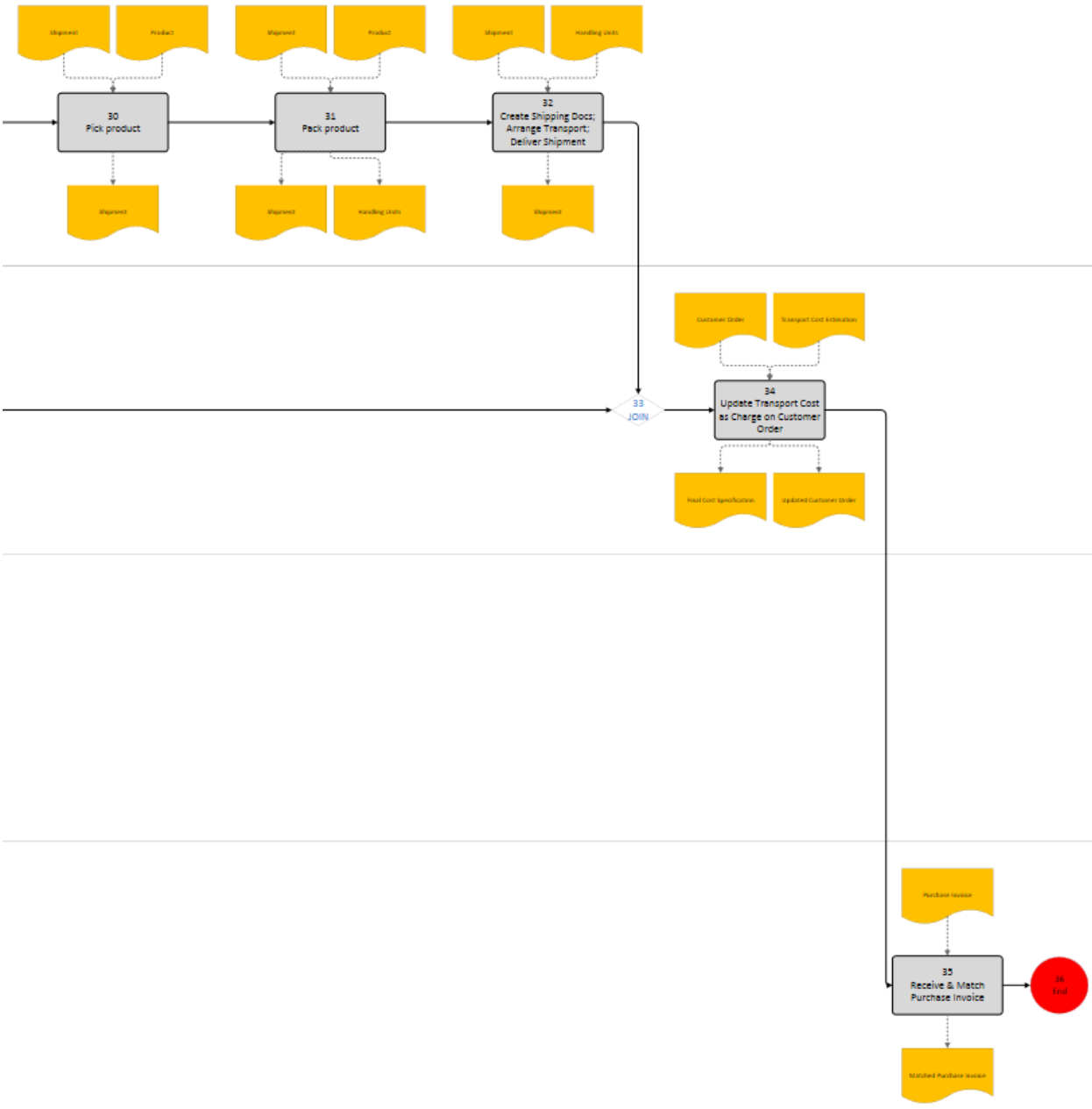
Appendix F Model of the purchase to order process.

