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A case study of express transport in Shell's upstream supply chain

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Preface

This thesis is mandatory for the final semester of the international master programme in Logistics at Molde University College. We found this research opportunity amongst several others which were made public to the master students.

After a discussion with the associated professor and supervisor for this subject, Bjørnar Aas, we got interested to take a closer look into the upstream supply chain for the international energy company Shell. Also, it was very attracting to work on a real case for Shell, which is one of the largest oil and gas companies in the world. After handing in a short report to associated professor Bjørnar Aas, we obtained this project. The first title for this thesis, which also ended up being the final, was “A case study of express transport for AS Norske Shell”. This title was change to “A chase study of express transport in Shell’s upstream supply chain”.

The research could not be effectively conducted without the help provided by AS Norske Shell, NorSea group and Waage SR. We herby thank Erik Gjul the Head Business Support and Liaison in Kristiansund for providing this research opportunity to us. We would like to show our great appreciations to the ISCL Contract Holder in Kristiansund, Wenche Rognskaug, for arranging meetings and build to build up the connections between us and our interviewees. We have also gained much guidance about Shell’s organization and other parties from her. Next we are grateful for the input from the onshore coordinator in Stavanger, Kjell Asbjørnsen who has been helpful supplying knowledge about the logistics operations. We would also like to thank the persons we interviewed and talked to working at Vestbase. They have been of great help gathering valuable information about the supply chain. These are the logistics supervisor Roger Nasvik, the offshore coordinator for WN Alf Tømmervåg and the transport coordinator Nina Bjerkeseth. Moreover, we would like to thank the transport manager Melisa Waage and the safety advisor EHS responsible Ove Vika for providing cooperative suggestions. Lastly, we want to express our great respect and sincere gratitude to our supervisor Bjørnar Aas for offering constructive guidance, encouragement and priceless criticism. Their contributions have made a great deal of positive influence on our research knowledge.

Molde, 10th May

Trygve Haram and Binqiang Xu

Summary

This thesis is regarded as a case study of express transport for AS Norske Shell. The main purpose for Shell was to let us focus on the express transport conducted in Shell's upstream supply in Norway. Furthermore, Shell was interested if we could propose recommendations for improving the supply chain, without a sub-optimality being created.

Our main objectives are set by means of qualitative and quantitative techniques and an exploratory research methodology. These objectives are elaborated in the following:

The first objective is to describe Shell's upstream supply chain in order to understand which parties are involved in the express transport issue. In this part, the relevant parties in our thesis are divided into Shell and the parties operating in Shell's upstream supply chain. The operating parties are West Navigator (referring to section 2.2.2) the supply base, the transporter and the vendors. In this part, we will define what outbound and inbound logistics is in Shell's upstream supply chain (referring to section 3.2).

The second objective is to describe how the onshore transport is planned and executed in order to keep the rig working. In this part, after we narrowed our study down to the Shell's upstream supply chain for West Navigator (referring to section 5.2), we will describe the lines of communications when the transport is being ordered. All key personnel in Shell and other logistics parties and their responsibilities will be described. Descriptive information of transportation, information interchange systems and relevant meetings will be presented as well.

The third objective is to explore the main reasons which may cause express transport in order to suggest improvements for Shell. In this part, we first use a statistical analysis to test to describe how the amount of express transports will be under certain conditions in comparison to normal transports.

After that we will put forward reasons for why express transport is generated, and analyzed these in order to find out they create the wrong amount of express transports

Latter, two suggestions will be put forward. The first of these is a decision making tool will be created by us to explain the relevant time and cost for inbound and outbound logistics with considering the 2 main reasons which we put forward. Moreover, we will state how this tool helps the decision maker make right decision on express transport. The second suggestion is to alter a contract term in order to avoid sub-optimality in the supply chain.

In the final part of our thesis, we made the conclusion for our research, summarize the recommendations, discuss the weaknesses of our research and future research.

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1 Introduction

Upstream in oil and gas industry, which can be defined as “the exploration and production portions of the oil and gas industry” (SPE, 2001), includes all logistics before production of oil and gas has started. It is the initial step in oil and gas production as well as the creation of demand of drilling and exploration equipments.

