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Potential Profitability of Investing in Voca's Optilift Motion Reporter

Case Study of the Ivar Aasen Field

[CONFIDENTIAL]

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I Preface

With this thesis the authors finishes a master's degree in Industrial Economics and Technology management at the University of Agder. The master thesis was written in the fourth semester of this program and corresponds to 30 credits. This thesis was suggested by Voca AS and was defined in cooperation with our supervisor Trond Bjørnenak.

First, we would like to thank the employees at Voca AS, especially Torbjørn Engedal, the founder and managing director of Voca, for being very helpful with providing guidance and the needed datasets for our analyses.

Secondly, we would like to thank the crane operator on an offshore rig and a captain on a supply vessel for their valuable inputs to this thesis.

We would also like to thank our supervisor, Trond Bjørnenak, for his excellent guidance and supervision with this thesis.

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II Summary

The recent significant fluctuations in oil prices have caused oil companies to look for alternatives for cost reduction. Aker BP has considered the field of digitizing and automation to be of great importance for future cost reductions. There are many alternatives in these fields, and this thesis will focus on Voca's Optilift Motion Reporter (OMR) technology. The main feature of the OMR is real-time heave monitoring, which shows the actual movement of the supply vessel deck during offshore lifting operations.

The main purpose of this thesis is to analyze the financial effects of investing in Voca's OMR technology, based on a case study for the offshore platform Ivar Aasen. The reason for choosing Ivar Aasen as a case study is because a pilot study was scheduled in the late spring of 2018.

The problem statement about the financial effects of investing in the OMR technology was then broken down into the two following research questions:

1. *What are the Optilift Motion Reporter's competitive advantages?*
2. *What is the potential profitability of implementing the Optilift Motion Reporter on the offshore platform, Ivar Aasen?*

The research questions were answered by analyzing weather data and shipment log for Ivar Aasen. Interviews were conducted to increase the validity of the research. The interviews were conducted with personnel at the logistics department at Aker BP, an offshore crane operator and a captain for a supply vessel.

Voca's industry is defined to be real-time heave monitoring systems for offshore lifting. The industry analysis shows that the profitability of the industry can be limited by the high power of buyers. The profitability is also highly dependent upon the value it creates for the customers. The VRIO analysis shows that two of OMR's features, the boom tip indicator and the real-time heave monitoring system, are considered to provide the OMR with a potential competitive advantage in the industry.

For the main analysis of customer value, three scenarios were established. The three scenarios are based on the minimum, average and maximum daily value of the significant wave height measured for every day with delivered supplies. A delay in the scheduled pilot led to a use of an average improvement percentage for implementation of the OMR. This percentage is based

on an analysis conducted by Voca on Valhall DP, showing that the actual heave-motion on the vessel deck in average is 35% lower than the significant wave height measured by the Miros wave sensor. All the three scenarios are based on analyzing the same 1791 containers towards the three different wave height scenarios. For the Minimum-, Average- and Maximum scenario, respectively 1, 3 and 57 more containers are expected to be lifted with the OMR. For all scenarios, the trend seems to be that OMR has the biggest impact on expanding the weather window for heavier lifts. This is also confirmed by interviews of offshore personnel. The difference in days waiting on weather is then calculated for each scenario with and without the OMR. The reduction in days waiting on weather for the Minimum, Average and Maximum scenarios are expected to be respectively 1 day, 12 days and 38 days with OMR. With a cost of 200 000 NOK for each day of waiting on weather, the annual customer value of the Minimum-, Average- and Maximum scenario respectively are 200 000 NOK, 2 400 000 NOK and 7 600 000 NOK. The annual cost of the OMR is calculated to be 850 000 NOK, making only the Average and Maximum scenario profitable.

A sensitivity analysis has been conducted to show the breakeven points of investing in the OMR. For a daily cost of waiting on weather of 200 000 NOK, the breakeven point is reached with approximately 4 days less waiting on weather with the OMR. The interviews conducted with a crane operator and a supply vessel captain imply that the OMR increase the safety during offshore lifting operations.

The annual customer value calculated in this thesis is an indication of the profitability of the OMR. For a final investment decision, should preferably an analysis be conducted after the pilot has finished, for finding a more accurate customer value. The methodological framework for analyzing the potential profitability of the OMR, that is presented, can be used as a guide for this final analysis. Further research on the overall profitability of the OMR together with the Deck Planner is recommended.

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1. Introduction

1.1. Background

The Norwegian Oil and Gas (O&G) industry have experienced dramatic changes the last four years, because of the drastic decline in oil prices. This has made oil companies look for possibilities for cost reductions, to remain competitive.

"The particularly harsh weather conditions on the Norwegian Continental Shelf, combined by the gradually more demanding offshore activities taking place, makes the supply of the installations very challenging" (Aas, Halskau, & Wallace, 2009).

Offshore installations need to be regularly supplied by supply vessels to ensure continuous production. If an installation's needs are not satisfied, enormous shortage costs can arise. The vessel's or fleets capacity to meet the demand for transport capacity is at all times crucial. The supply vessels represent one of the most significant cost elements in the upstream supply chain of the O&G industry. Therefore, maximizing the utilization of the chartered supply vessels have become gradually more important (Aas et al., 2009).

The World Economic Forum in cooperation with Accenture claims that digitalization can act as an enabler to tackle the challenges the oil and gas industry is facing and provide value for the stakeholders (World Economic Forum, 2017).

McKinsey also predicts application of new technology and automation to be of great importance for O&G companies:

"*The rapid progress of technology such as big data and analytics, sensors, and control systems offers oil and gas companies the chance to automate high-cost, dangerous, or error-prone tasks. The companies that successfully employ automation can significantly improve their bottom line*" (Martinotti, Nolten, & Steinsbø, 2014).

Voca's Optilift Motion Reporter (OMR) is a response to these challenges and the need for digitalization and streamlining of offshore logistics. Our target is to analyze the profitability of implementing the Optilift Motion Reporter by reducing shortage costs caused by bad weather.

1.2. Problem statement

The problem statement of this thesis is:

What are the financial effects of investing in the Optilift Motion Reporter (OMR) Technology?

To analyze this problem statement, weather data and logistics data for three different scenarios for Ivar Aasen will be analyzed to find the potential profitability of investing in the OMR. The different scenarios will show under which circumstances it is profitable to invest in Voca´s OMR technology. This thesis will mainly focus on the economic effects of implementing the OMR technology, but will also briefly analyze safety aspects of the OMR.

1.3. The thesis's relevance

The O&G industry is one of Norway's biggest industries, and lately many of the companies in the industry are evaluating possibilities for digitalization and automation of their offshore installations with the purpose of cost reduction and increasing safety. This is where Voca's Optilift Motion Reporter (OMR) technology can make a difference.

This thesis aims to analyze the potential profit for operator companies to invest in the OMR technology for improving the performance of lifting operations. These analyses will create knowledge about which variables that will affect the potential profitability of investing in the OMR.

1.4. The thesis's structure

This thesis consists of seven chapters. The first chapter covers the background, problem statement and the thesis relevance. In the second chapter, the theoretical framework of the thesis is presented. The theoretical framework is divided into two parts; offshore logistics theory and economic theory. The third chapter presents the methodology with the elaboration of the research question, presentation of the study object, research design, data collection, research quality, an approach for cleaning data sets and limitations of the study. Chapter 4 gives a presentation of the Optilift Motion Reporter (OMR), competing alternative products and the Ivar Aasen field. In chapter 5 an analysis of the potential profit of the industry is conducted, divided into the two parts called value allocation potential and value creation potential. Chapter 6 analyzes the customer value of implementing the OMR. In this chapter, analyses are conducted to determine the potential customer value of the OMR. Chapter 7 is the conclusion of the thesis.

2. Theoretical framework

In this chapter, the theoretical framework of the thesis is presented. The theoretical framework gives a better understanding of the research question and creates a basis for the analysis. The theoretical framework of this thesis is two folded. The first part consists of a fundamental introduction to offshore logistics and the second part introduces the applied economic theory in this thesis.

2.1. Offshore logistics theory

All of Norway's O&G production takes place offshore, which makes the logistics more demanding and unpredictable than the onshore logistics. The logistics function connected to oil and gas production is divided into two parts: upstream and downstream logistics. Downstream logistics concern the activities aiming towards bringing oil and gas out to the end customer, while the activities aiming towards supplying the offshore installations with needed supplies is named upstream logistics (Aas, Jahre, Gribkovskaia, Halskau, & Shlopak, 2007). This paper will focus on the upstream logistics of the O&G industry.

"Over the lifetime of an offshore oil field, supply operations and supporting logistics are two of the key operational segments required to have a high level of functionality to make offshore operations both economically and technically sustainable" (Milaković, Ehlers, Westvik, & Schütz, 2014).

The need for supply to offshore units for daily operation can vary significantly. Small unmanned platforms do usually not need many supplies, while large installations with several hundred workers onboard, need many supplies to support daily operations (Aas et al., 2009). Milaković et al. (2014) have two primary requirements for an offshore logistics system:

- Efficiency, to minimize the costs of delivery of services and products.
- Robustness, to maximize productivity and reduce the risk of operational delays caused by delayed deliveries of goods to and/or from offshore installations.

"In general, installations that are drilling have more fluctuating and uncertain demand patterns than producing installations. Both the due dates and the volumes are uncertain." (Aas et al., 2009).

2.1.1. Platform Supply Vessels (PSV)

Products and services are commonly delivered to offshore installations by using Platform Supply Vessels (PSVs) operating between an onshore supply base and the offshore installation (Milaković et al., 2014).

The geographical location where the offshore activity takes place is an essential indicator of the choice of the supply vessel. Weather conditions, the amount of equipment needed and the distance from the shore are essential factors that affect what properties the vessel should have (Aas et al., 2009).

The supplies delivered by PSVs can be divided into two main categories, bulk cargo, and deck cargo. Deck cargo is everything transported on the supply vessel's deck. Most of the deck cargo is stored in containers, but there are also some large pieces of equipment (e.g., drill pipe) that are stored on deck. Supply vessels often have a deck capacity ranging from 700 to 1100 square meters for storing deck cargo. Bulk cargo is transported in the tanks below the supply ship's deck and can be dry or liquid bulk. Examples of bulk cargo are drilling mud, fuel and drinking water (Friedberg et al., 2014).

The supply vessels are multi-task vessels and must be designed for many different purposes (Aas et al., 2009; Aas et al., 2007; Milaković et al., 2014)
It is normal to differentiate between short-term (spot) and long-term charters in the market. Vessels built for the spot-market are usually designed for a wide range of potential clients, while tailor-made vessels only are built when the shipowner is confident that it is a long-term charter (Aas et al., 2009).

Figure 2.1 shows a typical scenario with PSVs chartered on short and long-term contracts, supporting offshore installations with the needed supplies from an onshore base. PSVs on low cost, long-term contracts are usually routed to several installations, following a predefined route, in accordance with demands from the installations. A PSV on a high cost, the short-term contract is usually chartered because of large or unexpected demands from one or several of the installations, which exceeds the capacity of the PSVs operating on long-term contracts.

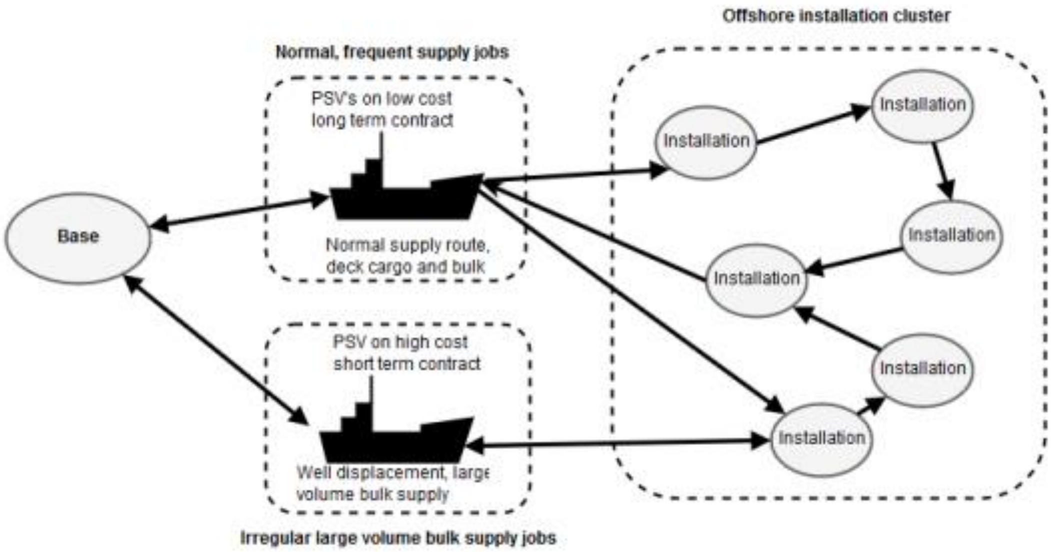

Figure 2.1 General representation of offshore logistics where supply vessels are chartered to supply the offshore installations with the needed supplies from an onshore base. Retrieved from (Resell, 2017).

The costs related to chartering and operating supply vessels is one of the most significant logistics cost elements in the upstream logistics. Supply vessels are usually chartered, rather than owned, by the oil companies. The rate the oil companies pay for the supply vessels depends on factors such as the features of the vessel, the duration of the charter period, the supply/demand balance at the time the charter is signed and the location of the vessel. The oil companies decide what the vessel should be used for during the charter period, which makes activities such as routing and scheduling the responsibility of the oil company. Chartered supply vessels are at the disposal of the oil company 24 hours a day, all year around. Limitations to this are that the supply vessel must be allowed to go to shore to rotate crew (typically every fourth week) and a few days every year is dedicated to maintenance (Aas et al., 2009).

To obtain a proper utilization of the supply vessels, the O&G companies usually attempt to serve several installations using the same vessel. When several installations naturally form a cluster, is it especially cost-effective. Most of the installations on the Norwegian Continental Shelf are visited 1-3 times a week. The planning of the routes typically starts with fixed routes, but the uncertainties related to demand and weather conditions make the routes change frequently. The uncertainties make it hard to obtain a high utilization of the supply vessels (Aas et al., 2009).

2.1.2. Limitations under offshore lifting operations

There are several factors that limit the offshore lifting operations from PSVs to offshore installations, or the other way around. The weather plays an important role here.
Aas et al. (2009) claim that the two main factors that affect the offshore loading/unloading process between an installation and a supply vessel are:

- The crane of the installations lifting capability
- The supply vessel’s capability to keep its position

With good weather conditions, all the deck and bulk cargo can be loaded/unloaded simultaneously. Deck cargo is lifted from the supply vessel deck to the deck of the offshore installation by using the cranes mounted on the installation. The bulk cargo is pumped from the tanks on the supply vessel to tanks on the installation by using hoses. However, severe weather conditions can stop offshore loading/unloading.
Ensuring that the loading/unloading is done safely is the responsibility of the captain of the supply vessel, but the crane operator and the platform chief also has the authority to stop the operation (Aas et al., 2009).

Also, there are regulations regarding working safety. These concern factors such as wave height, wind, currents, and visibility (Norwegian Oil Industry Association, 2013).
Wave height stands out as the primary contributor to decrease the capability of loading/unloading to offshore installations. *“Significant wave height (Hs) is defined as the average of the highest one-third waves in a wave spectrum. This happens to correlate very well with the wave height a skilled observer perceives in a wave spectrum”* (Ainsworth, 2005).

The supply vessel’s ability to keep its position, while loading/unloading, with a high degree of accuracy, is essential. This may vary among different supply vessels, and therefore it is required that a vessel must not use more than 50% of its machinery power to maintain its position (Aas et al., 2009). Offshore installations do in general have insufficient free space for storing containers and equipment on the platform deck, which increases the complexity of the offshore logistics (Aas et al., 2007).

2.2. Economic Theory

The overall goal of this thesis is to predict the profitability of investing in Voca's Optilift Motion Reporter technology. To be able to predict the profitability of the investment, it is important to understand the market situation and the potential for profit.

The economic theory in this thesis is crucial and creates the basis for the analysis that is conducted. The economic theory consists of investment theory and sensitivity analysis.

Profitability is generally defined as *"the degree to which a business or activity yields profit or financial gain"* (Oxford Dictionary, 2018). The buyer pays an initial price and/or a periodical price for the asset. Throughout the lifetime of the investment object, there is a need for sufficient positive cash flow to be able to equalize the capital invested and to make the investment profitable. Profitability analyses are used to evaluate whether one should invest in a product or not.

In this chapter, the economic frameworks for this thesis will be presented. The theoretical frameworks used in this thesis is Porter's Five Forces, The Profitability Tree, VRIO, and sensitivity analysis. The different frameworks will be explained by their field of use and some limitations.

In this thesis, the potential profitability by implementing Optilift Motion Reporter will be considered on three levels; industrial, firm and project.

2.2.1. Porter's Five Forces analysis

Porter's Five Forces will be one of two parts that will cover the industrial level in this thesis. Porter's Five Forces is a business analysis model used for analyzing the situation of competition in an industry. According to Porter (2008), understanding of the competitive forces and their underlying causes makes it possible to state whether the industry is profitable or not. Porter (2008) classifies the economic forces that impact the profitability of an industry into five forces, where the strongest force(s) decide the profitability in the industry. The five forces decide the profitability of the industry because they affect the prices, costs, the need for investment for businesses in an industry, and these are the elements that decide the return on the investments (Porter, 1992). If all the five threats are very high, competition in an industry starts to approach what is called perfect competition. If all five threats are very low, competition starts to approach monopoly, which means there is only one prominent actor in the market with all the power (Barney & Hesterly, 2010).

The five forces are shown in Figure 2.2 below. The forces can be divided into two categories; the vertical and horizontal axis. The vertical axis focuses on attracting customers and is called the axis of rivalry. The horizontal axis is called the axis of distribution and shows how the value creation in the business is divided among customers, suppliers and the companies of the industry. The two axes are connected because the axis of rivalry affects the axis of distribution of value (Jakobsen & Lien, 2015).

Rivalry among existing competitors is in the middle because it can be affected by all the other forces. The five forces are the threat of entry, the threat of substitutes, rivalry among existing competitors, the power of suppliers and power of buyers. They are all evaluated in the next paragraphs:

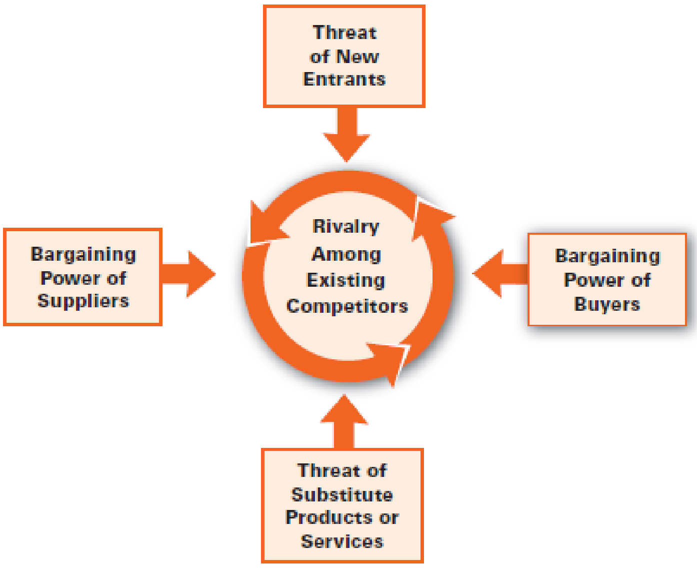

Figure 2.2 Porters Five Forces model. Retrieved from (Porter, 2008).