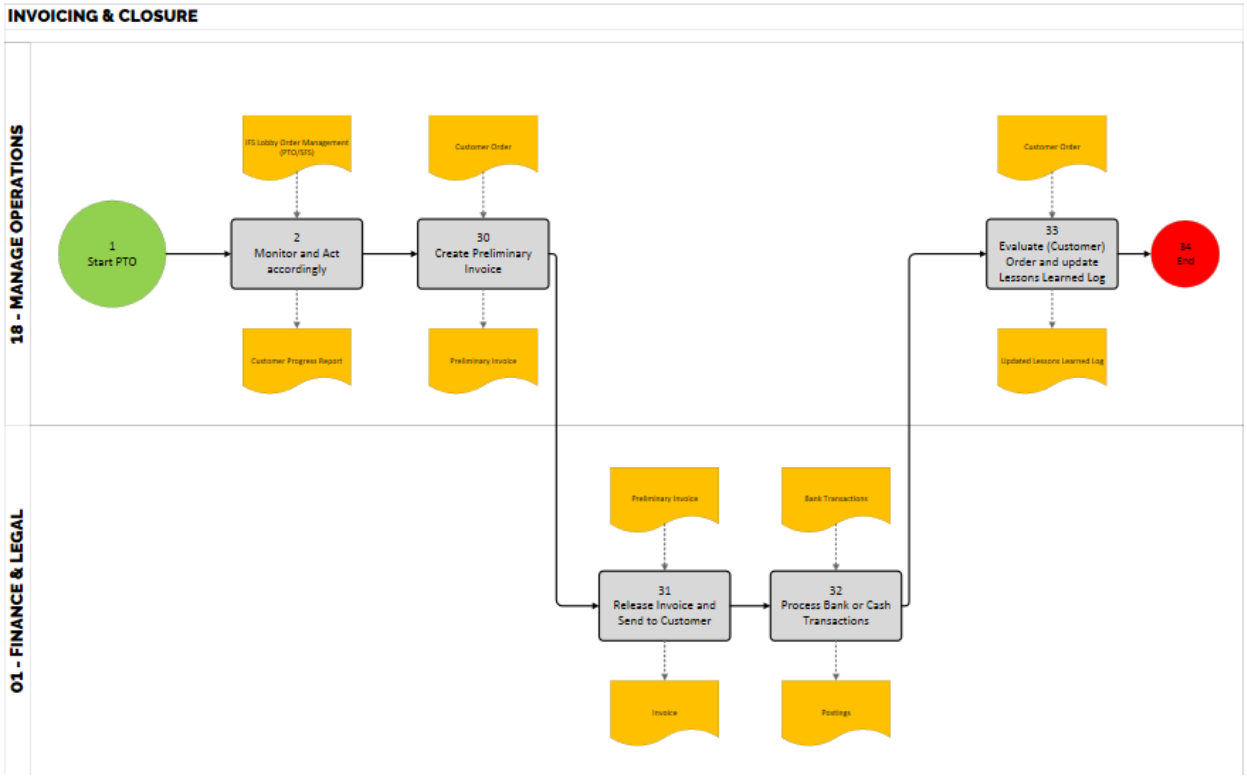

PROCUREMENT
18 - MANAGE OPERATIONS
09 - PHL PROCURE
1
Start PTO
26
AND
Released Purchase Requisition Lines
Supplier Agreement
RFOQ(s)
27
Verify Purchase Requisition
Released Purchase Requisition Lines
29
Create & Send RfOQ to supplier(s)
RFOQ(s)
Released Purchase Requisition Lines