The company, Shell¹ is an oil and gas production operator, operating in Norway, and their oil and gas units are located offshore. Shell has the possibility to use express transport to decrease the transportation time between vendors and the rig. The use of express transport affects both the transportation time and the logistical costs in the upstream part of Shell’s supply chain. The thesis addresses a problem for Shell and our solutions could help them to move out of a problem there they have to use express transport, and thereby increase the logistical costs, in order to keep the utilization at the rig high.

Upstream logistics within the supply chain includes many challenging elements such as stochastic demand, harsh weather conditions, contract attributes, staff satisfaction, customs, etc. This is a broad problem and there exist no perfect solution for it, but it should be possible to find out whenever it is possible to improve the current situation or not.

There are many factors and variables resulting into the generation of express transport and a consequently extra cost for Shell. The thesis tries to analyze whether the current way of express transport is the optimal solution for Shell. Although the research and relevant interviews is established upon the situation in Kristiansund region, the analysis demonstrated in the thesis should therefore be of interest not only to Shell but also to other companies which currently face similar problems, as well as to companies that carry out operations in the oil and gas sector or with similar supply chain structure. Furthermore, this thesis might be a decent first hand reference material for people who is willing to conduct further research in the relevant area.

¹ www.shell.com

2 Research plan

This chapter will present the research plan for our study.

2.1 Research area

Our research was conducted in the upstream part of a supply chain in the oil and gas industry in Norway. In the upstream part the rig will be treated as the end-customer and everything that happens before represents an activity which is needed in order to keep the rig operational. More specifically, the research will be conducted within the oil company Norske Shell's upstream chain, where the main focus will be on onshore transportation in between the supply base Vestbase located in Kristiansund.

The upstream part of the supply chain is shown in Figure 2-1². This figure illustrates the main relevant logistics parties within the supply chain, their locations and Ormen Lange gas field. The main logistics parties are Shell, the supply base Vestbase, the transporter and the vendors. The supply base and an office for the transporter are located in Kristiansund. The largest concentration of vendors can be found in Stavanger and Bergen, but they are located all over Norway and abroad.

² The pictures used in the illustrative map in Figure 2-1 are found on different web pages accessed 2010.05.10.
<http://www.nor-truck.de/SR%205er%20Scania%20Jumbo-Pritschen-SZ%20re.JPG> <http://www.nor-truck.de/SR%205er%20Scania%20Jumbo-Pritschen-SZ%20re.JPG> www.shell.com
http://w11.itrademarket.com/pdimage/11/1836311_casting5.jpg
<http://www.map-of-norway.com/map-of-norway-720.jpg>

Figure 2-1: Location of the logistics parties in Shell's upstream supply chain



The supply chain management research on the use of express transport in upstream logistics in the oil and gas sector in Norway is a research problem which, to the best of our knowledge, has not been addressed before. Cousins wrote in 2006 that, the term “supply chain management was typically introduced referring to the entire supply activity of a firm (Cousins, 2006). A supply chain management research is then a research conducted within the supply chain of a firm. This thesis will try to identify explanatory factors which explain today’s performance level in the upstream supply chain.

Information flow management, which is part of supply chain management, is also an important issue concerned here. Through the study of an information-flow, the coordination between internal and external parties are important parameters to look into. This could be how the coordination between different branches within the same company or the coordination between a branch within the company and an external party is operated.

2.2 Research problem

Today, onshore transport by trucks is the most used transportation method to and from Vestbase for Shell. The possibility to choose between normal and express transport allows Shell to reduce the transportation time when it is needed, but this also has some financial drawbacks.

This thesis will try to look at both the pros and cons with the use of express transport in order to suggest improvements for Shell. To be able to suggest improvements it is essential to have a good background analysis on which improvements can be based upon. The first step to make this analysis is to make a thorough examination of the supply chain and specially look at everything which might affect the transportation to and from Vestbase.

The research problem for this thesis is:

“Describe and analyze the current amount of express transport in order to suggest improvements for Shell”.

To solve this problem a hypothesis was made:

“Features in the supply chain, cause Shell to use an incorrect amount of express transport”.

This hypothesis indicates that there is something in the supply chain which causes the chain to use a non-optimal amount of express transport. It could be that they use express transport when it is not needed, or that they might use normal transport when it is beneficial to use express transport.