Threat of entry

New entrants are firms that have either recently started operating in an industry or threaten to begin operations in an industry soon (Barney & Hesterly, 2010). According to Barney and Hesterly (2010), what motivates new entrants to enter into an industry is the superior profits some of the incumbent firms in that industry may be earning (Barney & Hesterly, 2010). “New entrants to an industry bring new capacity and a desire to gain market share that puts pressure on prices, costs, and the rate of investment necessary to compete” (Porter, 2008).

Besanko et al. (2009) confirm that entry often reduces the profit by sharing the market's need among more sellers. The market shares of the different actors are then reduced and the internal competition increases (Besanko, Dranove, Shanley, & Schaefer, 2009).

The threat of entry in an industry depends on the height of entry barriers that are present and on the reaction entrants can expect from incumbents. If entry barriers are low and newcomers expect little retaliation from the entrenched competitors, the threat of entry is high, and industry profitability is moderated. Entry barriers are advantages the incumbents have relative to the new entrants (Porter, 2008).

According to Porter (2008) the seven significant barriers for entrants are:

1. *Supply-side economies of scale.* Economies of scale are reached when firms that produce larger volumes have lower costs per unit because they can spread fixed costs over more units, employ more efficient technology or get better terms from suppliers. Supply-side economies deter entry by forcing the aspiring entrants to come into the industry either on a large scale or accept a cost disadvantage (Porter, 2008).
2. *Demand-side benefits of scale*. These benefits arise in industries when buyer's willingness to pay increases with the number of other buyers that also prefer this company (Porter, 2008). Barney & Hesterly (2010) refers to this phenomenon as brand identification and customer loyalty. Buyers may trust bigger, well-known companies more because they are believed to have good products when they sell in big numbers. (Porter, 2008).
3. *Customer switching costs*. Switching costs are costs that occur for the customers to change their supplier of a product. The higher the switching cost is, the harder it is for an entrant to get customers (Porter, 2008).
4. *Capital requirement.* The capital requirement an entrant needs to be able to compete with the incumbents, affect how easy it is to enter the industry. The barrier is more significant if capital is needed for unrecoverable expenditures, such as up-front advertising or research and development (Porter, 2008).
5. *Incumbency advantages independent of size.* Independent of size the incumbents may have cost or quality advantages, that is not available for potential rivals (Porter, 2008). New entrants can engage in activities to try to overcome the cost advantages of incumbent firms, but as the cost of overcoming them increases, the economic profit potential for the entrants is reduced (Barney & Hesterly, 2010). Examples of

advantages are patented technology, access to the best raw material sources, having the most attractive geographic location and valuable experience (Porter, 2008).

6. *Unequal access to distribution channels.* New entrants are dependent on securing distribution of their products or services. In some cases, this barrier is so significant that the entrant may choose to make their distribution network or buy-pass distribution by having a store where they sell their product (Porter, 2008).
7. *Restrictive government policy.* Government policies can affect how easy it is for entrants to establish in an industry. Licensing requirements and strict government policies may act as a barrier, but may also help entrants (Porter, 2008).

Threat from substitutes

A substitute performs the same or a similar function as an industry's product by different means. When there are different industries with similar substitutes, the industry profitability suffers. Customers will compare the industry product to the substitutes by price and quality. (Besanko et al., 2009). Porter (2008) claim that there are always substitutes present, but they are easy to overlook, because they may appear to be very different from the industry's product. An industry needs to differentiate itself from substitutes through product performance, marketing or in other ways. If they do not, they will suffer regarding profitability. The threat of a substitute is high if there is an attractive price-performance trade-off to the industry product or the buyer's cost of switching to the substitute is low (Porter, 2008).

Rivalry among existing competitors

The internal rivalry is in the center of Porter's Five Forces model because it can be affected by the four other factors. The degree to which internal rivalry drives down an industry's profit potential depends on the intensity of the competition and on the basis on which they compete. The intensity of rivalry is greatest if there are numerous competitors or have roughly equal size, industry growth is slow, and exit barriers are high. Exit barriers keep companies in the market even though they may be earning low or negative returns. The result is that excess capacity remains in use, which causes other competitors to suffer (Porter, 2008).

Rivals are highly committed to the industry. Rivalry affects the profitability most if it is only based on price because price competition transfers profits directly from the industry to the customers. The basis for competition means whether rivals compete on the same dimensions. Competition on other dimensions than prices, such as product features, delivery time, support services or brand image is less likely to erode the profitability (Porter, 2008).

The power of suppliers

When there are few potential suppliers of a product, the suppliers are more powerful. Dominant suppliers take more of the value themselves by having higher prices, limiting quality or services, or shifting costs to the industry that buy the product. Dominant suppliers can reduce industry profitability dramatically when the industry is unable to pass on cost increases in its prices. A supplier group is powerful if it is more concentrated than the industry it sells to, closer to a monopoly in the market. This occurs if the supplier group does not depend heavily on the industry for its revenues, the industry participants face switching costs when changing suppliers, the supplier offers differentiated products or the supplier group can threaten to integrate forward into the industry (Porter, 2008).

The power of buyers

A marked dominated by customers, makes it possible for the customers to capture more value by forcing down the prices, demanding better quality or more service, and generally playing industry participant against each other. All these actions decrease the profitability of the industry. Buyers are powerful if they have negotiation leverage relative to industry participants, especially if they are price sensitive, using their power to pressure price reductions. Customers have negotiation leverage if there are few buyers or they purchase in volumes that are large relative to the size of a single vendor, the products are standardized and undifferentiated, buyers face few switching costs and when buyers can credibly threaten to integrate backward and produce the industry product themselves. A buyer group is price sensitive if the product supplied by the industry represents a significant fraction of the procurement budget, the buyer earns low profits or is under economic pressure, the quality of the buyers product is little affected by the industry’s product, or the product has little effect on the buyer’s other costs (Porter, 2008).

Limitations of Porter’s Five Forces

The model gives a good overview and can easily be applied to all industries, but do have some limitations. Examples of these limitations are addressed by Besanko et al. (2009) in the book “Economics of Strategy.” First, the model pays little attention to factors that might affect demand. Porter’s Five Forces do not take into account the changes in consumer income, tastes and firms’ strategies for boosting demand, such as advertising. Second, it focuses on an entire industry rather than individual firms that may have unique positions in the industry. Third, Besanko et al. (2009) claim that the government as a regulator can affect the profitability of the industry and could be considered as a sixth force. Fourth, the qualitative approach of the five forces framework does not show how to estimate whether the forces/threats are high or low. The qualitative approach makes it useful for accessing trends and identifying changes in a market (Besanko et al., 2009).

Jakobsen and Lien (2015) criticize Porter’s Five Forces for only covering value distribution and the lack of focus on value creation (Jakobsen & Lien, 2015).

2.2.2. The Profitability Tree

The Profitability Tree will be the second part of covering the industrial level of profitability. Based on the weaknesses of Porter’s Five Forces model, the Norwegian professors Lasse B. Lien and Erik W. Jakobsen developed a model called The Profitability Tree. The reason the model is called the Profitability Tree is that the reasons for profitability in a market can be decomposed like the branches of a tree (Jakobsen & Lien, 2015).

The Profitability Tree was developed to analyze the size of the values that are created in a market, and how these values are distributed among the actors in the market. This analysis is shaped like a tree, with a trunk and three levels of branches, as can see in Figure 2.3. The most detailed analyses are found in the thinnest branches, furthest from the trunk of the tree. As one goes from the thinnest branches towards the tree trunks, the complexity decreases. The design of the analysis makes it possible to increase the complexity of the analysis without losing the overview and can also help to form a better basis for making conclusions about the profitability of the industry (Jakobsen & Lien, 2015).

The Profitability Tree (see Figure 2.3) have two main branches; value allocation potential and value creation potential. The value allocation branch is covered by Porter’s Five Forces, while the Profitability Tree covers the value creation branch. The part of the Profitability Tree that is covered is the boxes colored in blue in Figure 2.3, while the orange boxes will not be a part of The Profitability Tree analysis, to not overlap with Porter’s Five Forces.

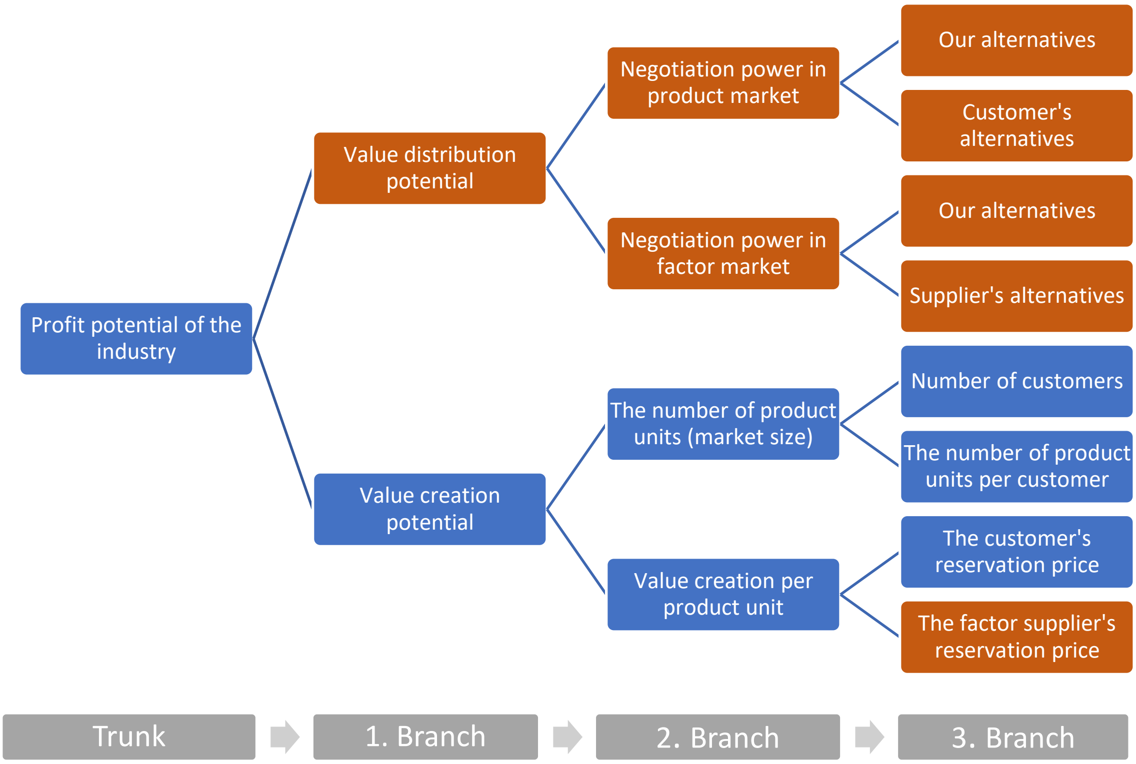

Figure 2.3 The Profitability Tree. Retrieved from (Jakobsen & Lien, 2015) and translated into English.

2.2.2.1. Value Creation Potential

The expected value creation in a market can according to Jakobsen and Lien (2015) be expressed as:

$$\text{Value creation potential} = \text{Value creation per product unit} \times \text{Number of products unit}$$

Both the value creation per product unit and the number of product units are found on the second branch of the Profitability Tree. These values on the second branch are determined by the value of the third branch boxes. The formula for value creation potential is decomposed by replacing the second branch boxes with the third branch boxes. The result is the following function:

$$\text{Value creation potential} = \begin{array}{l}(\text{the customer reservation price - the factor supplier reservation price}) \\ \times\ (\text{number of customers} \times \text{number of products units per customer})\end{array}$$

Value creation per product unit

The first part of the analysis consists of an evaluation of the value of the product units in a chosen market. To simplify, the market is assumed to be homogenous – the customers have the same preferences. The value creation per product unit is determined by subtracting the factor supplier's reservation price from the customer's reservation price (Jakobsen & Lien, 2015).

The value a product generates is decided by the customer's preferences and how the product meets the customer's demand. The upper limit for value creation in a market is created by the customer's reservation price, which is the highest price a customer is willing to pay for the product. This way of thinking can be transferred to the factor market, where the company has similar reservation prices to their suppliers. The factor supplier's reservation price is the lowest price the company is willing to sell its products for. Both the customer's reservation price and the supplier's reservation price are dependent upon the market situation; market demand and the availability of supplies from factor markets (Jakobsen & Lien, 2015).

The number of product units (market size)

The number of product units that can be sold is the result of the number of potential customers multiplied by the expected number of product units per customer. This means that value creation can be increased in two ways, by either increasing the product's value to the customers or selling more products (Jakobsen & Lien, 2015).

Jakobsen and Lien (2015) recommend that the market is limited in such a way, that the customers that are included in the market have an as little variation as possible from each other. In practice, it is usually quite hard to delineate the market, because there are usually many factors that affect the customers' and suppliers' decisions (Jakobsen & Lien, 2015).

2.2.3. VRIO analysis

Porter's Five Forces and the Profitability Tree covered profitability on an industrial level. In this part, the firm level will be covered. A VRIO-analysis consists of four questions that analyze the firm's resources to establish if the resource is a strength or a weakness for the firm. The four questions are asked to establish if the firm's resources are *valuable, rare, imitable* and *organized* (Barney, 2002).

The purpose of a VRIO-analysis is to find the firm's most important resources, establishing which resources that are a weakness or a strength and if they can provide the firm with a competitive advantage (Barney, 2002). VRIO is an important supplement to Porter's Five

Forces. While Porter focuses on the competition in the marked, VRIO analyzes a firm's resources to understand which resources that provide them with a competitive advantage (Barney, 2002).

Valuable

Value for a firm is either created through decreasing the product/service costs or by allowing the firm to charge a higher price by differentiating the product/service in a way that would allow for it (Barney & Wright, 1998). A resource is therefore only valuable if it can achieve reduced cost or increased revenues compared to the case where the firm lack that resource (Barney, 2002). A valuable resource is looked upon as a strength, but resources can also be a weakness. A resource is a weakness if it is not a part of exploiting possibilities or neutralizing threats in the market. In the worst case, if resources that are considered as weakness are used to develop strategies for the firm can they instead lead to increased costs and reduced revenues (Barney, 2002).

Rarity

Valuable resources are necessary for a firm, but it is not enough to give the firm a competitive advantage (Barney & Wright, 1998). If many competing firms have the same valuable resource or resources with the same characteristics, the resources would be common and would therefore only make sure the firms have competitive equality (Barney & Wright, 1998). Thus, not providing a source of competitive advantage for any of the firms. The rareness of the resources is also essential to provide a firm with a competitive advantage (Barney & Wright, 1998). How rare the resource has to be to provide a competitive advantage vary from situation to situation (Barney, 2002). The resource does not have to be utterly unique to one firm. A few numbers of firms may also possess the same resources and still maintain a competitive advantage (Barney, 2002). Generally, a resource can be seen as rare and as a source for competitive advantage, if the number of firms possessing that resource is less than the number of firms that are needed to create competition in the market (Barney, 2002).

Imitability

Resources that are valuable and rare can provide a higher than average profit for a firm, but it would only be short term if other firms can imitate the characteristics of the resources (Barney & Wright, 1998). The resources would then only provide a competitive parity (Barney & Wright, 1998). To keep the higher profit over a longer term, the firm must be able to develop characteristics of the resources that other, competitive firm cannot easily imitate (Barney & Wright, 1998). Imitation can be done in two ways, either through copying the resources directly or through developing substitutes (Barney, 2002). The resource may give a firm a permanent competitive advantage if the cost of directly copying the resources is higher than the cost of developing them, if not it would only provide a temporary advantage (Barney, 2002). Patents are a way for firms to keep other competing firms from directly copying their resources. Substitutes to the resources can be developed by competing firms, and if there are no cost disadvantages of getting those substitutes, then the competitive advantages will only be temporary (Barney, 2002). However, the resources may provide a permanent advantage if there are no substitutes or if the cost of getting them are higher than the cost of obtaining the original resources (Barney, 2002).

Organized

For resources to provide a firm with a source of sustained competitive advantage, the firm must be organized in a way that allows for the resources to be exploited (Barney & Wright, 1998). The resources' potential advantages can only be fully utilized if the firm is organized in a way that allows for it (Barney & Wright, 1998). The firm must have in place systems and practices to be effectively organized. Individually, these components only have a limited ability to create permanent competitive advantages, but they can make it possible for the firm to fully utilize their resources potential by combining them (Barney, 2002).

2.2.4. Sensitivity Analysis

In this part, the focus is moved from the actor level down to the project level. According to Rausand and Utne (2014), uncertainty can be categorized into two main categories; aleatoric and epistemic uncertainty. Aleatoric uncertainty, also known as random uncertainty, is caused by natural variation and coincidences, like for example variation caused by wind speed, wave height, rainfall and product quality. Epistemic uncertainty, also known as subjective, reduceable uncertainty or model-based uncertainty, is caused by lack of knowledge. This uncertainty can be reduced by gaining access to more knowledge. This thesis will analyze aleatoric uncertainty. Sensitivity analysis is a way of reducing the risk tied to uncertainty (Rausand & Utne, 2014, pp. 248-249).

Sensitivity analysis, also known as "what-if" analysis, is a method that is used to determine the outcome of an investment in response to independently giving an input variable different values (EduPristine, 2015). A sensitivity analysis is based on a simple principle which is "change the model and observe the behavior" (EduPristine, 2015). This type of analysis will show that some input variables have a more significant influence on the outcome than others. A sensitivity analysis starts by creating a base-case situation by using the most likely values for each input. Then specific variables of interest are changed by a specified percentage above or below the most likely value while keeping the other variables constant. The result of the sensitivity analysis can be presented through sensitivity graphs, where the slopes of the lines show how sensitive the outcome is to specific changes. The more sensitive the outcome is, the steeper the slope is. Sensitivity graphs are useful for identification of the crucial variables that impact the outcome the most (Park, 2014, pp. 601-602).

The two ways of approaching the sensitivity analysis are local and global sensitivity analysis. Local sensitivity analysis is a derivative based approach (numerical or analytical), which are taken at a single point (EduPristine, 2015). This approach is efficient for simple cost functions but struggles with complex models where the cost function is non-trivial. Local sensitivity analysis is a one-at-a-time (OAT) technique; this means that this technique analyses one parameter at a time and keep the other parameters fixed (EduPristine, 2015). It does not give an insight into how the interactions between parameters influence the outcome. Global sensitivity analysis uses a representative set of samples to explore the design space. A technique that is often implemented in global sensitivity analysis is the Monte Carlo technique (EduPristine, 2015).

Sensitivity analysis can be used in decision making by giving a prediction of the outcome of a decision with derivations from the most likely prediction. This can help to assess the risk of a strategy (EduPristine, 2015).

3. Methodology

Searching for new insight means testing, renewing and developing what appears to be established knowledge. This requires research that is relevant to the field and is done in a systematic and reliable way (Befring, 2007). The methodology is a fundamental prerequisite to being able to conduct serious and reliable research. Methodology gives a foundation for a systematic and structured approach to solving scientific problems, to gain new knowledge (Holme & Solvang, 1996).

(Befring, 2007) categorize the primary purposes of research into these three functions:

- Mapping and describing the current situation.
- Creating a foundation for a prediction of the development.
- Establish a foundation for the explanation - reveal links between different factors, variables, and phenomena.