30
Select Supplier (& create/ enrich SfPP)
RFOQ(s)
Order Quotation
Supplier for Purchase Part
37
Monitor and Act accordingly
IFS Lobby Order Management (PTO/SFS)


Released Purchase Requisition Lines
Purchase Order
Released Purchase Order
Additional Requirements (AR)
Updated / Confirmed PO
31
Create Purchase Order
32
Authorize & Release purchase order
33
Send Purchase Order to supplier & Expedite
34
If AR is required; receive documents and attach to PO lines
Purchase Order
Released Purchase Order
Updated / Confirmed PO
Updated / Confirmed PO
35
Join
36
End

PREPARE FOR DELIVERY

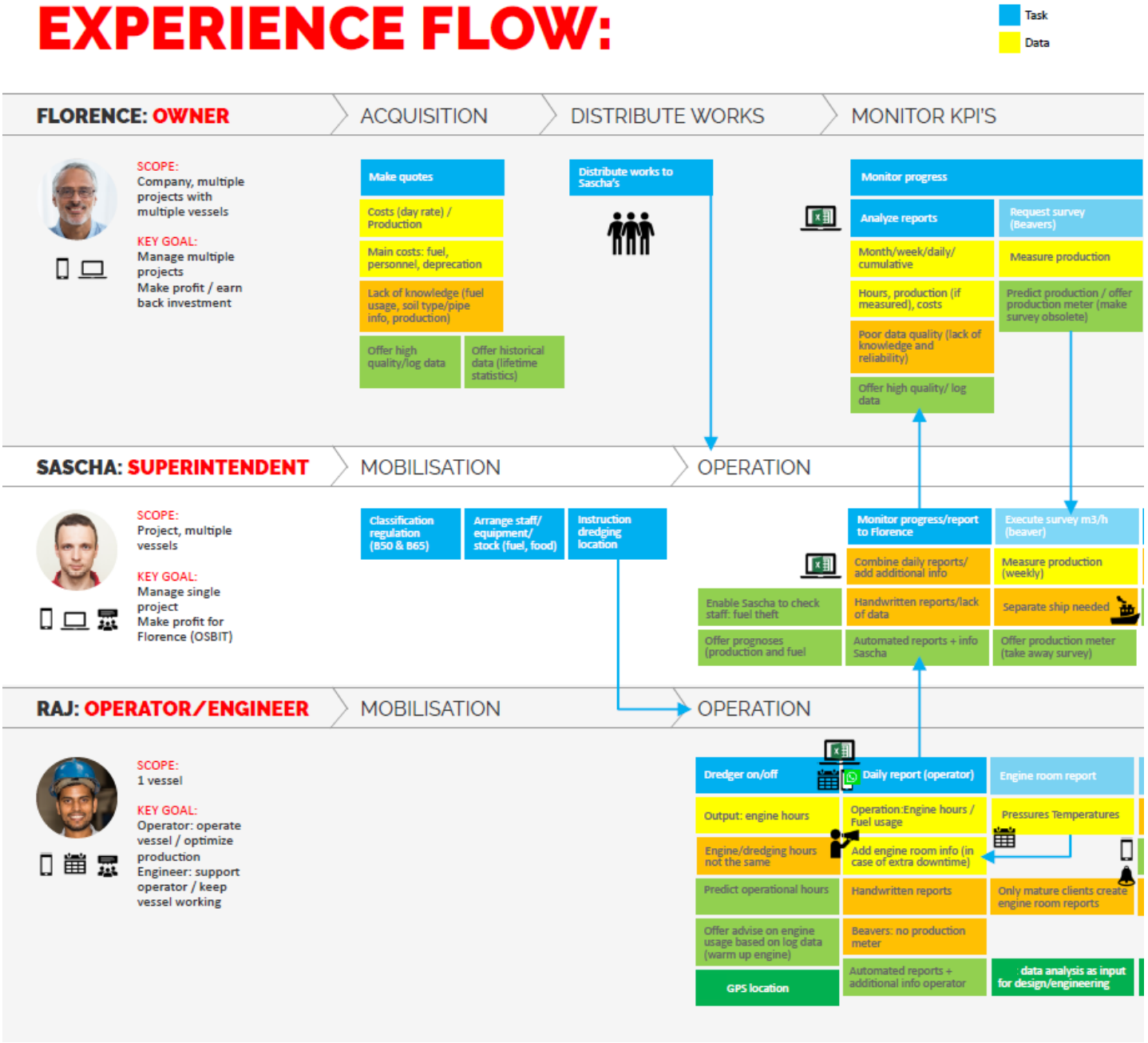