2.2.1 Research questions

In the article “The use of the case study method in logistics research” (Ellram, 1996), Ellram wrote that in exploratory research, research questions are used to establish a magnitude of research problem therefore the main research area is emphasized and explicit. In the same article she also wrote that the establishment of research questions also helps the researcher to collect the needed information for conducting exploratory research.

Based on this we chose to establish a set of research questions to help us with the research.

The research questions can be divided into two parts. Research questions related to explain the magnitude of the problem, and research questions related to explain the reasons for why express transport is used in Shell's upstream supply chain.

Research questions that could be used to explain the magnitude of the problem:

- How often are transports used and how much is transported to and from Vestbase?
- How often does Shell use express transport to and from Vestbase?
- What is the cost for a normal and for an express transport?

Research questions to explain the reasons for why express transport is used:

- Which kinds of products are sent by express transport?
- How is the information flow between the logistical-parties, shown in Figure 2-1, and could the information flow between these cause express transport?
- How are the contracts between Shell and vendors designed?
- How are the relationship between systems in the supply chain, what is automated and what has to be done manually?
- How is the express transport divided for each activity on the rigs? A rig carries out many different activities, such as drilling, testing and completion. Could it be that the amount of express transport varies between these activities?
- How is the work process for ordering an onshore transport to and from Vestbase?

2.2.2 Limitations

We found that West Navigator holds the largest number of land transport trips, largest number of express transport trips and second largest share of express transport. We decided to put our focus on West Navigator which operates at the Ormen Lange project in North Sea, not the other rigs operated by Shell in Norway.

Secondly, express transport is only relevant to the onshore transportation. So air and water transports between vendor and the supply base, or the transport between the supply base

and the rig is not analyzed in this thesis.

Thirdly, we decided to narrow the research down to onshore transportation inside Norway. Vendors located, or rule and regulations in other countries and customs is not included.

Fourthly, on the onshore transportation, we chose to focus on the time from the start of 2008 to the end of 2009. This means that we will use the processes for when Waage SR was the transporter for Vestbase. The historical data will be for the years when Waage SR where the service provider for Vestbase. The time period where Waage SR was the transporter is much longer than Grieg Transport, which made it easier to gather data. The change of the transporter also caused a lot of work for the involved persons. This made it harder to contact the person after this time period.

Fifthly, some of the processes used in the supply chain changed when Grieg Transport became the new transporter for Vestbase. The changes in these processes are not taken into consideration in this study.

2.3 Research design

2.3.1 Methodology

The choice of research methodology was based the article “The use of case study method in logistics research” written by Ellram in 1996 (Ellram, 1996). In this article she wrote that the research questions affect the appropriate methodology choice for a study. She also wrote that in exploratory research the issue is often how or why something is being done. Based on the research questions, presented in section 2.2.1, and Ellram’s writings we chose to use an exploratory research approach to solve our research problem.

This research will be conducted as a case study for AS Norske Shell. In the same article Ellram wrote that a case study methodology would be desirable to provide depth and insight into a little know phenomenon (Ellram, 1996). We think this description fits our research problem.

2.3.2 Data collection

Collecting of primary and secondary data helped us to answer the research questions in a good manner. Interviews with relevant personnel working for Shell or for a third party operating in Shell's upstream supply chain, and observations were conducted to gain primary data. Secondary data was gathered through the study of internal documents, books, articles and the internet.

In her book "How to Research" Blaxter wrote that to have a valid research it is important to know the conditions of the production of the document. Why, and when, the document was produced and whom it was written for is important questions to consider before a document is used in the research. (Blaxter, 2006).

These are some important questions to think about. Are there underlying reasons for the production of a document? If we e.g. look at a report made by a company selling a service, this report would most likely be favorable towards the service that company provides. For validity, as far as possible we tried try to crosscheck the primary and secondary data with each other in order to find out if there are some flaws with either of the data sources.

Comparing how a governing document says a process should be conducted with an interview of the person conducting the process today will be a good foundation to understand how that process is done in the day to day business. If there are inconsistencies we have to dig deeper to find out why, old document or description of the process or misunderstandings could and did happen.

2.3.2.1 *Written sources*

Governing documents, especially the Ormen Lange Logistics Guidelines has been used to describe how the supply chain is put together and how everything is organized.