For a scientist, it is important to be aware of that the choice of the methodology can affect the research results because the methodology will impact what kind of data processing and data analyses that are performed. Regardless of the applied methodology in the empirical research, it is possible that the results can be created by the research (research effects) (Jacobsen, 2005). The choice of methodology and the research approach is of great importance and contributes to increasing validity and reliability.

3.1. Elaboration of the research questions

The method is chosen with the intent of answering the problems statement:

What are the financial effects of investing in the Optilift Motion Reporter (OMR) Technology?

As many of the offshore O&G operator companies, Aker BP considers investment options within the fields of automation and digitizing for cost reduction. There are many different investment possibilities that are possible within the fields of automation and digitizing. Our comparison with other alternative products is limited to products that have the same application area as the Optilift Motion Reporter, and their competitiveness is evaluated against its features.

The primary focus will be on analyzing the profitability of implementing the Optilift Motion Reporter, and under which circumstances it is most profitable.

With contributions from the theoretical perspectives of the thesis, the following research questions are introduced:

1. What are Optilift Motion Reporter's competitive advantages?
2. What is the potential profitability of implementing the Optilift Motion Reporter on the offshore platform, Ivar Aasen?

3.2. Study object

The object studied in this thesis is the Aker BP-operated rig, Ivar Aasen.

3.3. Research design

After clearly formulating the research problem, the researchers need to state the conceptual structure which research would be conducted within – the research design (Kothari, 1990). The research design is the framework that has been created to organize research activity, including the collection of data, in a way that is most likely to achieve the research goals and answer the problem statement (Easterby-Smith, Thorpe, & Jackson, 2015; Johannesen, Kristoffersen, & Tufte, 2011). The choice of research design depends upon the problem statement and have consequences for both the validity and reliability of the research (Jacobsen, 2005). The research design is separated into two designs, intensive and extensive. Intensive design goes into depth with richness in details, while extensive design uses a broader approach. This thesis uses an intensive design, goes into depth studying the profitability of the OMR in one case, Ivar Aasen rig.

3.3.1. Purpose

Kothari (1990) group the purpose of research into exploration, description, diagnosis, and experimentation. When the purpose of the research is to describe a situation between variables accurately, the suitable design will be one that minimizes bias and maximizes the reliability of the data collected and analyzed (Kothari, 1990).

The main purpose of this thesis is to describe the financial effects of implementing Optilift Motion Reporter on the offshore installation Ivar Aasen for Aker BP. This analysis will be conducted by analyzing historical wave data to evaluate the potential cost reduction by extending the operational window by implementing the Optilift Motion Reporter.

3.3.2. Approach

There are two main approaches to research processes which are the inductive and deductive approach. In an inductive approach, the problem statement is studied to establish a theory about the phenomena. The approach starts with empiricism and ends up with theory. Inductive studies have an explorative design to get knowledge in fields where there is little former knowledge. The deductive approach is the opposite of the inductive approach. In a deductive approach the scientist form hypotheses based on theory, which are tested against the reality. The approach starts with theory and ends up with empiricism. Hypotheses are tested to confirm or deny assumptions in fields where there are done much research earlier (Sander, 2017; Tranøy, 2018).

This thesis has an inductive approach. The financial effects of implementing the Optilift Motion Reporter is studied in a case study on Ivar Aasen, and then it will be established if the case is generalizable to other similar rigs.

3.4. Data collection

A research process consists of collecting data and information, that is later analyzed and interpreted. Data collection is mainly split into two methods; qualitative and quantitative. According to Holme and Solvang (1998), there is no absolute line between two methods. The two methods are not competing with each other. The choice of method is strategic and depends on the problem statement, resources and potentially previous research experience (Holme & Solvang, 1998, p. 73). What mainly separates the two methods is the type of data that are gathered. Quantitative data is numerical information, also known as hard data. It can be categorized in a way that makes it possible to count how many that gives different answers, and gives a number as a result (Larsen, 2017, p. 25). Qualitative data concerns the qualitative properties (non-countable data) of the study subjects or objects, also known as soft data. This type of data is often given in the form of text (Larsen, 2017, p. 25).

Mixed methods have been introduced as a result of a growing interest in combining the two methods, qualitative and quantitative, in the same study. The fundamental idea of mixed methods is to use a combination of the qualitative- and quantitative method for the data collection and analysis. It is argued that by using a mix of the two methods, both the validity and generalization of the result will increase (Easterby-Smith et al., 2015, p. 95).

This thesis seeks to map whether digitizing offshore lifting operations with the use of Voca's OMR technology is profitable. It will analyze the possible annual saving and the data gathered will be numeric. In chapter 3.4.1-3.4.3 the methods will be explained more thoroughly.

3.4.1. Quantitative method

The quantitative method seeks to gather information that can be transformed into numbers or something countable. The result in a quantitative method aims to be generalizable. It aims to be applicable for the same problem for other similar cases. Quantitative methods use a standardized form to make it comparable with the other similar case objects (Holme & Solvang, 1998, p. 77). The standardized form is based on two conditions. First, there must be a clear line between theory and problem development and the practical data collection. Secondly, all unit researched must be faced with the same questions and answers to make it generalizable (Holme & Solvang, 1998, p. 77). When using the quantitative method, one must be aware of two prerequisites; pre-understanding and pre-judgment. These two prerequisites may affect the approach used to find an answer to the research question (Holme & Solvang, 1998, p. 143).

Quantitative data used in this thesis is weather data measured by the Miros weather sensor on Alvheim FPSO, an analysis of Optilift Motion Reporter compared with wave sensor for Valhall DP 2016 and 2017, and a shipment log for Ivar Aasen 2017. Due to lack of statistics covering waiting on weather, the time a supply vessel is a standby at an offshore installation due to bad weather, an estimate was generated by crosschecking the date for receiving supplies with the measured significant wave height for the same day. To determine if the lifts could have been made at the date of arrival at the rig, the limitations from the load chart table (Appendix C), where used. The result was then checked, by using the result from the OMR analysis from Valhall DP, to see if the lifts could have been executed with the use of OMR.

3.4.2. Qualitative method

The qualitative method gathers its data in the form of interviews, observations, text, and documents (Larsen, 2017). The most common way of gathering qualitative data is through interviews and observations. In this thesis, qualitative interviews are used. The approach of interviews is either structured or unstructured. Structured interviews have pre-prepared questions, which gives a good fundament to cover the problem statement, but allows for open answers (Larsen, 2017). Unstructured interviews use an interview guide, which is a list of questions or keywords, as a guide during the interview (Larsen, 2017). The interview subject is allowed talk freely around the topics for the interview, and the interview guide works as a checklist to ensure that all question and topics are covered during the interview (Larsen, 2017). The interview may ask follow-up questions to steer the interview in the right direction. In this thesis, the interviews have been semi-structured. Some questions were pre-prepared, while the interviewed subjects were still allowed to talk outside of these question and follow-up question could be asked.

The interviews have in this thesis only been used to support the quantitative analysis and assumptions due to the lack of data concerning if waiting for weather (WOW) is a problem or not. The semi-structured interviews were done with personnel from Aker BP, an offshore crane operator and ship captain on a supply vessel. The crane operator and the ship captain provided their perspective of the OMR and its benefits. This gave an insight into the point of view of both parts of offshore lifting operations, the offshore crane, and the supply vessel.

3.4.3. Mixed Method

Mixed methods want to merge the insight provided by both quantitative and qualitative method (Johnson & Onwuegbuzie, 2004). It seeks to fully respect the wisdom of both of the methods viewpoints, while also trying to establish a usable middle solution between the two methods (Johnson, Onwuegbuzie, & Turner, 2007). The sequence of which the methods are used can vary, from qualitative first, or quantitative first or use both at the same time. Which methods that are dominant can also vary (Easterby-Smith et al., 2015).

In this thesis, a mixed method is used. The quantitative method is dominant and will be supported by the qualitative method to strengthen the quality of the research. The qualitative method will be used to establish if waiting for weather (WOW) is a problem in the offshore industry. It will also be used to get offshore personnel's perspective on the benefits of the OMR

3.4.4. Primary and secondary data

Data collected are mainly separated into two categories; primary and secondary data (Easterby-Smith et al., 2015, p. 221). Primary data is often collected by the researcher directly from the source, while secondary data is data that has already been collected by others and are being stored in databases.

Primary data used in this thesis are interviews with an offshore crane operator and a ship captain on a supply vessel, both working for Aker BP.

Secondary data that has been used is literature study about offshore logistics to get a fundamental understanding of the industry. As well as load charts for Ivar Aasen, shipment log for Ivar Aasen for 2017 and weather data from Alvheim FPSO received from Voca. Also, an analysis comparing wave height measurements with Miros and Optilift Motion Reporter for 2016 and 2017 has been available. Prices for implementation of OMR has also been used in the analysis.

3.5. Research quality

It is essential to take both reliability and validity into account to obtain credibility for the research. A higher degree of validity and reliability ensures higher credibility for the research.

3.5.1. Validity

Validity is about relevance (Larsen, 2017, p. 45). To ensure high validity, it is crucial to choose causal variables that are relevant and a sufficient number of them, so that the result of the research can be explained. The validity depends upon the conclusions that are drawn based on the gathered data (Larsen, 2017, pp. 45-46). Validity consists of two parts; internal and external validity. Internal validity measures to which extent conclusions on the relationships between cause and effect can be made. External validity is a measure of the generalizability of the study (Nkwake & Mayne, 2015).

Internal validity

There was a lack of registered data concerning waiting on weather. Therefore, semi-structured interviews were carried out to support the claim that waiting for weather is a problem for the offshore logistics. The problem was acknowledged by both logistics personnel at Aker BP, the offshore crane operator and the ship captain of a supply vessel. It was also necessary to create estimates for the analysis. To keep a high internal validity the estimates were established by using real weather data (measured at Alvheim FPSO), and a shipment log for incoming supplies to Ivar Aasen. All the data is from 2017. The improvement by installing OMR is based on an analysis from 2016 and 2017 conducted on Valhall DP, where Miros and OMR were both measuring significant wave height simultaneously. Based on the analysis comparing the measurements from the two sensors, the average percentage of improvement was found. The framework used to calculate the potential customer value for the OMR is considered to be correct, but to achieve a higher internal validity is more accurate data concerning waiting on the weather during lifting operations needed.

External validity

The result from this study considered to be as generalizable for other rigs similar to Ivar Aasen. The weather data from Alvheim is considered to be similar to the other fields on the Norwegian Continental Shelf (North Sea), some variations are expected. The number of annual shipment to Ivar Aasen is also considered were checked with the other rigs in the received shipment log for 2017. Ivar Aasen seems to be about average when it comes to number of shipments. A standard offshore crane is considered to have a lifting ability of around 50-60 tons, which is consistent with the lifting ability for Ivar Aasen's crane. The load chart tables for Ivar Aasen has also been compared to Valhall DP's load chart table; they are assumed to be quite similar. Therefore, Ivar Aasen is considered as an average case, and the result of the analyses can be transferable to other similar rigs.

3.5.2. Reliability

Reliability is related to accuracy and can be defined as *"the degree of compliance between a different collection of data from the same phenomenon based on the same study approach"* (Larsen, 2017, p. 47). There are two main types of reliability; stability and equivalence. Stability describes the compliance between data about the same phenomenon gathered with the same research approach, but in different time periods. If the result is the same, independently of the chosen time-period, then the results have high reliability. Equivalence describe independent data collections in the same time period. It concerns the compliance between the collected data gathered by different researchers using the same research approach. Great compliance between the data collected from the different researchers leads to high reliability. This will in quantitative methods means a lower degree of random measurement errors (Larsen, 2017, p. 47).

This thesis has data gathered directly from installations operated by Aker BP, but some simplifications had to be made to compare the data with each other. The weather data was first given for every minute then changed to every half an hour to make the analyze easier. However, the shipment log only stated the date of delivery of the supplies and not the exact time. The result was that the weather data had to be made into daily values. If more precise data had been available, the reliability would have increased for this thesis, but the methodological framework formulated is still considered to be valid for the calculation of potential customer value by implementing the OMR. To keep high reliability, three scenarios have been made for calculating the daily wave height, Minimum, Average and Maximum scenario.

3.6. Approach for cleaning data sets for analysis

Two big datasets were received from Aker BP, upon request. The approach for cleaning and making the data sets ready for analyses is described in 3.6.1 and 3.6.2.

3.6.1. Weather data

The first file is the wave and wind data from Alvheim, 70 km from Ivar Aasen. This is a big file on a special format that the offshore wave and wind sensor Miros writes. Voca helped us with translating the file into Excel format and organizing the file. The file consisted of readings from every minute during 2017, which sums up to more than 500 000 rows and size of 100MB. This document was massive, and it was not possible to handle with any of the computers we had available. Therefore, we needed to do some simplifications to be able to work with the document. We had to reduce the number of readings from one reading per minute to one reading every half an hour. Our computers still had a tough time processing the data, so a little patience was needed.

The next step was to clean the dataset. The wave and wind sensor, Miros, had some error readings both for wave height and wind strength, which we filtered out and deleted from the set. The error reading had the values of -999 and -9999, which would impact the statistics of the data set significantly. This made it essential to get rid of them. We have been informed by Miros that the error readings occur because the sensor is not able to measure wave height with less than 2m/s wind speed.

Table 3.1 compares the number of data points before and after removing the error readings in the dataset for the months of 2017. The datasets went from 17512 rows with errors, to 16475 rows when the error readings were removed. In total, the error readings make up 5,9% of the total rows of the original dataset. The percentage of error readings varies significantly between the different months. The fact that most error readings occur in the summer months of July and August are reasonable since the summer months are known for having the calmest and stable weather with good conditions for offshore operations. Therefore, the data points that are missing will not have a significant effect on the result of the analysis. The chance of being able to lift while having error readings is significant since the error readings are a result of calm weather conditions.

Table 3.1 Statistics for error readings for wave data

Month	Number of days	The number of data points after deleting errors	The number of data points before deleting errors	Missing data points	% missing data points
Jan	31	1472	1480	8	0,5
Feb	28	1218	1344	126	9,4
Mar	31	1387	1488	101	6,8
Apr	30	1316	1440	124	8,6
May	31	1479	1488	9	0,6
Jun	30	1434	1440	6	0,4
Jul	31	1272	1488	216	14,5
Aug	31	1248	1488	240	16,1
Sep	30	1276	1440	164	11,4
Oct	31	1477	1488	11	0,7
Nov	30	1425	1440	15	1,0
Dec	31	1471	1488	17	1,1
Sum	**365**	**16475**	**17512**	**1037**	**5,9**

3.6.2. Logistics

The second file is the outgoing container shipment log for 2017 from the supply base Tananger, close to Stavanger. The Tananger base act as temporary storage from when suppliers deliver the supplies to the base, to the supplies is transported to offshore installations by PSVs. In 2017 there were 56944 outgoing containers from the Tananger base in total. Next, the filter function is used for sorting out the outgoing containers that are sent to Ivar Aasen. The result of the sorting was 1823 units that were sent to Ivar Aasen in 2017. Among these 1823 units that were sent to Ivar Aasen, 1338 are classified as containers. The rest of the units are baskets, compactors, skips (small containers), tanks, racks and a few other. In the analysis, it will not be differentiated between the different types of containers. All the units will be referred to as containers since the majority are containers.

A sample from this dataset is shown in Appendix D. The most important content of the container shipment log is weight specification and the received date. The weight specification is divided into two weight categories that are called *Weight* and *Tare weight*. The *Weight* category specifies the weight of the actual supplied item, given in metric tons (MT). “Tare weight” specify the weight of an empty container and is given in kilograms in the excel sheet. These two weights are then added to get the total weight.

For some of the lifts, the *Tare weight* value is set to “-.“ In these cases, the shipped items are assumed not to be stored in a container, while being transported. The values “-“ are in those cases changed to 0 for the analysis.

3.7. Limitations of the study

The main limitation of this study has been the lack of accurate data concerning waiting on weather. Aker BP did not have accurate data concerning today's waiting on weather situation, and the delay of the pilot study at Ivar Aasen prevented the gathering of accurate improvement data by implementing the OMR. The initial plan was to study today's WOW situation, then study the pilot for the improvement by implementing the Optilift Motion Reporter (OMR). As a result of these limitations, the OMR improvement had to be partly made based on former analyses conducted by Voca. The analysis conducted by Voca on Valhall DP, it compared relative heave motion on vessel deck with significant wave height measured by Miros’ wave sensor.

The lack of data considering waiting for weather has also been a limitation of the study. There have been made estimates to compensate for this, but actual statistics for waiting for weather would give a more precise picture of the actual annual saving by using OMR.

Another limitation is that the weather data that is analyzed is measured at the Alvheim field and not at Ivar Aasen. Even though the distance is only 70 km, there might be some variations. There has also been some error reading on the weather data; there may have been different reasons for this. There might have been maintenance executed on the sensor, or the wind speed have been under 2 m/s. The error data has caused some dates to have fewer measurements than others.

The arrival of the supply shipments has only been given by date and not time. This causes uncertainty about what the wave heights actual were at the time of the day of delivery, forcing estimates to be made. These estimates would have been more precise if more accurate time data had been available for the shipments.

4. Presentation of the case study

In this chapter, Voca, Optilift Motion Reporter, alternative product and the chosen offshore installations will be presented.

4.1. Voca, the developer of the Optilift Motion Reporter technology

Voca's technology consist of different aspects which aims to make the offshore operations more profitable for their customer by reducing costs related to lifting and logistics, reduce the risk related to lifting operations as well as reducing the offshore industries environmental footprint (Optilift AS, 2018a). Voca's subsidiary Optilift, achieved this by optimizing lifting operations, making the logistics handling more effective, and by detecting and alerting when people are in the lifting area (Optilift AS, 2018a).

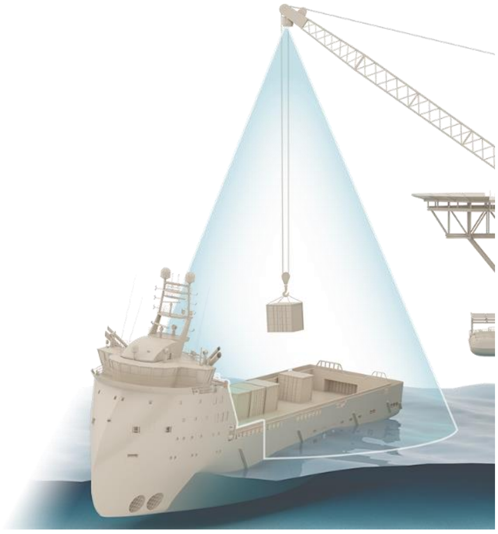

Figure 4.1 The Optilift Motion Reporter system. Retrieved from (Voca AS, 2018a)

Voca's main expertise is in three fields; robot vision, artificial intelligence, and machine control. Robot vision is used for detection and identification of objects, navigation and mapping (SLAM – simultaneously localization and mapping), 3D reconstruction, pattern recognition and motion estimation (Voca AS, 2018a). Their systems have been developed for use in harsh and uncontrollable environments. Artificial intelligence is utilized through Voca Engine to classify objects and train object identification. Voca's experience spans from neural networks and deep learning to mathematical models and predictive control algorithms. The machine control aspect of Voca's expertise is seen through their ability to provide state-of-the-art control systems for industrial automation by implementing and utilizing mathematical models, predictive control algorithms and intelligent sensor technology (Voca AS, 2018a).