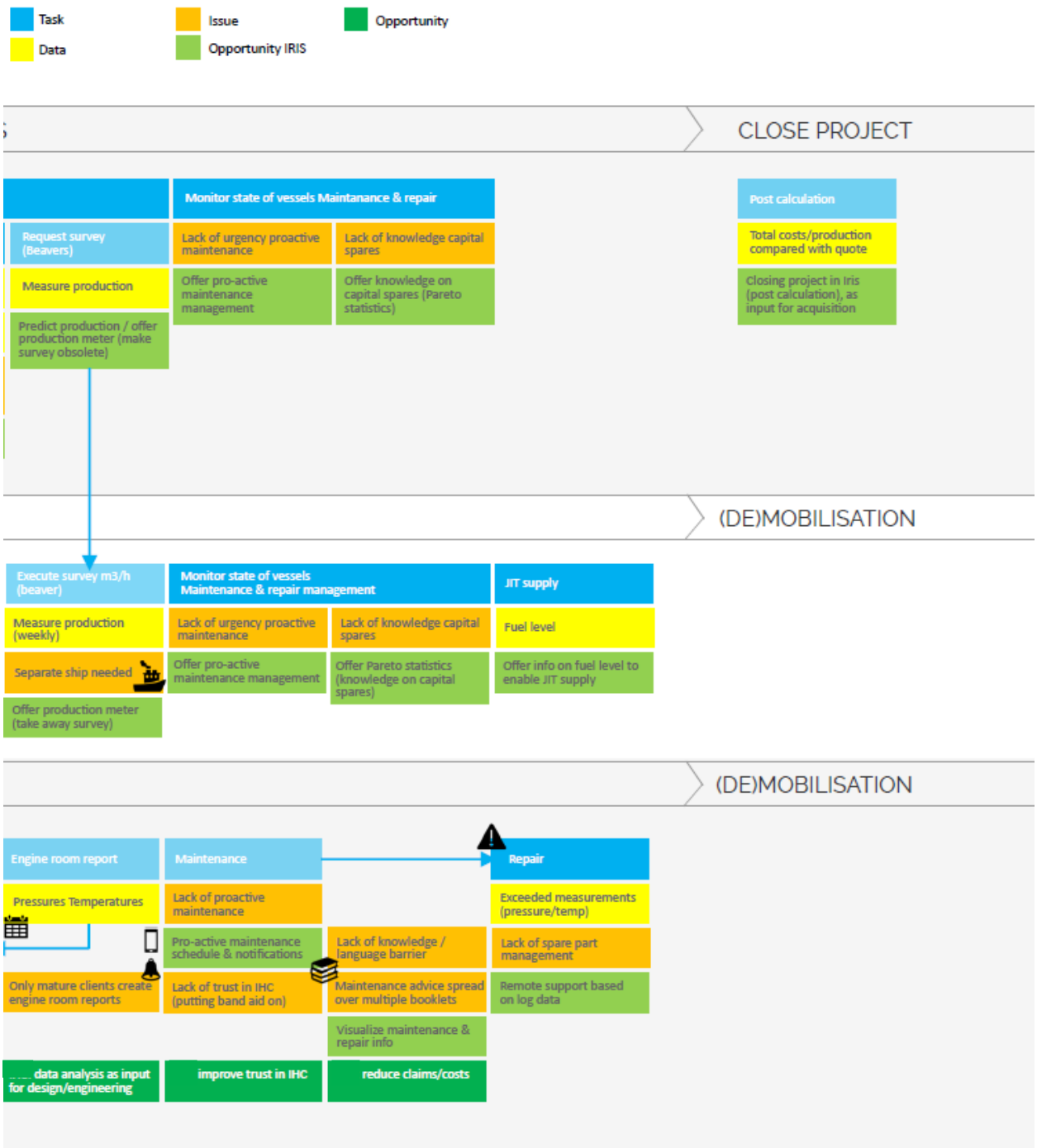

30
Pick product
31
Pack product
32
Create Shipping Docs; Arrange Transport; Deliver Shipment
33
JOIN
34
Update Transport Cost as Charge on Customer Order
35
Receive & Match Purchase Invoice
36
End



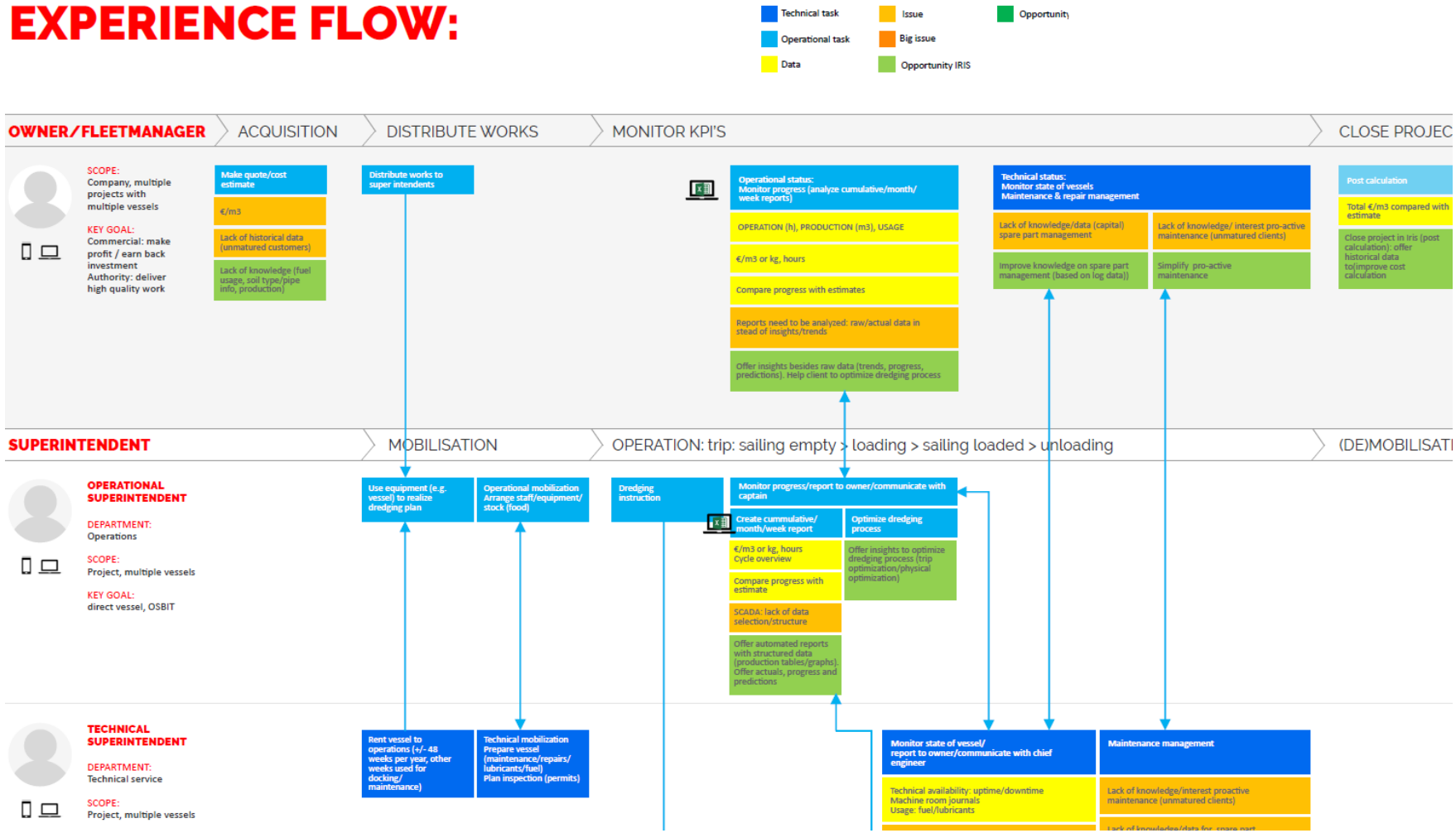
Note: Retrieved from Company X intranet.