Master dissertations

We found six previous master dissertations written about the oil and gas sector at Molde University College. None of these concerned the express transport issue for Shell. But, they hold useful general information about the oil and gas sector in Norway and how it

was operated at the point in time the dissertations was written. How the operations are conducted is under a never-ending development to be improved. As a result, some of the processes and how things were operated when the dissertation was written has been changed.

The information gained through the previous dissertations can therefore not be used as a specific source but more as a general information source regarding the industry. These dissertations has been useful since they gave us a quicker learning curve in order to obtain the necessary knowledge for how the oil and gas companies run their operations, how parts of their supply chain is organized and which processes a rig do when it is in an operative stage.

Documents used

Ormen Lange Logistics Guidelines

This document outlines methods to be used for planning, managing and coordination materials and logistics for the Ormen Lange drilling operation. The overall purpose of this document is to provide a reference guide that can be used by all personnel engaged on drilling, completion and workover projects. Key topics covered are:

- Onshore and offshore logistics organization
- Communication and phone numbers for relevant personnel
- Ordering services and equipment
- Transportation of cargo to and from Kristiansund
- Vessel operations/coordination
- Back loading of cargo
- Return of rental equipment
- Aviation booking and travel

Transportation reports for 2008 and 2009

These reports were first made in 2008 as an attempt to get a better understanding and control over the onshore, sea and air transportation between vendors and the supply base. The reports contain the amount of onshore trips with containers larger than 8 feet and the complete amount for the air and sea transport. These reports contain information such as:

- Amount of tons transported between Kristiansund and rigs
- Total cost for the transportation
- Total number of trips for land, air and sea
- Share of express transport on the land transport
- Amount of km on road for land transport

For more information, see the appendix. Appendix 1 is a screenshot made of the data for all transports in April 2009. Appendix 2 is a screenshot made of the data for onshore transport in April 2009. NB they are in Norwegian.

Pricelist

The acting pricelist for when WSR was the transporter for onshore transportation can be found in appendix 3. It contains the prices Shell has to pay Vestbase for the transportation services.

Operational lookahead

Also called the POB-Planner, it is a planning tool used to plan the transportation to and from the rig. It also contains historical data about the operations at the rig.

2.3.2.2 Interviews

Interviews are a common used source for data gathering. Dunne gave in 2005 a number of explicit explanations for the reasons why interview is critical for a research (Dunne, et al., 2005), these are as follows:

- The use of interviews in research suggests that the views and interpretations of certain social actors are important to the research questions.
- Interviewees' knowledge is significant to the research.

These two bullet points are spot on regarding the need for interview as a data gathering tool in our research. Dunne wrote in the same book that “The interview is a very adaptable and powerful method in a broad range of research projects” and “the interview is a very malleable research tool appropriate to a very wide range of research” (Dunne, et al., 2005).

Consequently, the use of interviews to conduct our thesis seemed unavoidable. The interviews played a critical part in our effort in the research for this thesis, and much effort has been put on the interview issue throughout the entire data collection process.

An interview makes it possible to gather specific data and the opinions the interviewee's responsible area.

Semi-structured interview as a core thought

Having discussed the reasons for why an interview is important, we should decide the core thought of interview for our research. Dunne wrote that the interview has multiple forms. One of these forms is a "structured" versus an "unstructured" (Dunne, et al., 2005). In 2007 Denscombe introduced a new term called a semi-structured interview (Denscombe, 2007). A semi-structured interview is when the researcher has a clear list of issues and questions to be addresses, but the interviewee can speak freely about the issues raised by the researcher (Denscombe, 2007).

We preferred to use semi-structured interviews when interviews were conducted in this study. Since, a semi-structured interview would give the interviewee freer space to talk about a clear list of questions which is proposed by the interviewer. The answer we get from interviewees will not be only too simple ones as "Yes" or "No". The interviewees were also allowed to talk outside the questionnaire, and address issues he or she thought where important. Since the interviewee could feel free to talk to us, we are able to attain a quantity of sparkling opinions from the experienced interviewees that could become the breakthrough to our research.

Detailed interview methods for research

Having stated the reasons for why an interview is significant and found a suitable form, it is needed to find out which interviewing method we will use. Blaxter wrote that "Interviews may take place face-to-face, or at a distance, e.g. over the telephone or by email" (Blaxter, 2006).