Voca's primary products include the Optilift Motion Reporter (OMR) and Integrated Logistics which is utilized through the Deck Planner (Optilift AS, 2018b). The Optilift Motion Reporter focuses on optimizing the lifting operations, while the Deck Planner's focus is on increasing the efficiency of logistic handling. The Optilift Motion Reporter has received a technology qualification certification by DNV GL (Optilift AS, 2018d). This thesis will mainly focus on the Optilift Motion Reporter, leaving the Deck Planner for future research.

4.2. Optilift Motion reporter (OMR)

Voca's slogan for the Optilift Motion Reporter is:

> *"Increase your effective lifting capacity, reduce time spent waiting on weather and optimize cargo handling." (Voca AS, 2018b)*

The Optilift Motion Reporter (OMR) is a decision support tool which gives information to the crane operators about the actual heave motion of supply vessels during lifting. Figure 4.2, the picture on the left show the concept of the OMR and the picture on the right show the OMR sensor besides the screen that goes into the crane cabin. The OMR also provides information about boom tip location to avoid lifting with an off-lead angle and is equipped with a people detection system (Voca AS, 2018b). The Optilift Motion Reporter shows the heave motion of the vessel in real-time and can therefore give a precise picture of the actual wave heights that affects the supply vessel, and shows the actual distance between the boom tip and vessel deck (Voca AS, 2018b). OMR seeks to extend the operational window of the offshore crane by being able to give more precise wave height measurements. Analysis of wave height in 2016 and 2017 at Valhall DP showed an average of 35 % lower heave motion on the point of the vessel deck with most movement than the reported wave height from the Miros sensor (Optilift AS, 2018c). Extending the window for lifting operations leads to a reduction in time spent waiting on weather, the rental time for equipment and damage to equipment can be reduced (Optilift AS, 2018c).

The Optilift Motion Reporter utilizes a camera and a laser range measurement device which allows it to offer several features (Voca AS, 2018b). Two features it provides are the Boom Tip Indicator and People Detection. The Boom Tip Indicator shows the location of the boom tip on a monitor and will then show the crane operator where the cargo will land. A significant safety advantage with this feature is that it helps the crane operator to avoid lifts being executed with off-/side-lead angles (Optilift AS, 2018c). The People Detection system alerts the crane operators if people are moving inside the lifting area. It can therefore prevent dangerous situations and decrease the number of accidents that occur during lifting operations.

The Optilift Motion Reporter can be installed on cranes both on stationary platforms and on floating and mobile units. It does not need any instruments on the supply vessels, and can therefore be used on all types of vessels (Optilift AS, 2018c).

Figure 4.2 The Optilift Motion Reporter. Retrieved from (Voca AS, 2018b, 2018c)

4.3. Alternative to the Optilift Motion Reporter

To uncover alternatives to the Optilift Motion Reporter, Voca was asked if they could elaborate on who their competitors are. An internet search for alternative products providing the same main feature, real-time heave monitoring for offshore lifting operations, was conducted. Only one other product providing the real-time heave monitoring was found, this was ShoreConnections's product Deck Motion Monitor.

ShoreConnection's Deck Motion Monitor

ShoreConnection's Deck Motion Monitor (DMM) system's objective is to conduct safer crane operations by providing accurate measurements, which allows for operations in a broader range of weather conditions (ShoreConnection, 2018a). The primary display includes three elements; deck area, effective significant wave height and a real-time heave trend curve. The deck of the vessel shows a grid which changes color according to set wave limits for the crane, where the green area indicates safe lifting conditions, yellow is a warning indication for conditions approaching unsafe area and red is unsafe conditions (ShoreConnection, 2018a). The Deck Motion Monitor is installed on the supply vessels.

An add-on module that can be added to the Deck Motion Monitor system is Relative Deck Motion; this aims to provide safer sealift between floating installations and vessels (ShoreConnection, 2018b). The crane's movement is taken into consideration and added to the movement of the ship to form a relative motion between the ship and the crane(ShoreConnection, 2018b). The Relative Deck Motions system measures and calculates the offshore lift area based on a fixed measuring point in the crane pedestal (ShoreConnection, 2018b).

4.4. Ivar Aasen

The field chosen for analysis is the Ivar Aasen field, operated by Aker BP. Voca has agreed to perform an extensive offshore pilot together with Aker BP, funded by an EU project awarded to Voca AS. The project is focusing on piloting new digitalization of the offshore logistics handling.

The original plan was that a pilot study of the Optilift Motion Reporter (OMR) should start on Ivar Aasen in the first half of the spring of 2018 and should be finished within the end of the master thesis period. The original plan was to compare the situation before and after implementing the OMR. Due to delays of the pilot, this thesis has been changed from comparing the actual before and after situations of the offshore logistics for Ivar Aasen, establishing today's situation for logistics of the field and based on former analyses done by Voca, predict the potential improvements by implementing the OMR technology. The actual improvements will be found after finishing the pilot and analyzing the data from the pilot-period.

The Ivar Aasen field is located in the northern part of the North Sea, close to the Edvard Grieg and John Sverdrup fields (Aker BP, 2018). The production started less than two years ago, and it can be characterized as a new field. The field is developed as a stand-alone production platform for partial processing and water conditioning and injection, where the hydrocarbons are sent through pipelines to the neighboring field, Edvard Grieg, for processing and export. The platform is shown in Figure 4.3. Aker BP is the operator of this field and the license is shared between seven petroleum companies, where Statoil is the most prominent owner and Aker BP is the second biggest owner (Aker BP, 2018). The main base for supplies for the Ivar Aasen field is Tananger, located close to Stavanger.

Figure 4.3 The Ivar Aasen platform in the North Sea. Retrieved from (Aker BP, 2018).

5. The potential profit of the industry

Jakobsen and Lien (2015) have developed a framework called the Profitability Tree. The Profitability Tree framework divides the profit potential of industry into two parts, which value allocation potential and value creation potential. The industry that is analyzed is the industry of real-time heave monitoring systems for offshore lifting. This industry develops products that improve the offshore cranes' performance by monitoring real-time heave motion, which also leads to improved safety.

5.1. Value distribution

According to Porter (2008), the potential profitability of an industry is determined by competitive analysis. The goal of this thesis is to determine the potential profitability of OMR, and it will start by analyzing the industry it operates in. It is important to pinpoint that it does not look at the entire petroleum industry, but have limited the analysis to cover the industry of real-time heave monitoring systems for offshore lifting. A Porter's Five Forces analysis is conducted to determine the strength of the competitive forces in the industry. Together these five forces affect how the value is allocated in the industry.

Threat of entry

The seven major barriers for entrants are analyzed here:

1. *Supply-side economies of scale.* The industry's complex products are demanding and time-consuming to develop and require highly skilled developers, which leads to big expenditures during the development phase. There are regulations that demand the products to be certified after specific standards before the products can be used for offshore lifting operations. Both the initial cost of development of the products and the cost of certifications are quite high. It is therefore important in this industry to reach supply-side economies of scale, to divide the cost of development, cost of certification and the cost of production, on many product units. Compared to other mass-produced products in other industries, the potential scale for the offshore lifting accessories are rather limited. There are just not that many offshore installations on the Norwegian continental shelf.
2. *Demand-side benefits of scale*. The Norwegian offshore oil and gas industry is the target customers for these products. In general, the Norwegian O&G industry is known for being conservative (Haugstad, 2013). Their skepticism is understandable as they potentially face devastating consequences if something goes wrong on the

offshore installations. During lifting operations, it is crucial that the lifting products be reliable and safe to use. These factors contribute to that incumbents with known products often will be preferred, and it makes it harder for new entrants to establish themselves in the market.

3. *Customer switching costs*. In this industry, the products have high complexity, and the product prices are quite high per unit. The operating personnel will also need the training to learn how to handle new equipment correctly. It is considered to be only two competitors in this market. Therefore, the cost of changing supplier is high if one of the competitor's product is installed first. This results in a high barrier against entrants.
4. *Capital requirement.* The capital needed for entries to enter the market is high. The cost of development is especially high. Additional costs for testing, certifications, and advertising also come in addition to the high cost of development.
5. *Incumbency advantages are independent of size.* It seems like the incumbents in the industry have advantages independent of size. Most of the technology in the industry is patented, and valuable experience is very important. This act as a big barrier.
6. *Unequal access to distribution channels.* The access to distribution channels is not important to the industry. The transportation cost will be assumed to be very small compared to the total cost of the products.
7. *Restrictive government policy.* The restrictive government policy is not considered as relevant for this thesis and will therefore not be discussed.

To summarize, the barriers for entrants are high, so the threat of entry is relatively low. It seems like big investments are needed to enter the industry of real-time heave monitoring systems for offshore lifting.

Threat from substitutes

We have not been able to find any good substitutes that are available to the offshore crane and lifting industry today. In an article in Offshore Support Journal, the use of unmanned aerial vehicles or drones to transport cargo between offshore vessels and offshore installations is mentioned as a potential future substitute for traditional lifting by cranes. There is currently going on a research project that is supported by the Research Council of Norway, where four Norwegian companies work together to manufacture drones that can carry heavy cargo (Foxwell, 2018). Some challenges are that the drones need to be able to lift heavy cargo and it also must be very accurate in rough weather conditions. It will probably be hard to convince the operators of the offshore installations to start using drones due to the extra safety concern related to having drones flying over the installations. A standard offshore crane can lift up to about 50-60 tons. It is hard to imagine that drones can handle the same weights. There are clearly many years of research and thorough testing needed before drones can potentially substitute the traditional offshore cranes for the lifting of supplies to offshore installations. The threat from substitutes is low.

Rivalry among existing competitors

When it comes to rivalry among existing competitors, there are no competitors that can offer the same as the Optilift Motion Reporter with all its features, but there are products that can rival some of the individual features of the Optilift Motion Reporter. The focus lies in if someone can rival the Optilift Motion Report's main feature, which is monitoring of real-time heave motion. There seem only to be one competitor that can directly rival this feature. This competitor is ShoreConnection's Deck Motion Monitor. The main difference between these two products is where the products are installed. The Optilift Motion Reporter is installed on the boom tip of the offshore cranes, while the Deck Motion Monitor is installed on the supply vessel's deck. OMR can be considered to have an advantage because it does not require any installed equipment on the supply vessels. This flexibility results in that the offshore installations are not dependent upon using specific supply vessels with special equipment installed.

Rivalry among existing competitors is considered to be low.

The power of suppliers

The power of suppliers is assumed to be medium. Most of the parts that are bought by the industry from suppliers are highly specialized, and there are not very many suppliers available. Many of the industry products are built around the customized components, e.g., sensors, from suppliers, and the industry is dependent on the specific suppliers. This dependency gives suppliers more power.

There are two key suppliers for certifications, DNV GL in relations with crane standards and Presafe in relations to explosion certifications. In Norway these two suppliers do almost have a monopoly providing these services, giving them much power when it comes to new technology. Once the technology is certified and approved their power is reduced.

The power of buyers

Statoil is clearly the biggest actor on the Norwegian Continental Shelf and the biggest potential customer. The second biggest customer is Aker BP, and there are some other smaller companies that are just operating a few installations. The petroleum industry has been through significant changes since 2013 and has had a great focus on cutting their costs since. E.g., the supply vessels industry has been pressed very hard on the day rates, and they do hardly cover their operating expenses with the day rates they are paid by the offshore operator companies. This is an example of how big power the major offshore operators have over their suppliers in general. The big power of buyers can threaten the profitability of the real-time heave motion systems for lifting industry. The high power of buyers is assumed to be slightly reduced by only having two different suppliers in the industry of real-time heave monitoring system for offshore lifting. However, the power of buyers is still considered to be high in this industry.

Summary of Porters 5 Forces for the industry

The entry barriers for entrants are high, so the threat of entry is relatively low. It seems hard for entrants to compete with the incumbents. It seems like 6 out of 7 barriers are high. The only exception is that the access to distribution channels seems not to be an important aspect of the industry.

The threat from substitutes is low. Today there are no available substitutes to the real-time heave motion systems for lifting industry. There is a research project going on where drones are tested for carrying the offshore supplies between PSV’s to the offshore installations. The potential implementation of drones lifting offshore supplies will be demanding.

The rivalry among existing competitors is considered to be low. There are no other competitors with the exact same features as OMR. There is one competitor with a similar product, but it has to be installed on all the PSVs, instead of on the crane. This makes the operator companies dependent upon using the specific PSVs with the equipment installed, which gives OMR a big advantage by being able to work on all boats without no installed equipment on the PSVs.

The power of suppliers is medium. The industry products are built around highly specialized products supplied by suppliers, which makes the industry dependent on specific suppliers.

The power of buyers is high in the industry. Companies like Statoil and Aker BP, have significant market shares in the Norwegian petroleum industry and together they are a big part of the potential customer base on the NCS for the real-time heave motion systems for lifting industry. The high power of buyers significantly limits the potential profitability of the industry.

5.2. Value creation potential

The industry's potential for profitability is also dependent on the potential for value creation, in addition to the potential for value allocation. The potential for value creation in the industry will be determined by applying the Profitability Tree framework, developed by Jakobsen and Lien (2015).

Value creation per product unit

The value creation per product unit is determined by the difference between the customer's reservation price and the factor supplier's reservation price (Jakobsen & Lien, 2015). In this thesis, the aspect of factor suppliers' reservation price will not be analyzed. The value creation for the customer is important and will be thoroughly analyzed in the customer value chapter.

The number of product units (market size)

Jakobsen and Lien (2015) decide the number of project units (market size) by the number of customers multiplied by the number of products units per customer. The big variances in numbers of offshore rigs per customer on the NCS have made it necessary take an alternative path to find the number of product units.

The map for the offshore Norwegian Continental Shelf created by the Norwegian Petroleum Directorate (Norwegian Petroleum Directorate, 2017) was checked towards the online fact pages from the same directorate (Norwegian Petroleum Directorate, 2018) to determine the number of offshore installations on the NCS. There were set two prerequisites to filter the potential customers of the products of the industry. First, the offshore installations have to be topside and not subsea. Second, the offshore installations have to be manned. The reason that we only look at manned installations is that the need for supplies are regularly small for the unmanned installations, and thereby the installation of the Optilift Motion Reporter is rather unlikely. After applying these two prerequisites, it was determined that there are 37 offshore installations that are in production today, and there are also several fields under development. Together these offshore installations form the potential market for the products of the industry.

5.3. Summary of chapter 5

The result of Porter’s Five Forces analysis concluded in a high level of entry barriers and power of buyer. OMR has already passed the entry barriers through a collaboration with Aker BP. The main limitations for the profitability of the OMR are therefore considered to be the power of the buyer and the customer value of the OMR.

The market for the OMR consists today of 37 offshore installations in production, and several fields are also under development.

6. Analysis of customer value

Due to lack of statistics concerning waiting on weather, three scenarios were established based on weather and shipment data provided by Aker BP and Voca. The three scenarios are called Minimum-, Average- and Maximum significant wave height scenario. They will be used to analyze the potential profitability of investing in OMR.

The analysis is presented as a framework, where the three different scenarios are analyzed. Therefore, this thesis should not be used as a final evaluation of the profitability of the Optilift Motion Reporter, but rather as a guide for the final analysis after the pilot on Ivar Aasen is finished.

6.1. VRIO of Optilift Motion Reporter

To see the value of the motion reporter, a VRIO analysis is conducted. The Optilift Motion Reporter offers several different features. In this analysis the OMR is divided into three main features; which are real-time heave motion, boom tip indicator, and people detection.

VRIO is typically used for analysis on a company level, but in this thesis, it will be used on a technological level. The O of VRIO, which concerns how efficient the resources are organized, will not be a part of this analysis, therefore making it a VRI analysis instead.

6.1.1. Boom Tip Indicator

The boom-tip indicator shows the crane operator was the lifting block is in comparison to the boom tip. This feature lets the operator know if the lifting operation is about to be executed with an off- or side-lead angle, which can reduce the chance of the cargo swinging during the lift-off and potentially damage the supply vessel, the offshore installation and other cargo. This can create damage with a significant cost. Decreasing the chance for it to occur, can therefore be considered to be valuable. The interviewed crane operator told that it felt safer during lifting operations with the use of the boom tip indicator.

As a result of not being able to find other products providing the same feature as the boom tip indicator, it is considered to be rare.

The technology behind the boom-tip indicator is being protected with patents, as a result avoiding other companies from directly copying it. There is also a lack of substitutes signaling that the boom-tip indicator may be hard to imitate.

To conclude, the boom-tip indicator seems to be able to provide the OMR with a permanent competitive advantage as shown in Table 6.1.

6.1.2. Real-time heave monitoring

The real-time heave monitoring system can reduce offshore companies' cost related to supplying the offshore installations. This can be achieved by reading the actual heave motion on the deck of the supply vessels and thereby increase the weather window for operation. This can reduce the cost tied to waiting on weather, as well as increasing the range for when equipment can be lifted onto the platform from the supply vessel. It can therefore reduce costs related to renting a supply vessel, the extra fuel consumed by the supply vessel while waiting and may reduce the number of containers going on round trips due to bad weather. It can also let the crane operator know if the effective, significant wave height is higher than shown with the traditional wave radar so that the lifting operation can be stopped. This can save repairs on the crane and potential damage to the cargo. The real-time heave monitoring is therefore considered as valuable.

There are not many products that can provide the same or similar services. After talking with Voca and executing an internet search, only one direct competitor was found, ShoreConnection's Deck Motion Monitor (DMM). The OMR is installed on the boom tip of the cranes, while the DMM is installed on the supply vessel deck. As a result, the real-time heave monitoring feature is considered to be rare.

The Optilift Motion Reporter is patented, protecting it from being directly copied. Since only one other substitute to the Optilift Motion Report's real-time heave monitoring feature was found, this feature is considered to be imitable. Only finding one substitute may also suggest that other companies do not find it very profitable to imitate it. As discussed in chapter 5.1, it seems to be a race to hit the market first due to high customer switching cost after one alternative is installed. Therefore, imitating this feature is considered to be moderate.

To conclude, this feature is considered to be a potential permanent competitive advantage as shown in Table 6.1.

6.1.3. People Detection

People detection lets the crane operator know when people are moving inside the lifting zone. This feature may therefore be able to potentially reduce the risk of accidents occurring during lifting operations. Safety for the employees on the offshore installation has a high priority, and ways of reducing the number of accidents involving people are considered to be valuable for the companies.

People detection is not a rare feature in itself, but it is more used in onshore companies using overhead cranes so that it can be considered as rare for use on offshore installations.

After an internet search for alternative products delivering the same feature, were several products found. Therefore, the people detection feature is considered not to be hard to imitate.

To conclude, the people detection feature only be offering a temporarily competitive advantage due to several substitute products being used by onshore companies. This is shown in Table 6.1.

6.1.4. Conclusion of VRI for Optilift Motion Reporter

To conclude, the results shown in Table 6.1 shows that the Optilift Motion Reporter as a total product can be considered to have a potentially permanent competitive advantage.

Table 6.1 VRIO analysis of OMR

Resource/Feature	Valuable	Rare	Hard to Imitate	Implication
Real-time heave motion	Yes	Yes	Yes/No	Temporarily permanent competitive advantage
Boom tip indicator	Yes	Yes	Yes	Permanent competitive advantage
People detection	Yes	Yes/No	No	Temporarily competitive advantage

6.2. Analysis of weather data

Rough weather conditions are known to be a limiting factor for supply to offshore installations. This thesis aims to analyze this phenomenon throughout 2017 for the Ivar Aasen field, based on the wind and wave measurements retrieved from the Miros sensor from the Aker BP-operated field, Alvheim. The Alvheim field is located about 70 km north from Ivar Aasen, and the weather conditions are expected to be very similar to Ivar Aasen. The weather data file we received from Aker BP contain readings of significant wave heights and wind speeds for 2017. As described in chapter 3.6, about the approach to analyzing datasets, there had to be done some simplifications to be able to conduct the analyses with these big data sets. The weather data had to be reduced from readings every minute through the year, to one reading every half an hour.