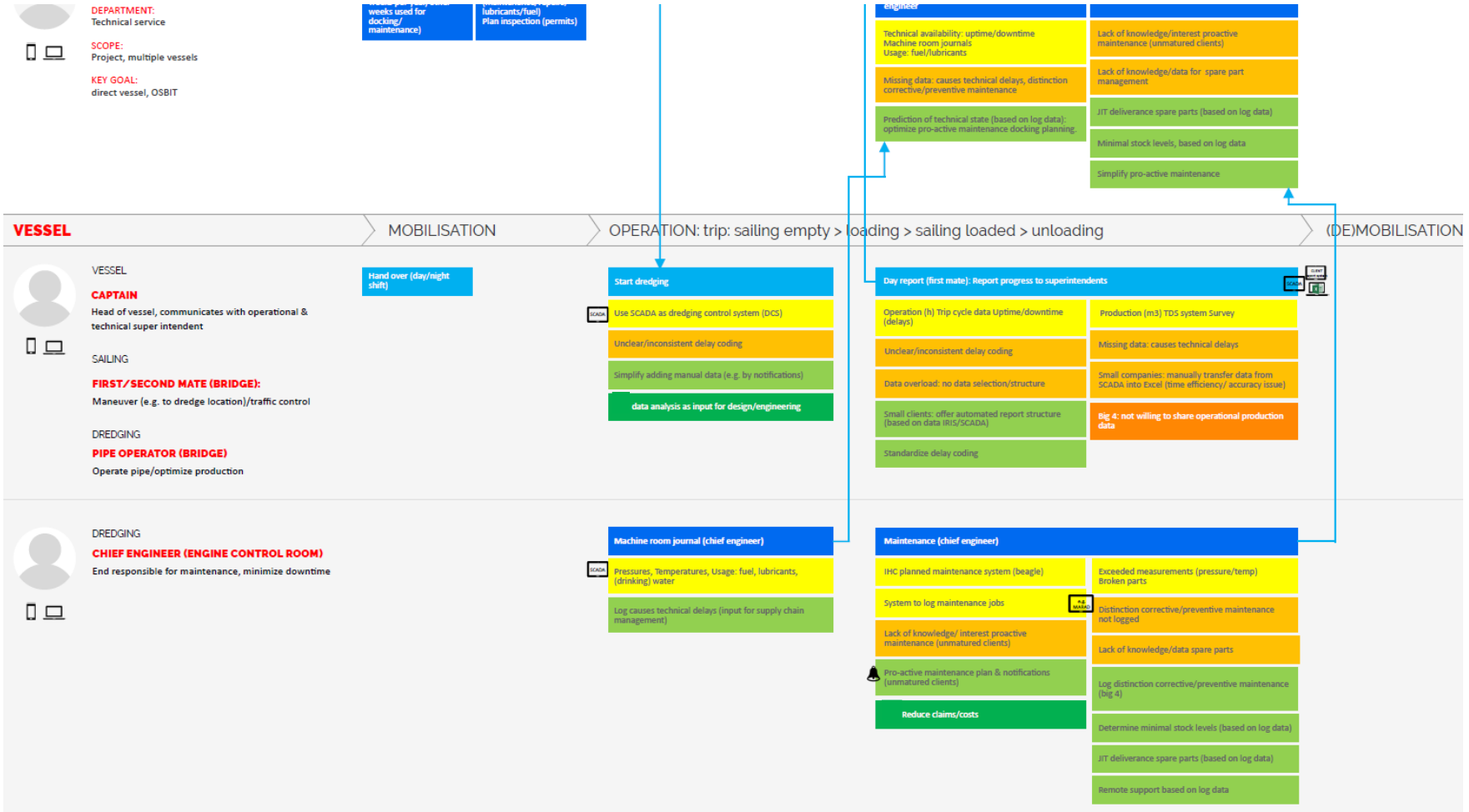
Appendix G Experience flows Dredgers and hoppers




Task
Issue
Opportunity
Data
Opportunity IRIS
CLOSE PROJECT
Monitor state of vessels Maintanance & repair
Request survey (Beavers)
Lack of urgency proactive maintenance
Lack of knowledge capital spares
Measure production
Offer pro-active maintenance management
Offer knowledge on capital spares (Pareto statistics)
Predict production / offer production meter (make survey obsolete)
Post calculation
Total costs/production compared with quote
Closing project in Iris (post calculation), as input for acquisition
(DE)MOBILISATION
Execute survey m3/h (beaver)
Monitor state of vessels Maintenance & repair management
JIT supply
Measure production (weekly)
Lack of urgency proactive maintenance
Lack of knowledge capital spares
Fuel level
Separate ship needed
Offer pro-active maintenance management
Offer Pareto statistics (knowledge on capital spares)
Offer info on fuel level to enable JIT supply
Offer production meter (take away survey)
(DE)MOBILISATION
Engine room report
Maintenance
Repair
Pressures Temperatures
Lack of proactive maintenance
Exceeded measurements (pressure/temp)
Pro-active maintenance schedule & notifications
Lack of knowledge / language barrier
Lack of spare part management
Only mature clients create engine room reports
Lack of trust in IHC (putting band aid on)
Maintenance advice spread over multiple booklets
Remote support based on log data
Visualize maintenance & repair info
data analysis as input for design/engineering
improve trust in IHC
reduce claims/costs

EXPERIENCE FLOW:




DEPARTMENT:
Technical service
SCOPE:
Project, multiple vessels
KEY GOAL:
direct vessel, OSBIT
weeks used for docking/ maintenance)
lubricants/fuel)
Plan inspection (permits)
Technical availability: uptime/downtime
Machine room journals
Usage: fuel/lubricants
Missing data: causes technical delays, distinction corrective/preventive maintenance
Prediction of technical state (based on log data): optimize pro-active maintenance docking planning.
Lack of knowledge/interest proactive maintenance (unmatured clients)