In the data set we received from Alvheim FPSO there was only one data reading of wind speed exceeding the operational limit of 25m/s. This data point with a measured wind speed of 25,12m/s only barely exceeded the limit of 25m/s. The day this exceeding wind speed was measured, no supplies arrived at Ivar Aasen. Therefore, the impact of wind is ignored in this analysis. Conversations with offshore personnel have made us realize that having just one data point exceeding the limit of 25m/s may be unreasonably low.

First, the weather dataset was analyzed to find the distribution of the significant wave heights through 2017 for the Ivar Aasen field. The significant wave height is measured by the Miros sensor as the average of the highest one-third waves during the past 20 minutes. The result of this analysis is shown in Figure 6.1. The figure shows that it is not often that there is less than 1-meter significant wave height. Most of the measurements fall into the two intervals 1-2 meters and 2-3 meters. The descriptive statistics of the significant wave height and wind speed for 2017, is found in Appendix A.1.

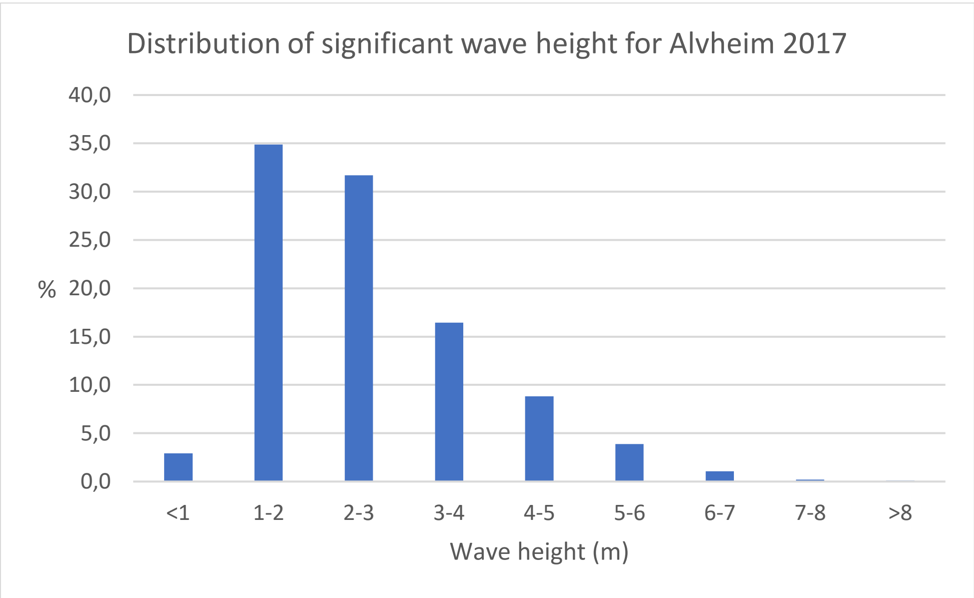

Figure 6.1 Distribution of significant wave heights for Alvheim 2017

Table 6.2 shows the distribution of significant wave heights from Figure 6.1. The two intervals 1-2 meters and 2-3 meters together add up to more than 65% of the total data points. Significant wave heights of more than 7 meters are rare, with 0,3%.

Table 6.2 The distribution of significant wave heights for Alvheim 2017

Significant wave height interval	Count	Percent
<1	481	2,9
1-2	5747	34,9
2-3	5220	31,7
3-4	2708	16,4
4-5	1451	8,8
5-6	640	3,9
6-7	177	1,1
7-8	33	0,2
>8	15	0,1
Sum	16475	100

To be able to say more precisely at what point the frequency of measurements is peaking, Figure 6.2 where constructed. The figure show that the significant wave height has the highest frequency around 2 meters, as indicated in Figure 6.1.

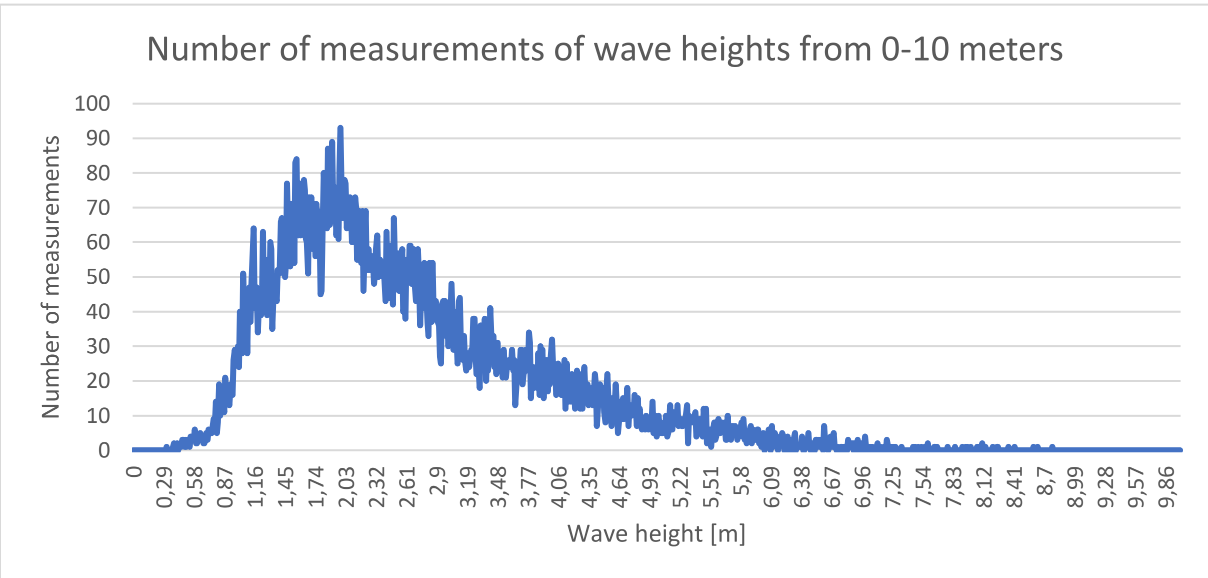

Figure 6.2 Number of measurements of wave heights from 0-10 meters

For analyzing the trends of the wave data, the Pivot table function in Excel was used for Figure 6.3, Figure 6.4 and Figure 6.5. Figure 6.3 shows the general trends of the average significant wave height for the months of 2017. The dataset shows significant seasonal variances. The wave height clearly seems to be highest in the winter and lower in the summer.

The months January-April and October-December all have average significant wave height of more than 2,5 meters. October is the month with the highest average significant wave height with more than 3,5 meters. The summer months from May to August have an average monthly wave height of 2 meters or less. July has the lowest average significant wave height with a little more than 1,5 meters.

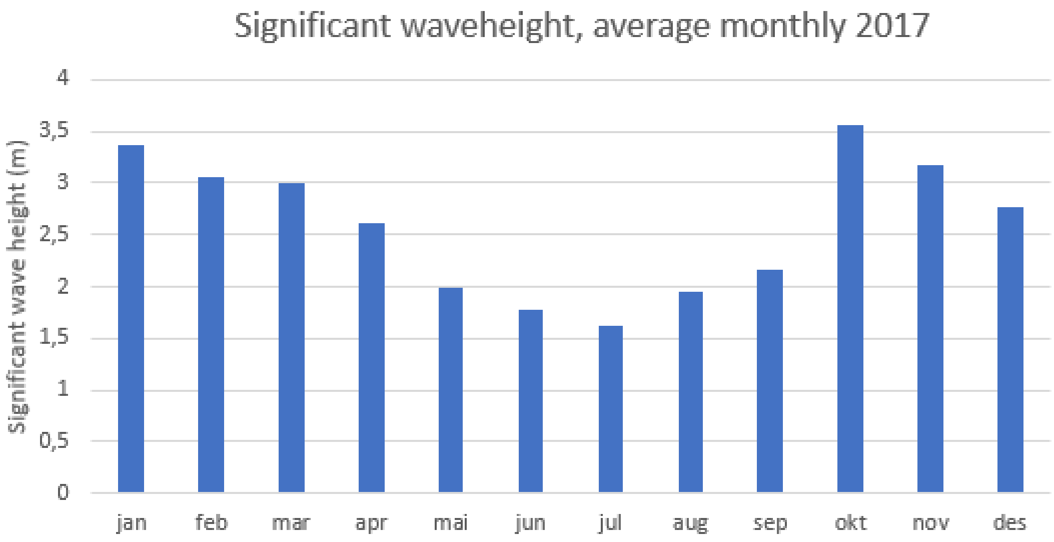

Figure 6.3 Significant wave height, the average monthly in 2017

Figure 6.4 shows the average significant wave height for every day in 2017. There are few days with an average significant wave height exceeding 6 meters. The trends from Figure 6.3 is transferred to Figure 6.4, with the variations through the year. Figure 6.4 shows that from the middle of May to the middle of September there are few days with average significant wave height close to or exceeding 3 meters. All the months from January-May and September-December have days with average significant wave heights exceeding 4 meters. January, October, and November are the only months with days where the measured average significant wave height is exceeding 6 meters.

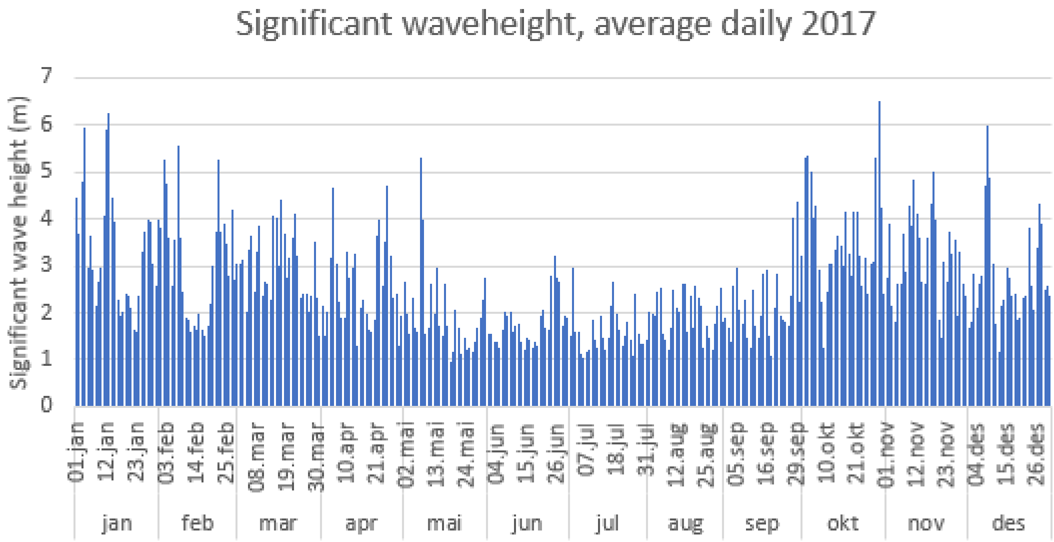

Figure 6.4 Significant wave height, the average daily in 2017

The fact that only the date and not the time of the arriving PSVs with supplies to Ivar Aasen is given in the data set create the need to also look at both the Minimum and the Maximum significant wave heights for each day. The possibility of supplies arriving at Ivar Aasen in better or worse weather conditions than the daily average is then taken into account.

Figure 6.5 shows the highest measured significant wave height for every day in 2017. The trends from Figure 6.3 and Figure 6.4 that are mentioned earlier in this chapter, also apply for Figure 6.5. The same seasonal differences can also be seen in Figure 6.5. Figure 6.5 compared with Figure 6.4, show that there are significant variations from the measurements for average daily significant wave height to the measurements of max significant wave height for the days of 2017. For example, the two storms in the first half of January have an average daily significant wave height of around 6 meters, and the max daily significant wave height is between 8 and 9 meters. That is a significant difference.

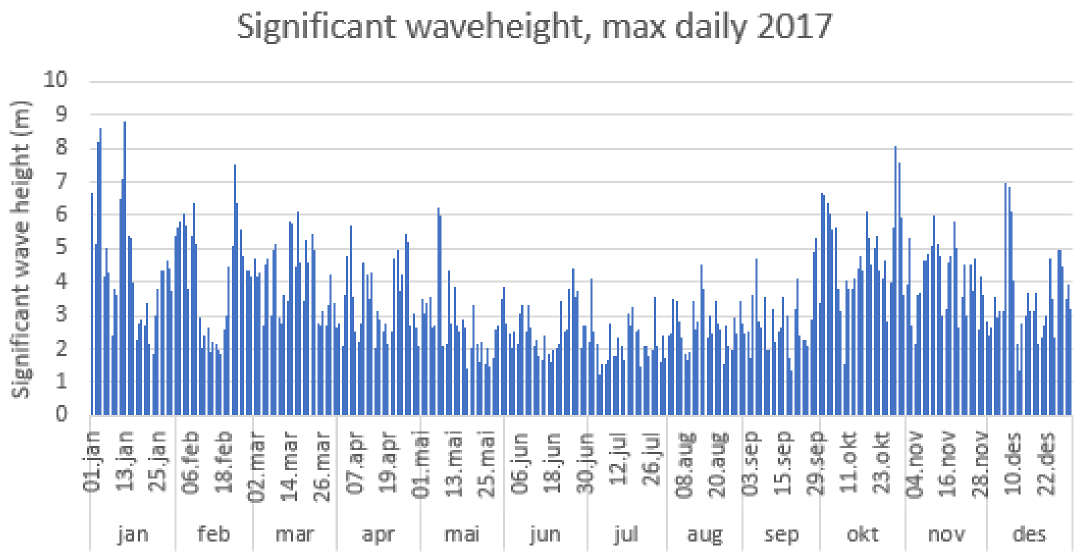

Figure 6.5 Significant wave height, the max daily in 2017

There are quite significant differences between the highest and lowest daily measurements for 2017. Figure 6.6 shows that the highest values of the Minimum significant wave height scenario are significantly lower than highest values of the Maximum and Average significant wave height scenarios. The highest value in the Minimum significant wave height scenario is approximately 5,5 meters, compared to close to 9 meters in the Maximum scenario.

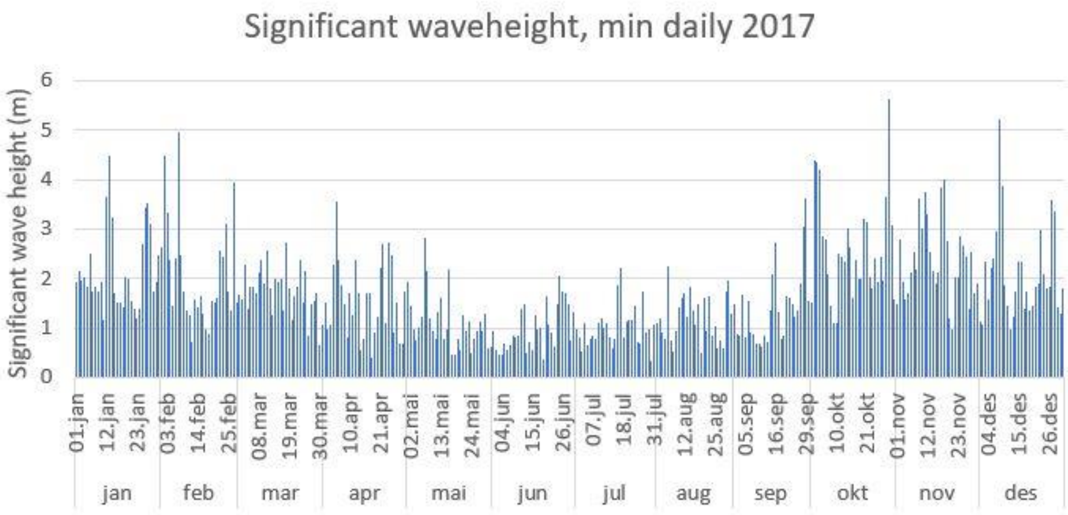

Figure 6.6 Significant wave height, the min daily in 2017

6.2.1. Summary of weather data analysis

To summarize, 65 % of the measured significant wave heights are measured between 1-3 meters of height. The significant wave height that has the highest measured frequency is around 2 meters as shown in Figure 6.2. There are visible seasonal variances in the measured wave heights. The winter half of the year has higher measured wave heights than in the summer. This was the same for all scenarios. The difference in wave heights between the three scenarios are significant, and the Average scenario is expected to be closest to the reality.

6.3. Analysis of logistics data

Offshore installations need many supplies for one year of operation. The needed supplies span from technical equipment, tools, and fuel, to consumables like drinking water and food.

In 2017, Ivar Aasen received 1823 units from PSVs with a total weight of 8988,64 tons. To put this number into number context, the weight is slightly exceeding the weight of the steel jacket of the platform of 8900 tons (Aker BP, 2015). These 1823 containers have been delivered in 132 different shipments by PSVs. These 132 shipments are delivered by 17 different vessels in 2017, which give 2-3 shipments per week. The two PSVs that are used most are Island Challenger and Saeborg. They have both delivered a little less than 600 containers, with an approximate total weight of 2800 tons each. The 1823 containers received in 2017 have 36 different suppliers. The biggest supplier for Ivar Aasen in 2017 was ASCO Norge AS with 2400 tons. These statistics prove the complexity of offshore logistics.

Figure 6.7 summarizes the number of containers supplied in each month to Ivar Aasen. The number of containers supplied monthly varies from the more significant amount of 229 in January to the smallest amount of 110 in September. In average, 152 containers are supplied to Ivar Aasen each month.

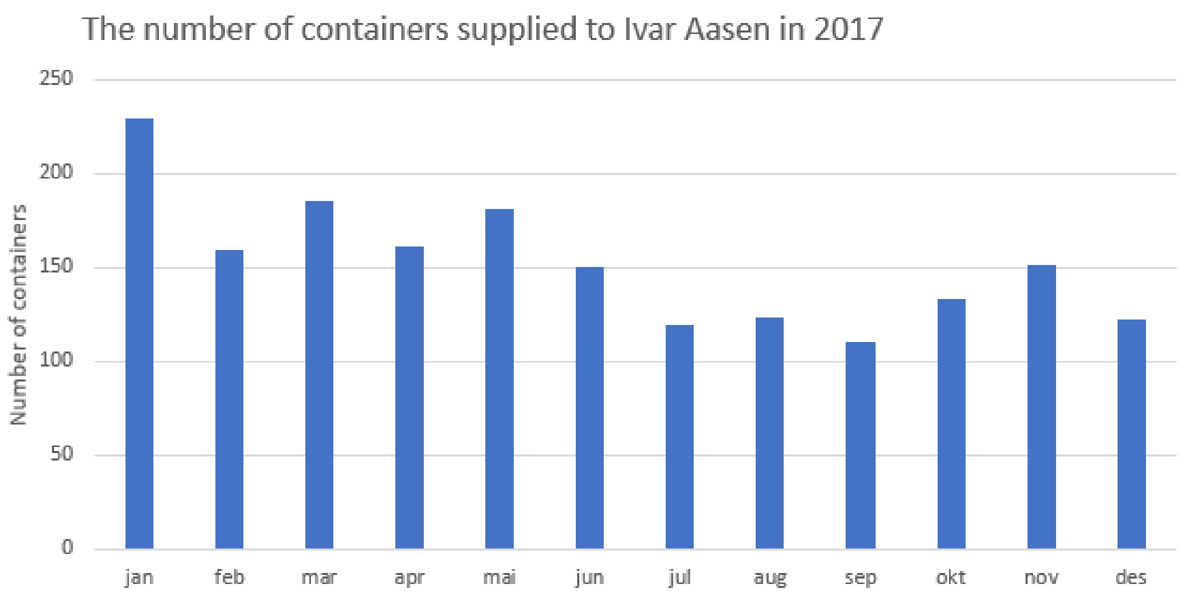

Figure 6.7 The number of containers supplied to Ivar Aasen in 2017

Figure 6.8 shows a summary of the number of containers supplied to Ivar Aasen in 2017 in the 132 different shipments in a year. The average number of containers in a shipment is 14 containers. The number of containers in a shipment, in the data set, varies from 1 to 53.

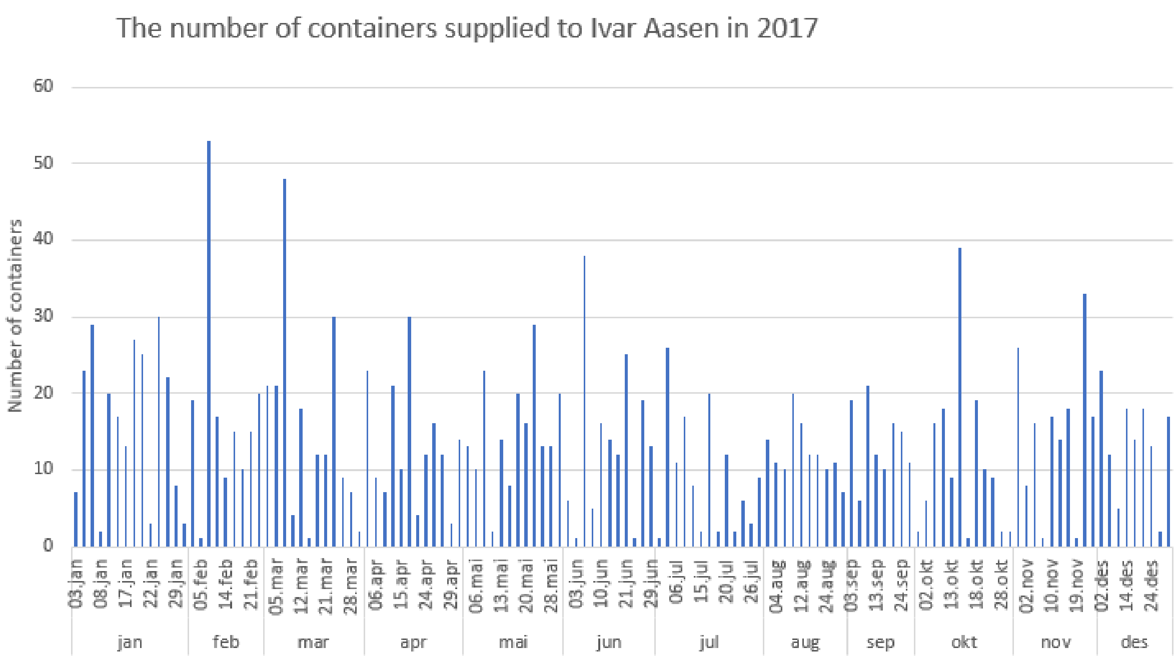

Figure 6.8 The number of containers supplied to Ivar Aasen in 2017

The weight distribution of the containers is an essential aspect of this dataset. The result of an analysis of the percentage of shipments that fall into given weight intervals is shown in Figure 6.9. Most of the supplies are found in the interval from 0-5 tons.

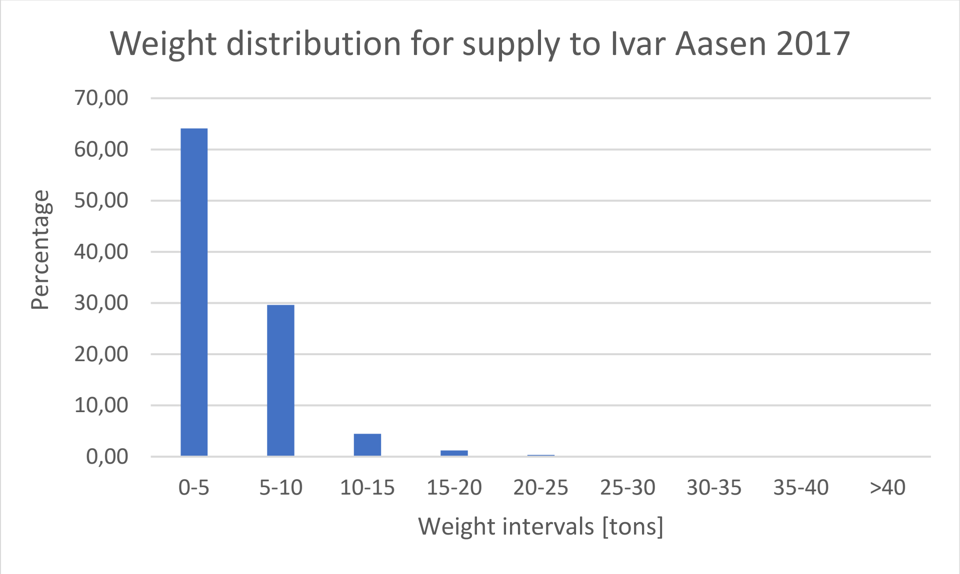

Figure 6.9 Weight distribution for supplies to Ivar Aasen

The associated numbers in Figure 6.9 are shown in Table 6.3. 64,13% of the supplies are found in the weight interval 0-5 tons and 29,62% in the weight interval 5-10 tons. The supplies with weight from 0 to 10 tons make up 93,75% of the total supplies. There are only eleven containers with weight exceeding 20 tons.

Table 6.3 Weight distribution for supplies to Ivar Aasen

Weight interval	Count	Percentage
0-5	1169	64,13
5-10	540	29,62
10-15	81	4,44
15-20	22	1,21
20-25	6	0,33
25-30	1	0,05
30-35	1	0,05
35-40	1	0,05
>40	2	0,11
Sum	1823	100

6.3.1. Summary of logistics data analysis

To summarize, Ivar Aasen received 1823 units in 2017 which were delivered in 132 different shipments, giving an average of about 14 units per shipment. For each month, an average of 152 containers was supplied to the rig.

The analyses show that most of the units supplied to Ivar Aasen in 2017 are in the weight interval 0 – 5 tons. A total of 93,75% of the supplied units can be found in the weight interval from 0 – 10 tons and only eleven units exceed 20 tons.

6.4. Lifting analysis

In the primary analysis, the data sets for wave height and logistics together will form the foundation for the analysis. General analyses have been conducted for wave data in chapter 6.2, and general analyses for logistics data have been conducted in 6.3. Based on the readings for wave height it has been established three scenarios. The three scenarios are called Minimum, Average and Maximum.

In the Minimum scenario, the lowest wave height measured through the day of delivery is used in the further analysis of the lifting of the containers. For the two other scenarios, the same logic applies, but with the calculated average wave height and the highest measured wave height through the day of delivery.

For offshore lifting operations, there are strict rules. The main limiting factors are the weight of the container, wave height, and wind speed. As mentioned earlier the wind speed is ignored in the analysis, because none of the days with deliveries have wind speeds exceeding the limit of 25m/s. The product of weight and wave height decide whether containers can be lifted. These limitations are based on the strength of the crane and the safety of the personnel. The safe working loads of a crane is determined by the load radius and wave height. In general, when the load radius or the significant wave height increases, the safe working loads decreases.

The weight limitations for lifting operations at Ivar Aasen is given in the load chart tables (Appendix C), which is a part of the operating instructions for the crane. The load chart tables give the safe working loads for single, double and triple fall. The number of “falls” tell how many wires that are connecting the boom tip to the lifting hook while lifting. Table 6.4 is based on the extremal values of each of the three load charts and show the max loads and the max wave heights that establish the limitations of the Ivar Aasen crane. It is important to mention that for all the three load chart tables, the max safe weight load cannot be reached simultaneously with having the max wave height or the maximum load radius of the table. The load chart tables show that the highest safe weight loads (SWL) in every load chart need to be taken at lower load radiuses, to be within the operational limits.

The advantage of the single fall is that it is fast and can handle wave heights up to 6 meters. The disadvantage of the single fall is that the max weight is limited to 20 tons. The double fall is stronger and can take up to 35 tons, but it is slower, and the max wave height is reduced to 4 meters. The triple fall is mainly designed for heavy lifts and lift loads up to 50 tons. The disadvantage of the triple fall is that it is slow and can only operate in wave height up to 2,5 meters. The max load radius of the crane is 60 meters for single fall, 57,6 meters for double and 57,8 meters for triple fall.

Table 6.4 Falls with their max weight and max wave height

Number of falls	Max safe weight load (tons)	Max wave height (m)	Max load radius (m)
Single	20	6	60
Double	35	4	57,6
Triple	50	2,5	57,8

There are also some other additional limitations factors for lifting operations, such as trim[1] (krenging) and temperature limitations. The trim angle is the angle between the rotational axis of the crane and the true vertical. The limit for trim for the Ivar Aasen crane should not exceed 1°. The operational manual state that the crane has temperature limits of -20°C and +26°C. Another requirement for lifting for the Ivar Aasen crane is that the AOPS (Automatic Overload Protection System) have to work to protect the crane from overload during lifting operations. There have not been given any data on these variables, so trim, temperature and AOPS have been ignored in this thesis.

The platform supply vessels can also be a limiting factor for offshore lifting operations. As mentioned in 2.1.2, the PSV's ability to keep its position during lifting operations, with a high degree of accuracy is important. Aas et al. (2009) state that it is required that a vessel must not use more than 50% of its machinery power to maintain its position. This creates another limitation for lifting operations. In an interview a crane operator said that "In general, we (crane operators) like to have the supply vessel as close as possible to the platform during

[1] With *Trim* means tilting towards one side (betydningdefinisjoner.com, 2018).

lifting operations, to be able to do heavier lifts. On the contrary, the PSV captains normally like to be as far as possible from the platform, to avoid drifting into the platform." The captain also mentioned that lifting operations are put on hold while helicopters are flying over the installation for safety reasons.

In chapter 6.4.2 to 6.4.3, the three scenarios are analyzed with the limitations given above. All the tables for the three cases are color coded. The cells colored with green is the number of containers that can be lifted and the cells in red are the number of containers that cannot be lifted. When the measurements for significant wave height are matched with the dates for delivery of supplies, there are three days with deliveries where there are no available weather data. These three dates are 20. June, 05. August and 17. September. None of the delivered supplies these days are heavier than 7 tons. This reduces the total number of containers analyzed from 1823 to 1791. A wave analysis performed on Vallhall DP for 2016-2017 by Voca, show that the highest measured effective heave motion on the PSV deck, measured by OMR, is in average measured to be 35% lower than the significant wave height measured by Miros at the same times. The analysis also shows that in some cases the OMR measure higher relative heave motions on the PSV deck, than the Miros sensor. In the three following scenarios, the 35% lower measured effective heave motion has been used to find the potential improvements by using the OMR.

6.4.1. Minimum significant wave height scenario

In the Minimum scenario, the lowest significant wave height measured for each day with shipments is analyzed towards the containers that arrived at the specific days. Table 6.5 shows the results of the analysis for the Minimum scenario. In the two vertical columns, the wave data from the Miros sensor is compared to the Optlift Motion Reporter (OMR). All the values in the *OMR* column are based on wave heights that are 35% lower than the significant wave heights analyzed in the *Miros* column. In the table, single, double and triple fall are first analyzed separately. For each fall it is specified how many of the containers that are within limits for lifting (green) and the ones that cannot be lifted (red). After analyzing them separately, *Total* show the number of containers that can and cannot be lifted according to the three load chart tables. The result of the Minimum scenario is that with Miros 1790 out of a total of 1791 containers can be lifted. With OMR all the containers are expected to be lifted to the platform. This makes a difference of one container that can be lifted when using the OMR.

Table 6.5 Analysis of Minimum scenario

CRANE FALL	Miros	OMR	Difference
Single	1772	1776	4
	19	15	4
	1791	1791	
Double	1781	1787	6
	10	4	6
	1791	1791	
Triple	1571	1785	214
	220	6	214
	1791	1791	
Total	1790	1791	1
	1	0	1
	1791	1791	

The reason for the high amount of lifts that cannot be lifted according to the triple fall load chart is because of the low limits for wave heights for the triple fall. In the right part of the figure, *Total* summarize that one lift could not be executed according to the Miros sensor. With OMR this lift could have been taken, and that results in one container in difference. The container that could not be lifted according to Miros was delivered 15. October and weighed 43 tons, which is one of the heaviest lifts during the year.

6.4.2. Average significant wave height scenario

In the Average scenario is the average significant wave height calculated for each day with shipments, is analyzed towards the containers that arrived at the specific days. Table 6.6 has the same color logic as Table 6.5. The number of containers that cannot be lifted by the three falls is all increasing from the Minimum scenario. The total of lifts that could not be taken by any of the falls with Miros is three containers. With OMR all these are expected to be lifted to the platform.

Table 6.6 Analysis of Average scenario

CRANE FALL	Miros	OMR	Difference
Single	1769	1775	6
	22	16	6
	1791	1791	
Double	1714	1787	73
	77	4	73
	1791	1791	
Triple	953	1583	630
	838	208	630
	1791	1791	
Total	1788	1791	3
	3	0	3
	1791	1791	

The three containers that could not be lifted by any of the falls according to Miros are shown in Table 6.7. All the three containers that could not be lifted by Miros can be lifted by OMR. These three lifts are all heavy lifts with weights over 35 tons. The heaviest container with a weight of 43 tons is the same one that made the difference in the Minimum scenario.

Table 6.7 Lifts that could not be made by using Miros

Date	Weight (tons)	Miros	OMR
15.10	43,00	No	Yes
24.12	36,70	No	Yes
30.12	35,00	No	Yes

6.4.3. Maximum significant wave height scenario

In the Maximum scenario, the maximum significant wave height measured for each day with shipments is analyzed towards the containers that arrived at the specific days. Table 6.8 shows that the number of containers that cannot be lifted with the three separate falls has increased drastically from the Average scenario. The total amount of lifts that could not be taken by any of the falls are now 59 with Miros and is expected to be improved to only 2 with the OMR.

Table 6.8 Analysis of Maximum scenario

CRANE FALL	Miros	OMR	Difference
Single	1711	1772	61
	80	19	61
	1791	1791	
Double	1216	1758	542
	575	33	542
	1791	1791	
Triple	372	1133	761
	1419	658	761
	1791	1791	
Total	1732	1789	57
	59	2	57
	1791	1791	

The 59 containers that could not be lifted according to the measurements from Miros are all shown in Table 6.9. Among the 59 lifts that cannot be taken according to Miros, 57 of these are expected to be within the limits of the load chart tables with the OMR measurements. The seasonal trends of rougher weather in the winter half of the year can be seen in Table 6.9. All the containers that cannot be lifted according to Miros, except for one, are found in January, February, October, and November. 11 out of these 59 containers have a weight that exceeds 10 tons. The two containers that are not expected to be lifted according to OMR are heavy with weights of 43 and 35 tons. The two containers were also included in the Average scenario, but they were then both expected to be lifted according to OMR.

Table 6.9 Lifts that cannot be taken with Miros

Date	Weight (tons)	Miros	OMR
03.01.2017	9,90	No	Yes
03.01.2017	4,20	No	Yes
03.01.2017	4,20	No	Yes
03.01.2017	2,20	No	Yes
03.01.2017	3,30	No	Yes
03.01.2017	9,90	No	Yes
03.01.2017	6,88	No	Yes
05.01.2017	13,40	No	Yes
05.01.2017	17,40	No	Yes
05.01.2017	14,04	No	Yes
03.02.2017	4,30	No	Yes
03.02.2017	3,80	No	Yes
03.02.2017	4,10	No	Yes
03.02.2017	1,30	No	Yes
03.02.2017	2,50	No	Yes
03.02.2017	4,10	No	Yes
03.02.2017	1,10	No	Yes
03.02.2017	3,71	No	Yes
03.02.2017	5,55	No	Yes
03.02.2017	3,60	No	Yes
03.02.2017	4,60	No	Yes
03.02.2017	6,24	No	Yes
03.02.2017	3,81	No	Yes
03.02.2017	5,56	No	Yes
03.02.2017	4,41	No	Yes
03.02.2017	1,30	No	Yes
03.02.2017	4,10	No	Yes
03.02.2017	6,25	No	Yes
03.02.2017	4,40	No	Yes
11.05.2017	18,56	No	Yes

Date	Weight (tons)	Miros	OMR
01.10.2017	1,30	No	Yes
01.10.2017	1,30	No	Yes
02.10.2017	3,90	No	Yes
02.10.2017	2,50	No	Yes
02.10.2017	1,80	No	Yes
02.10.2017	3,20	No	Yes
02.10.2017	3,20	No	Yes
02.10.2017	6,18	No	Yes
15.10.2017	20,00	No	Yes
15.10.2017	19,10	No	Yes
15.10.2017	43,00	No	No
15.10.2017	25,45	No	Yes
15.10.2017	15,00	No	Yes
28.10.2017	3,94	No	Yes
28.10.2017	6,20	No	Yes
07.12.2017	5,25	No	Yes
07.12.2017	4,40	No	Yes
07.12.2017	4,80	No	Yes
07.12.2017	4,00	No	Yes
07.12.2017	4,00	No	Yes
07.12.2017	3,60	No	Yes
07.12.2017	8,85	No	Yes
07.12.2017	4,45	No	Yes
07.12.2017	4,85	No	Yes
07.12.2017	6,26	No	Yes
07.12.2017	6,10	No	Yes
07.12.2017	3,80	No	Yes
24.12.2017	36,70	No	Yes
30.12.2017	35,00	No	No

To summarize, there are big differences among the three scenarios. Table 6.10 shows that the Minimum scenario gives a difference of 1 container that can be lifted with OMR, the Average scenario gives a difference of 3 and the Maximum scenario gives a difference of 57. This shows that the scenario where the OMR have the most significant potential, relative to the Miros sensor, is for the Maximum scenario. For all the scenarios the trend is that more of the marginal, heavy lifts can be taken while using OMR. A crane operator with long experience with using the OMR, confirm that "The OMR increase my security with its precise measurements of wave heights, which makes it possible to take lifts that could not have been taken before installing the OMR. The OMR is especially helpful for marginal, heavy lifts". It was necessary to find a crane operator who was familiar with the use of OMR, preferably someone who had used it over a longer time. The chosen crane operator was recommended by Voca for having long experience with the use of OMR.