Lack of knowledge/data for spare part management
JIT deliverance spare parts (based on log data)
Minimal stock levels, based on log data
Simplify pro-active maintenance
VESSEL
MOBILISATION
OPERATION: trip: sailing empty > loading > sailing loaded > unloading
(DE)MOBILISATION
VESSEL
CAPTAIN
Head of vessel, communicates with operational & technical super intendent
SAILING
FIRST/SECOND MATE (BRIDGE):
Maneuver (e.g. to dredge location)/traffic control
DREDGING
PIPE OPERATOR (BRIDGE)
Operate pipe/optimize production
Hand over (day/night shift)
Start dredging
Use SCADA as dredging control system (DCS)
Unclear/inconsistent delay coding
Simplify adding manual data (e.g. by notifications)
data analysis as input for design/engineering
Day report (first mate): Report progress to superintendents
Operation (h) Trip cycle data Uptime/downtime (delays)
Unclear/inconsistent delay coding
Data overload: no data selection/structure
Small clients: offer automated report structure (based on data IRIS/SCADA)
Standardize delay coding
Production (m3) TDS system Survey
Missing data: causes technical delays
Small companies: manually transfer data from SCADA into Excel (time efficiency/ accuracy issue)
Big 4: not willing to share operational production data
DREDGING
CHIEF ENGINEER (ENGINE CONTROL ROOM)
End responsible for maintenance, minimize downtime
Machine room journal (chief engineer)
Pressures, Temperatures, Usage: fuel, lubricants, (drinking) water
Log causes technical delays (input for supply chain management)
Maintenance (chief engineer)
IHC planned maintenance system (beagle)
System to log maintenance jobs
Lack of knowledge/ interest proactive maintenance (unmatured clients)
Pro-active maintenance plan & notifications (unmatured clients)
Reduce claims/costs
Exceeded measurements (pressure/temp) Broken parts
Distinction corrective/preventive maintenance not logged
Lack of knowledge/data spare parts
Log distinction corrective/preventive maintenance (big 4)
Determine minimal stock levels (based on log data)
JIT deliverance spare parts (based on log data)
Remote support based on log data