Table 6.10 Summary of the three scenarios

Scenario	Normal	OMR	Difference
Minimum	1790	1791	1
Average	1788	1791	3
Maximum	1732	1789	57
Total lifts	1791	1791	

6.5. Cost reduction connected to improvement from OMR

6.5.1. Cost drivers affected by the use of Optilift Motion Reporter

In order to calculate the cost reduction connected to improvement from the Optilift Motion Reporter, the cost drivers and cost items per cost driver that potentially can be reduced with the OMR must be found. If the time waiting on weather becomes long, it can affect the work efficiency on the offshore installation. It can, for example, be that the supply vessel carries crucial equipment needed to complete work onboard the installations. Therefore, a cost for loss in work efficiency must be found, in addition to the probability for it to occur. This leads to the formula shown beneath for calculating the total cost of waiting on weather, where P is a probability.

$$\text{Cost of WOW} = \begin{array}{c} \left(\text{Cost items per driver} \times \text{Cost driver}\right) \\ + \left(\text{P}\left(Loss\text{ of work effeciency}\right) \times \text{Cost for loss of work efficiency}\right) \end{array}$$

Based on an overview of costs in the material supply chain, received from Aker BP, three cost items have been considered to be potentially affected directly by the use of OMR. These are the *cost of rental of equipment, supply vessel day rate, fuel cost*. The initial formula for the cost of WOW is:

$$\text{Cost of WOW} = \big((\text{Cost of rental equipment} + \text{Supply vessel day rate} + \text{Fuel cost}) \times \text{Days WOW}\big) + \big(P(\text{Loss in work efficiency}) \times \text{Cost of loss in work efficiency}\big)$$

However, cost of rental of equipment used is difficult to say something about, because this varies depending on what equipment that is being rented. It is not known how much of the equipment that is rented or what the rental agreements look like for the equipment. It will therefore not be taken into the calculations in this thesis, but it will give additional cost savings due to the cost of rental before and after the period of use that can be reduced with less waiting on weather. Less waiting on weather means that the equipment will be delivered faster to the offshore installation and be returned faster after use. The probability of loss of work efficiency is considered to be low by Aker BP, but it can still occur. The cost of loss in work efficiency is very difficult to assign a number and will therefore not be a part of further calculations in this thesis. However, it is still an aspect that should be considered in a final evaluation of the profitability of the OMR. In absolute worst case for the operator companies would the production be shut down as a result of shortages in supply. In that case the rig rate should also be included in the calculations, which would have a significant impact for the customer value.

This thesis will therefore only use supply vessel rate and fuel cost when calculating the potential customer value with the use of OMR. The prices on supply vessel rate and fuel will also vary from time to time, but they are constant cost items per cost driver on each shipment. These costs can therefore potentially be reduced on each shipment independent of the cargo. This will give the following formula which will be used in further calculations:

$$\text{Cost of WOW} = \text{Days WOW} \times (\text{Supply vessel day rate} + \text{Fuel cost})$$

6.5.2. Methodology for calculating the potential saving with the use of OMR

This chapter will try to show the approach to find the potential annual saving with the use of Optilift Motion Reporter (OMR). It will describe the methodology used for calculating potential customer value of implementing the OMR. Figure 6.10 shows the recommended sox steps to calculate the potential customer value of implementing OMR.

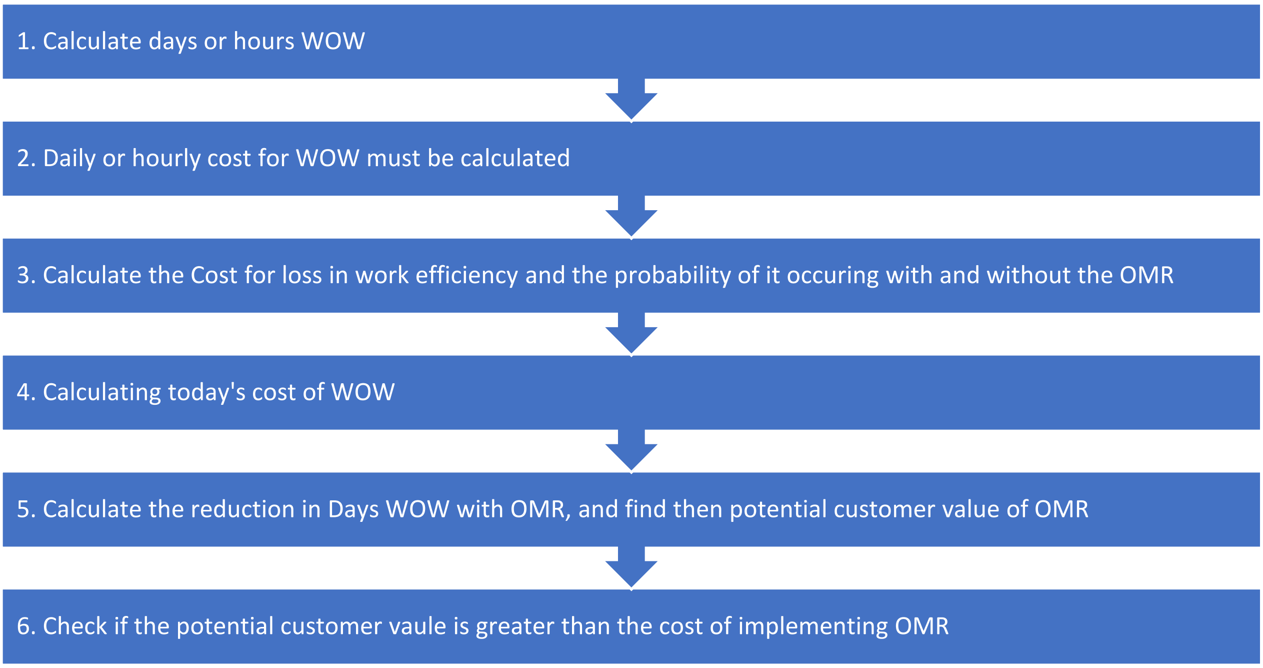

Figure 6.10 Methodology for calculating potential customer value of implementing OMR

1. *Calculate days or hours of WOW*

   Make an overview of the number of days or hours a PSV has spent waiting on weather (WOW) before lifts could be made from and to the offshore installations. This must be obtained or find a way to calculate it if no statistics are kept. It can be calculated by for example crosschecking the time of deliveries to/from the offshore installation with wave height data to see when the lifts could have been executed. To make it as accurate as possible, the time of deliveries should be as precise as possible, preferably down to the exact minute. The cost driver, number of WOW days or hours, will give the basis for calculation of annual savings with the OMR.

2. *Daily or hourly cost must be calculated*

   Next, the daily or hourly cost must be calculated. Preferably, all of the four cost drivers should be included. The following costs together will make up the daily or hourly costs for today's situation.

   a. First, the supply vessel day rate must be found. This may vary from vessel to vessel depending on the demand/supply situation. High demand gives higher rates, while low demand leads to lower rates.
   b. Then the fuel cost must be calculated. The fuel cost depended on the vessel and its size. Bigger vessels consume more fuel. The type and age of the engine on the vessels also have an impact on the fuel consumption. The fuel prices will also vary. To make this cost as accurate as possible, the consumption of fuel for the

vessel used to deliver supply to the offshore installation must be found. One should therefore ideally calculate fuel cost based on each PSV that has been used for deliveries to the installation that is analyzed. In reality, this would be demanding, and therefore estimates can be used.

   c. The last thing to consider is the days on hand with rented equipment before and after use. This is the hardest to obtain, and it can only be obtained if extensive records are kept of rented equipment, which specifies how much time it has been on hand without being used. This number will be affected by the number of days waiting for weather.

3. *Calculate the Cost for loss in work efficiency and the probability for loss of work efficiency with and without the OMR*
   A cost for loss in work efficiency must be calculated to get the full picture of the cost of WOW. Then the probability for the loss in work efficiency to occur with and without the OMR must be analyzed or calculated. This would provide an understanding of whether OMR can reduce the probability of loss in work efficiency.
4. *Calculating today's cost of WOW*
   When the time spent waiting on weather, and the daily or hourly cost of WOW, as well as the cost for loss in work efficiency, is found, the total cost of waiting on weather for today's situation can be calculated.
5. *Calculating the reduction in days WOW with OMR, and then find the potential customer value of OMR*
   After today's situation is calculated, the reduction of days or hours waiting for weather by using the OMR can be calculated. The number of reduced days or hours with OMR multiplied with the daily or hourly cost calculated earlier, will give the potential customer value by using OMR.
6. *Check if the potential customer value is greater than the cost of implementing OMR*
   The last thing to do is to check if the potential customer value is greater than the costs of implementing the OMR, to check if it is profitable.

6.5.3. Calculations of customer value for Ivar Aasen

To calculate the potential customer value by implementing OMR for Ivar Aasen, some simplifications had to be made. The wave height data received from Voca was given for every half an hour. Since the shipments only had specified received date, and not time, it was necessary to convert the wave height data into the daily wave heights. The cost for the three scenarios, Minimum, Average and Maximum significant wave height, will be analyzed.

The daily cost will be the same independent of which scenario that is used. The numbers for the daily cost have been given by Aker BP. A supply vessel rate of 150 000 NOK per day will be used. This has been given as the rate for vessels built the last 5-6 years with a building cost around 300 million NOK.

The fuel cost is calculated from a fuel consumption of 10 m^3 per day for each supply vessel. An estimate of 5 000 NOK per m^3 gives a fuel cost of 50 000 NOK per day. This gives a total cost of 200 000 NOK per day and is the daily cost that will be used in further calculations. However, this daily cost is considered to be the lowest daily cost possible and will therefore only increase when the excluded unknown costs, like the cost of rental equipment and cost of loss in work efficiency, are added to the total daily cost of WOW.

Table 6.11 shows the number of days spent waiting on weather (WOW) today and the potential improvement by using the OMR for each scenario.

Table 6.11 Days WOW with and without OMR

Scenario	Days WOW without OMR	Days WOW with OMR	Difference
Minimum	1	0	1
Average	12	0	12
Maximum	49	11	38

6.5.3.1. Minimum significant wave height scenario

This scenario uses the lowest value for significant wave height per day extracted from the wave height data. Then the date for lifts that could not be executed with any of the wire falls, were crosschecked with the wave height data with the lowest values to check when the lift could have been completed. In this scenario there were only one lift that could not be executed on received date, but when crosschecked with the wave height data it showed that the lift could be completed the next day. This gives one day waiting on weather delay as shown in Table 6.11, therefore making cost for waiting on weather with this scenario:

$$\text{Cost of WOW}_{min} = 200\,000\,\text{NOK/day} \times 1\ \text{day} = 200\,000\ \text{NOK}$$

Then it was check if this lift could have been executed if OMR was installed on the offshore installation or the earliest date it could have been completed with OMR. The analysis then showed that it could have been completed with OMR, reducing the time of WOW to 0 with the OMR and making the potential customer value to be:

$$\text{Potential customer value}_{\text{min}} = 200\,000 \text{ NOK} - 0 \text{ NOK} = 200\,000 \text{ NOK}$$

6.5.3.2. Average significant wave height scenario

This scenario uses an average value for wave height per day which has been calculated from the wave height data. Then a cross-checking of the date for the failed lifts (lifts that could not be executed with any of the wire falls), with the earliest date they could have been completed, was done. This scenario showed that there were 3 lifts that could not be completed at the received date for the shipment, and it was discovered a waiting on weather time of 12 days in total, as shown in Table 6.11. These days of waiting on weather for this scenario gives an annual cost for waiting on weather (WOW) to be:

$$\text{Cost of WOW}_{average} = 200\,000 \text{ NOK/day} \times 12 \text{ day} = 2\,400\,000 \text{ NOK}$$

Then it was checked if these three lifts could have been executed if OMR was installed on the offshore. The analysis then showed that all the lifts could have been completed at the received date, therefore reducing the time of WOW to 0 with the OMR and making the potential customer value for this scenario to be:

$$\text{Potential customer value}_{average} = 2\,400\,000 \text{ NOK} - 0 \text{ NOK} = 2\,400\,000 \text{ NOK}$$

6.5.3.3. Maximum significant wave height scenario

In the Maximum scenario the highest value for significant wave height per day, has been used. Then a crosschecking as describe in previous scenarios, was conducted. In this scenario a total of 59 lifts could not be completed at the received date for the shipment. It was then discovered that the total days waiting on weather would be 49, as shown in Table 6.11, for this scenario. This would result in the annual costs for waiting for weather (WOW) to be:

$$\text{Cost of WOW}_{\text{max}} = 200\,000 \text{ NOK/day} \times 49 \text{ day} = 9\,800\,000 \text{ NOK}$$

Then it was check if these 59 lifts could have been executed if OMR was installed on the offshore installation and what the earliest date they could have been completed with OMR. The analysis then showed that only two of the lifts could not have been completed at the received date by using OMR. As shown in Figure 6.13 would these two lifts only cause 11 days of waiting on weather, giving a reduction of 38 days. This will give a cost of waiting on weather (WOW) with OMR to be:

$$\text{Cost of WOW}_{max} \text{ with OMR} = 200\,000\,\text{NOK/day} \times 11\text{ day} = 2\,200\,000\text{ NOK}$$

As a result, the potential customer value for this scenario would be:

$$\text{Potential customer value}_{max} = 9\,800\,000\text{ NOK} - 2\,200\,000\text{ NOK} = 7\,600\,000\text{ NOK}$$

6.5.3.4. All significant wave height scenarios

Figure 6.11 shows a comparison of the annual saving for each of the scenarios. It clearly shows which scenarios that are profitable and how much difference there are between the different scenarios. The comparison show that the Minimum scenario has a low customer value, while the Average scenario and Maximum scenario have higher customer value.

Figure 6.11 Customer value for all scenarios

After going through the weather data for the dates where lifts could not be executed in the Maximum scenario, it is difficult to establish which scenario of Maximum and Minimum that is most realistic. It became clear that the wave heights for these days depend on which time of the day the vessel delivered the cargo to the offshore installations. In general, these days seems to have higher wave heights in the morning and evenings than in the midday, as shown in Table 6.12. From the Table 6.12, the Maximum scenario is considered to give a too high customer value, while the Minimum scenario seems to be too low. There can be seen that there are some days that only had a few numbers of times were the wave height exceeded the limit for lifting, making the Maximum scenario give too many failed lifts. It can also be seen that it is more than one day were lifts could not have been done most of the day, making the

Minimum scenario too low. The Average scenario is therefore considered to be the best estimate, as it provides a middle value between the two other scenarios.

Table 6.12 Times of day were the lifting in the Maximum Scenario could not be executed

Date	Wave Height restriction [m]	Time lifts could not be done
03.01.2017	6	17:00 – 00:00
05.01.2017	4	00:00, 04:00,
03.02.2017	6	00:30
11.05.2017	4	11:24 - 11:54, 13:54, 14:54
01.10.2017	6	19:48 – 22:18
02.10.2017	6	19:48 – 22:18
15.10.2017	2,5	Never
28.10.2017	6	00:24 – 07:24, 20:54 – 23:54
07.12.2017	6	20:24 – 08:24
24.12.2017	2,5	00:24 – 08:24
30.12.2017	2,5	09:24 – 23:24

6.6. Description of investment – Optilift Motion Reporter

To establish what Voca's piece of the customer value would be has a price list for the OMR been received from Voca. The purpose of this chapter will therefore be to give an overview of the costs of purchasing the Optilift Motion Reporter. This will then show if the OMR is profitable depending on the different scenarios. The costs can be found in Appendix B, and the relevant costs for the analyses are put into Table 6.13. In this analysis one offshore unit is bought with a purchase price of 790 000 NOK and an additional rental price of 39 000 NOK per month in operation. There are also costs related to installation and commissioning of 210 000 NOK. There will probably also be some costs related to service and maintenance of the equipment, but they are not included in this calculation.

Voca specify that these prices are estimates and depends on the actual installation with the type of crane, the crane availability, travel costs and more. The Optilift Motion Reporter does not come with expected lifetime. The oldest Motion Reporter has been operating on an offshore installation for four years, so Voca expects the lifetime to be at least five years.

Based on the costs given in Table 6.13 the annual cost is calculated, based on an expected lifetime of 5 years. First, the prices for purchase, installation, and commissioning are added.

$$(790\ 000\ \text{NOK} + 210\ 000\ \text{NOK}) = 1\ 000\ 000\ \text{NOK}$$

This number is then divided by the number of years of an expected lifetime for the OMR.

$$\frac{1\ 000\ 000\ \text{NOK}}{5\ \text{years}} = 200\ 000\ \ \text{NOK/year}$$

Then we make the monthly rental cost of 39 000NOK into the annual rental cost and adds it to the total annual cost.

$$\text{Total annual cost} = 200\ 000\,\text{NOK/year} + (39\ 000\,\text{NOK/month} \times 12\ \text{months}) = 668\ 000\ \ \text{NOK/year}$$

Then a real rate of return of 5% has been chosen and added to the annual cost of 668 000 NOK/year for the Optilift Motion Reporter.

$$668\ 000\,\text{NOK/year} \times 1{,}276282 = 852\ 556{,}4\,\text{NOK/year}$$

In the calculations will the number 850 000 NOK/year be used to make the calculations easier.

Cost categories	**Costs [NOK]**
Purchase price	790 000
Additional rental price	39 000 / per month
Installation and commissioning	210 000
Service and maintenance	Not specified

Table 6.13 Costs related to purchasing the Optilift Motion Reporter for an offshore unit

Table 6.14 shows that with the current annual cost of implementing OMR, would the Minimum scenario would not be profitable for Aker BP, while both the Average and Maximum scenarios would be profitable.

Table 6.14 Remaining customer value after implementing OMR

Scenario	**Potential customer value**	**Cost of OMR**	**Profitability for Aker BP**
Minimum	200 000 NOK/year	850 000 NOK/year	- 650 000 NOK/year
Average	2 400 000 NOK/year	850 000 NOK/year	1 550 000 NOK/year
Maximum	7 600 000 NOK/year	850 000 NOK/year	6 750 000 NOK/year

6.7. Sensitivity analysis

The purpose of this sensitivity analysis is to understand how sensitive the customer value is to changes in the variables and when the breakeven point for investing in OMR is reached. In this case, there are only two variables, *Days of WOW* and *Daily cost of WOW*. Table 6.15 shows the changes in customer value. The *Daily cost of WOW* is starting at 200 000 NOK which is most likely the lowest the daily cost will be; it is then increasing with 50 000 NOK for each step until it reaches 500 000 NOK. The *Days WOW* is starting at one day and ending with five. The bottom line shows the breakeven point, how many days it will take to cover the cost of OMR which is set to be 850 000 NOK.

Table 6.15 Sensitivity analysis, Daily cost and Days WOW

Days WOW	**Daily cost of WOW**						
	200 000	**250 000**	**300 000**	**350 000**	**400 000**	**450 000**	**500 000**
1	200 000	250 000	300 000	350 000	400 000	450 000	500 000
2	400 000	500 000	600 000	700 000	800 000	900 000	1 000 000
3	600 000	750 000	900 000	1 050 000	1 200 000	1 350 000	1 500 000
4	800 000	1 000 000	1 200 000	1 400 000	1 600 000	1 800 000	2 000 000
5	1 000 000	1 250 000	1 500 000	1 750 000	2 000 000	2 250 000	2 500 000
Breakeven point [days]	**4,25**	**3,40**	**2,83**	**2,43**	**2,13**	**1,89**	**1,70**

Table 6.15 shows that with *Daily cost of WOW* set to 200 000 NOK, will the annual cost of OMR be covered after only 4,25 days. This is most likely the maximum number of days that will be necessary to cover the annual cost of the OMR. If the daily cost of WOW is increased by 50 000 NOK, will the days WOW be reduced to 3,4 days. The sensitivity analysis clearly shows that it will only take a few days to cover the annual cost of implementing the Optilift Motion Reporter with the lowest daily cost of WOW, meaning it will take fewer days if the daily cost increases.

6.8. Safety Aspect of OMR

An important area that is in focus in the offshore industry is safety. The OMR can contribute by increasing safety for both the personnel and the equipment during lifting operations. This is an aspect of the OMR that has been highlighted by both the ship captain and the crane operator through interviews. Both the interviews were conducted in Norwegian, transcribed and translated into English. The crane operator told that *"the OMR gives me safety by making me capable of judging the wave height on the vessel better."* The crane operator highlights the Boom Tip Indicator as a good feature for improving safety during lifting operations. It prevents lifts with a side-angle being done so that the cargo will not slide during lift-off and cause crush injuries on personnel. The crane operator also mentions that *"a great benefit of OMR is the increased possibility of lifting in tight areas, where the boom tip indicator makes sure that other equipment will be damaged while lifting. It makes sure that the cargo is lifted straight up, instead of having to take the lifts based on eyesight".*

The ship captain explains that while the vessel may be able to keep its position, the movement up and down on deck makes it insecure for the crew on deck. He also mentions that *"the OMR can from the vessel's side increase the safety of the crew working on the deck of the vessel."* The ship captain explains that *"OMR will make it easier for the crane to follow the vessels movement, so the right slack on the crane's wire is assured to connect the hook to the container. This will prevent a sudden pull on the container that can be dangerous for the deck crew because they will not be able to get to safety before the lift is started".*

Another feature with the OMR that was not mentioned by either the ship captain or the crane operator, but still adds to the increase of safety is the people detection system. There may not have been a problem with not detecting people in the lifting area before because of strict routines during lifting operations. It still adds an extra safety element. If offshore personnel moves into the lifting area during lifting operations, without being noticed, the crane operator will receive a warning of the danger.

The increased level of safety by implementing the OMR is expected to lead to fewer accidents during offshore lifting operations, which are expected to have a positive impact on both personnel and supplies. Fewer accidents are expected to lead to a cost reduction for the operator companies.

7. Conclusion

The purpose of this thesis has been to analyze the financial effects of implementing the Optilift Motion Reporter, by conducting a case study of the Ivar Aasen field. To analyze this case, container shipment log, weather data, load chart tables and former analyses conducted by Voca, were used. The problem statement has been answered through the following research questions:

1. What are Optilift Motion Reporter's competitive advantages?
2. What is the potential profitability of implementing the Optilift Motion Reporter on the offshore platform, Ivar Aasen?

In chapter 7.1 and 7.2, the research questions are answered. Chapter 7.3 evaluates the profitability of the OMR and provides a proposal for further research.

7.1. What are Optilift Motion Reporter's competitive advantages?

An industry analysis for the industry of real-time heave monitoring systems for offshore lifting, found the power of buyers to be the main limiting condition for profitability. The profitability of the industry is also highly dependent upon the customer value of the product. An analysis conducted on a technological level for the OMR considers two of OMR's features, boom tip indicator and the real-time heave monitoring system, to provide the OMR with a potential competitive advantage in the industry.

7.2. What is the potential profitability of implementing the Optilift Motion Reporter on the offshore platform, Ivar Aasen?

The profitability of the OMR in the three scenarios is analyzed based on a customer value analysis for each scenario. The analysis shows that the Minimum-, Average- and Maximum scenarios are expected to have an annual customer value of respectively 200 000 NOK, 2 400 000 NOK and 7 600 000 NOK. After subtracting the annual cost of OMR of 850 000 NOK from the annual customer value, only the Average and Maximum scenario are profitable. The result of a sensitivity analysis expects the breakeven point of investing in the OMR to be reached after a reduction of approximately 4 days of waiting on weather, with a daily cost of waiting on weather of 200 000 NOK.

A crane operator and a supply vessel captain also emphasize the importance of the value of increased safety during offshore lifting operations, by implementing the OMR.

7.3. Evaluation of the profitability and proposal for further research

Based on the best estimate of the three analyzed scenarios, the Average scenario, investing in OMR for the Ivar Aasen field is expected to be profitable. The trend from the lifting analyses implies that the OMR has the biggest impact on expanding the weather window for heavier lifts. The OMR will therefore give a higher customer value for platforms receiving more heavy containers.

The customer value calculated in this thesis is an indication of the profitability of the OMR. For a final investment decision should preferably an new analysis be conducted after the pilot has finished, for finding a more accurate customer value.

The methodological framework for analyzing the potential profitability of the OMR, that is presented, can be used as a guide for a final analysis of the profitability. Further research on the overall profitability of the OMR together with the logistics part of the Optilift technology, the Deck Planner, is recommended.

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Appendix A Descriptive Statistics

Descriptive statistics data in Excel is used to describe the datasets.

A.1. Descriptive statistics for weather data

The table below shows the descriptive statistics for the Average scenario for wave data for Alvheim for 2017.

Significant wave height (m)	
Mean	2,60
Standard Error	0,01
Median	2,32
Mode	1,98
Standard Deviation	1,23
Sample Variance	1,51
Kurtosis	1,03
Skewness	1,05
Range	8,46
Minimum	0,32
Maximum	8,78
Sum	42848,84
Count	16475,00
Confidence Level (95,0%)	0,02

The table below shows the descriptive statistics for the wind data for Alvheim for 2017.

Wind Speed (m/s)	
Mean	8,56
Standard Error	0,03
Median	8,09
Mode	0,00
Standard Deviation	4,21
Sample Variance	17,70
Kurtosis	-0,23
Skewness	0,46
Range	25,12
Minimum	0,00
Maximum	25,12
Sum	140973,26
Count	16475,00
Confidence Level (95,0%)	0,06

A.2. Descriptive statistics for lifting data

The table below shows the descriptive statistics for the weight of the containers that is lifted from the PSV to the offshore installation.

Weight (tons)	
Mean	4,93
Standard Error	0,08
Median	4,20
Mode	3,20
Standard Deviation	3,42
Sample Variance	11,70
Kurtosis	26,23
Skewness	3,70
Range	43,00
Minimum	0,00
Maximum	43,00
Sum	8988,64
Count	1823,00
Confidence Level (95,0%)	0,16

Appendix B Prices from Voca

This data is retrieved from a sales presentation Voca is using for customers, where the relevant slides are copied and pasted below.

This slide shows the costs for an offshore unit. The prices used in the thesis is for the core package.

OFFSHORE UNIT

	Core (hardware + lifting apps)	Logistics (Add-on, requires Core)
Purchase price	790[1)]	Monthly rental only – see price below
Rental price (per month)	39	30 / month
Motion Reporter	✓	
Boom Tip Indicator	✓	
People Detector	✓	
CCU Tracker		✓
Deck Planner		✓
Maps		✓

Prices in 1000 NOK per unit.
1) SMA level B is mandatory first year, not included

The costs for installation and commissioning is given in the table below.

INSTALLATION AND COMMISSIONING

Estimates (1000 NOK)	Offshore	Onshore
Custom accessories (cables & brackets)	60	60
Work & travel (engineering, mobilization, survey, installation, commissioning)	150	100
Total per unit	210	150

Prices in 1000 NOK per unit. The prices are estimates and depends on the actual installation type of crane, the crane availability, travel costs and more.

The service and maintenance are assumed to be included in the other costs, according to alternative A.

SERVICE AND MAINTENANCE

	A	B	C
For rental agreements	Included	N/A	N/A
When purchased - Offshore	N/A	9	3
When purchased – Onshore	N/A	7	2

Prices in 1000 NOK per unit per month. The prices are estimates and depends on the actual installation type of crane, the crane availability, travel costs and more.

Appendix C Operational limits for Ivar Aasen crane

The safe working loads of the crane is determined by the load radius and wave height. In general, when the load radius or the significant wave height increases, the safe working loads decreases. The safe working loads are given by three different charts; single fall, double fall and triple fall.

11.2.2 Load chart tables

Table 11.2-1 Safe working loads – WHIP HOIST, SINGLE FALL

Load radius [m]	Boom angle [°]	Rated capacity (SWL) [tonnes]								
		Platform lift	Sea lift, significant wave heights [m]							
			0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0
10.3	84.99	20.0	20.0	20.0	20.0	18.7	15.2	12.8	11.2	10.0
12.5	82.83	20.0	20.0	20.0	20.0	18.8	15.3	12.9	11.3	10.0
15.0	80.36	20.0	20.0	20.0	20.0	18.9	15.4	13.0	11.4	10.1
17.5	77.87	20.0	20.0	20.0	20.0	19.0	15.5	13.2	11.5	10.3
20.0	75.35	20.0	20.0	20.0	20.0	19.1	15.6	13.3	11.6	10.4
22.5	72.79	20.0	20.0	20.0	20.0	19.2	15.7	13.4	11.7	10.5
25.0	70.20	20.0	20.0	20.0	20.0	19.3	15.9	13.5	11.8	10.6
27.5	67.55	20.0	20.0	20.0	20.0	19.4	16.0	13.6	12.0	10.7
30.0	64.85	20.0	20.0	20.0	20.0	19.5	16.1	13.8	12.1	10.8
32.5	62.08	20.0	20.0	20.0	20.0	19.6	16.2	13.9	12.2	10.9
35.0	59.22	20.0	20.0	20.0	20.0	19.8	16.4	14.0	12.3	11.1
37.5	56.27	20.0	20.0	20.0	20.0	19.9	16.5	14.1	12.5	11.2
40.0	53.21	20.0	20.0	20.0	20.0	20.0	16.6	14.3	12.6	11.3
42.5	50.00	20.0	20.0	20.0	20.0	20.0	16.8	14.4	12.7	11.5
45.0	46.62	20.0	20.0	20.0	20.0	20.0	16.9	14.6	12.9	11.6
47.5	43.03	20.0	20.0	20.0	20.0	20.0	17.1	14.7	13.0	11.8
50.0	39.14	20.0	20.0	20.0	20.0	20.0	17.2	14.9	13.2	11.9
52.5	34.86	20.0	20.0	20.0	20.0	18.1	15.1	13.0	11.5	10.4
55.0	30.01	20.0	20.0	19.0	17.5	15.6	13.0	11.1	9.8	8.8
57.5	24.19	18.7	17.7	16.0	14.7	13.3	11.0	9.4	8.3	7.4
60.0	16.23	15.6	14.4	13.0	11.9	11.0	9.1	7.7	6.8	6.1

OPERATIONAL LIMITS:

- Wind velocity: 25 m/s
- Ice and snow on boom: Lifting not allowed
- Trim: 1,0°
- AOPS: The crane is protected

Table 11.2-4 Safe working loads, MAIN HOIST, DOUBLE FALL

Load radius [m]	Boom angle [°]	Rated capacity (SWL) [tonnes]								
		Platform lift	Sea lift, significant wave heights [m]							
			0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
8.8	84.99	35.0	35.0	35.0	35.0	35.0	32.9	30.0	27.7	25.7
10.0	83.78	35.0	35.0	35.0	35.0	35.0	33.1	30.2	27.8	25.8
12.5	81.25	35.0	35.0	35.0	35.0	35.0	33.5	30.6	28.2	26.2
15.0	78.70	35.0	35.0	35.0	35.0	35.0	33.9	31.0	28.7	26.6
17.5	76.12	35.0	35.0	35.0	35.0	35.0	34.3	31.5	29.1	27.1
20.0	73.51	35.0	35.0	35.0	35.0	35.0	34.7	31.9	29.5	27.5
22.5	70.86	35.0	35.0	35.0	35.0	35.0	35.0	32.3	29.9	27.9
25.0	68.16	35.0	35.0	35.0	35.0	35.0	35.0	32.7	30.4	28.4
27.5	65.40	35.0	35.0	35.0	35.0	35.0	35.0	33.1	30.8	28.8
30.0	62.58	35.0	35.0	35.0	35.0	35.0	35.0	33.5	31.2	29.2
32.5	59.68	35.0	35.0	35.0	35.0	35.0	35.0	34.0	31.7	29.7
35.0	56.69	35.0	35.0	35.0	35.0	35.0	35.0	34.4	32.1	30.1
37.5	53.58	35.0	35.0	35.0	35.0	35.0	35.0	34.8	32.5	30.6
40.0	50.33	35.0	35.0	35.0	35.0	35.0	35.0	33.1	30.9	29.1
42.5	46.91	35.0	35.0	35.0	35.0	34.1	31.4	29.1	27.1	25.5
45.0	43.27	33.1	33.1	33.1	33.1	30.1	27.6	25.6	23.8	22.4
47.5	39.36	30.5	30.5	30.5	29.0	26.6	24.3	22.5	20.9	19.6
50.0	35.06	27.8	27.8	27.7	25.4	23.4	21.4	19.7	18.3	17.2
52.5	30.21	25.1	25.1	24.1	22.0	20.3	18.7	17.3	16.0	15.0
55.0	24.44	22.2	22.2	20.8	18.9	17.4	16.2	15.0	13.9	13.0
57.6	16.34	18.6	18.6	17.3	15.8	14.1	12.7	11.5	10.4	9.6

OPERATIONAL LIMITS:

- Wind velocity: 25 m/s
- Ice and snow on boom: Lifting not allowed
- Trim: 1,0°
- AOPS: The crane is protected

Table 11.2-5 Safe working loads, MAIN HOIST, TRIPLE FALL

Load radius [m]	Boom angle [°]	Rated capacity (SWL) [tonnes]					
		Platform lift	Sea lift, significant wave heights [m]				
			0.5	1.0	1.5	2.0	2.5
9.0	84.94	50.0	50.0	50.0	50.0	50.0	49.3
10.0	83.93	50.0	50.0	50.0	50.0	50.0	49.7
12.5	81.40	50.0	50.0	50.0	50.0	50.0	50.0
15.0	78.85	50.0	50.0	50.0	50.0	50.0	50.0
17.5	76.27	50.0	50.0	50.0	50.0	50.0	50.0
20.0	73.66	50.0	50.0	50.0	50.0	50.0	50.0
22.5	71.02	50.0	50.0	50.0	50.0	50.0	50.0
25.0	68.32	50.0	50.0	50.0	50.0	50.0	50.0
27.5	65.57	50.0	50.0	50.0	50.0	50.0	48.3
30.0	62.75	50.0	50.0	50.0	50.0	50.0	46.1
32.5	59.86	50.0	50.0	50.0	50.0	48.2	44.2
35.0	56.87	48.2	48.2	48.2	48.2	45.8	42.0
37.5	53.77	43.4	43.4	43.4	43.4	41.5	38.0
40.0	50.53	39.0	39.0	39.0	39.0	37.0	33.8
42.5	47.12	35.0	35.0	35.0	35.0	32.6	29.8
45.0	43.50	31.5	31.5	31.5	31.5	28.8	26.2
47.5	39.60	28.2	28.2	28.2	27.9	25.4	23.1
50.0	35.33	25.2	25.2	25.2	24.4	22.3	20.3
52.5	30.52	21.8	21.8	21.8	21.4	19.6	17.8
55.0	24.82	19.4	19.4	19.4	18.7	17.0	15.4
57.8	16.14	17.3	17.3	17.0	14.9	13.2	11.8

OPERATIONAL LIMITS:

- Wind velocity: 25 m/s
- Ice and snow on boom: Lifting not allowed
- Trim: 1,0°
- AOPS: The crane is protected

Appendix D Samples from dataset

Sample from container shipment log for Ivar Aasen for 2017:

	A	B	C	D	E	F	G	H	I
1	Container Type	Manifest	Manifest	Received Port	Vessel	Weight (MT)	Tare Weight (kg)	Weight Total (MT)	Received Date
2	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	5,00	4900,00	9,90	03.01.2017
3	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	4,20	0,00	4,20	03.01.2017
4	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	4,20	0,00	4,20	03.01.2017
5	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	2,20	0,00	2,20	03.01.2017
6	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,30	0,00	3,30	03.01.2017
7	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	5,00	4900,00	9,90	03.01.2017
8	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	4,20	2675,00	6,88	03.01.2017
9	container	roundtrip	Ivar Aaser	Ivar Aasen	Island Challenge	3,70	2600,00	6,30	05.01.2017
10	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,60	0,00	3,60	05.01.2017
11	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,60	2600,00	6,20	05.01.2017
12	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,20	0,00	3,20	05.01.2017
13	skip	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,20	0,00	3,20	05.01.2017
14	basket	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,50	2100,00	5,60	05.01.2017
15	container	roundtrip	Ivar Aaser	Ivar Aasen	Island Challenge	7,30	6100,00	13,40	05.01.2017
16	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	2,60	2130,00	4,73	05.01.2017
17	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	4,20	3100,00	7,30	05.01.2017
18	container	roundtrip	Ivar Aaser	Ivar Aasen	Island Challenge	11,80	5600,00	17,40	05.01.2017
19	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	2,50	2050,00	4,55	05.01.2017
20	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	1,40	0,00	1,40	05.01.2017
21	container	roundtrip	Ivar Aaser	Ivar Aasen	Island Challenge	2,20	2050,00	4,25	05.01.2017
22	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,20	2340,00	5,54	05.01.2017
23	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,40	3100,00	6,50	05.01.2017
24	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	3,00	1600,00	4,60	05.01.2017
25	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	2,10	1850,00	3,95	05.01.2017
26	tank	roundtrip	Ivar Aaser	Ivar Aasen	Island Challenge	6,50	1970,00	8,47	05.01.2017
27	container	loadout	Ivar Aaser	Ivar Aasen	Island Challenge	2,10	1700,00	3,80	05.01.2017

The sample for weather data for Ivar Aasen for 2017:

	A	B	C	D	E	F
1	DataForm	SiteIdentifier	Date	Time	WaveHeigt (m)	WindSpeed(m/s)
2	DF022 ALL	Alvheim	01.01.2017	00:00:00	3,47	10,38
3	DF022 ALL	Alvheim	01.01.2017	00:30:00	3,43	9,21
4	DF022 ALL	Alvheim	01.01.2017	01:00:00	3,27	9,97
5	DF022 ALL	Alvheim	01.01.2017	01:30:00	3,5	9,91
6	DF022 ALL	Alvheim	01.01.2017	02:00:00	3,63	6,94
7	DF022 ALL	Alvheim	01.01.2017	02:30:00	3,63	9,57
8	DF022 ALL	Alvheim	01.01.2017	03:00:00	3,46	9,17
9	DF022 ALL	Alvheim	01.01.2017	03:30:00	3,46	11,62
10	DF022 ALL	Alvheim	01.01.2017	04:00:00	3,18	13,13
11	DF022 ALL	Alvheim	01.01.2017	04:30:00	3,08	10,93
12	DF022 ALL	Alvheim	01.01.2017	05:00:00	2,9	6,09
13	DF022 ALL	Alvheim	01.01.2017	05:30:00	3,77	6,65
14	DF022 ALL	Alvheim	01.01.2017	06:00:00	3,31	5,45
15	DF022 ALL	Alvheim	01.01.2017	06:30:00	3,32	10,82
16	DF022 ALL	Alvheim	01.01.2017	07:00:00	3,02	10,42
17	DF022 ALL	Alvheim	01.01.2017	07:30:00	3,25	11,08
18	DF022 ALL	Alvheim	01.01.2017	08:00:00	3,27	11,25
19	DF022 ALL	Alvheim	01.01.2017	08:30:00	3,35	12,25
20	DF022 ALL	Alvheim	01.01.2017	09:00:00	2,72	14,46
21	DF022 ALL	Alvheim	01.01.2017	09:30:00	1,92	10,66
22	DF022 ALL	Alvheim	01.01.2017	10:00:00	2,17	12,92
23	DF022 ALL	Alvheim	01.01.2017	10:30:00	3,42	14,22
24	DF022 ALL	Alvheim	01.01.2017	11:00:00	3,52	17,18
25	DF022 ALL	Alvheim	01.01.2017	11:30:00	3,88	15,42