In a face-to-face interview, it is easy for the researcher to control the conversation and stick to the main object of the interview. The danger of misinterpretation for the questions

can be minimized by re-explaining or restating them. The level of interaction between interviewees and interviewers is high in face-to-face interview, which could make it easier to keep a conversation flowing.

A telephone interview is the second method a researcher can use to conduct an interview. This method makes researcher save time of traveling. However, the disadvantage of telephone interview is obvious. The researcher and the interviewee are not capable to use body language to express to the person at the opponent side of the phone. Some persons are also more reluctant to talk on the phone compared to a face-to-face conversation. So, compared with face-to-face interview, telephone interview may have a reduced output from the interview. A phone interview may also take more time, caused by the time it used on reinterpreting the questions against misinterpretation.

To use email is the third form of conducting an interview. It is done by sending a set of questions to the interviewee. The disadvantage with using email is that the danger of misinterpretation is higher when the interviewee is writing down the answers based on his or her personal understanding on some questions. This is especially true when we are going to have qualitative interviews. Table 2-1 summarizes the advantages and disadvantages for three methods of interview.

Table 2-1: Advantages and disadvantages with different interview methods

	Level of interaction	Danger of misinterpretation
Face-to-face interview	High	Low
Telephone interview	Medium	Medium
Email	Low	High

A face-to-face interview was preferred to be used for all of the interviews. The exception was when the distance is long (Stavanger) or when we just have a couple of short questions. In addition, the interviewee and we are able to use body language to assist ourselves in the conversational interview. The low danger of misinterpretation for face-to-

face interview could make interview conducting smoothly.

A telephone interview was preferred to use if the interviewee were located too far from us. It would also be preferable when we are aware that we have missed asking a few questions or if we have questions from a previous interview.

Recording

A recording of the interview allows the interviewer concentrate on the process of the interview. The interviewer can focus his attention on the interviewee and give eye contact and non-verbal communication (Blaxter, 2006). To use a recording would therefore give us the ability to focus our effort on the conversation between the interviewee and us, instead of the notebook while we conduct the interview. But according to Blaxter a recording also has its shortcomings. It takes a longer time to transcribe and analyse the interview in a later occasion (Blaxter, 2006). Nevertheless we thought that the pros for being able to access the interview at a later time weigh far greater than the extra time it would take to write and analyze it. We therefore decided to use a recording when the interviews were conducted. But because of a problem with the recorder the first interview with the transport coordinator at Vestbase and the first interview with WSR were not recorded.

How interviews were conducted during our study

During our first trip to Shell in Kristiansund on 27th October 2009 our contact person gave us some ideas about who we should interview first; this was the transport coordinator at Vestbase and personnel at WSR. We decided to interview both of them during our next trip the 2nd December 2009. These interviews gave us valuable input into how the onshore transportation was carried out. Based on this and the suggestion from our contact person, we chose to interview the onshore coordinator in Stavanger and the offshore coordinator at West Navigator. The interview with the Logistics supervisor at Vestbase and the logistics coordinator at Vestbase were next. In addition to these interviews most of the people are contacted on several occasions, this is by a phone call, and or email. For a detailed schedule over how of the main interview round were conducted see Appendix 9.

3 Description of Shell's upstream supply chain

This chapter will present a description of Shell, the main logistical parties within Shell's upstream supply chain and how the material flow within this supply chain is organized. This is done to get an understanding of the area of responsibility for each of the parties and to understand their role in the chain. The knowledge about the different parties and how they are related in the upstream supply chain is especially important for a reader without comprehensive knowledge, about the Norwegian oil and gas sector. Parties which will be described in this chapter are:

- AS Norske Shell
- Oil Platforms and drillship
 - West Navigator
- The Supply base, Vestbase
- Vendors

Information in this chapter is found with a combination of studying internal documents and - reports and by interviewing relevant people.

3.1 AS Norske Shell

The parent company of the Shell group is Royal Dutch Shell plc, which is incorporated in England and Wales (Shell, 2010). Shell started as a domestic Royal Dutch Shell plc in Holland but is now one of the world's leading energy companies. According to Shell's webpage, Shell (Shell, 2010):

- Has 2% of the world's oil production
- Has 3% of the worlds gas production
- Operates in more than 100 countries
- Approximately 100,000 employees

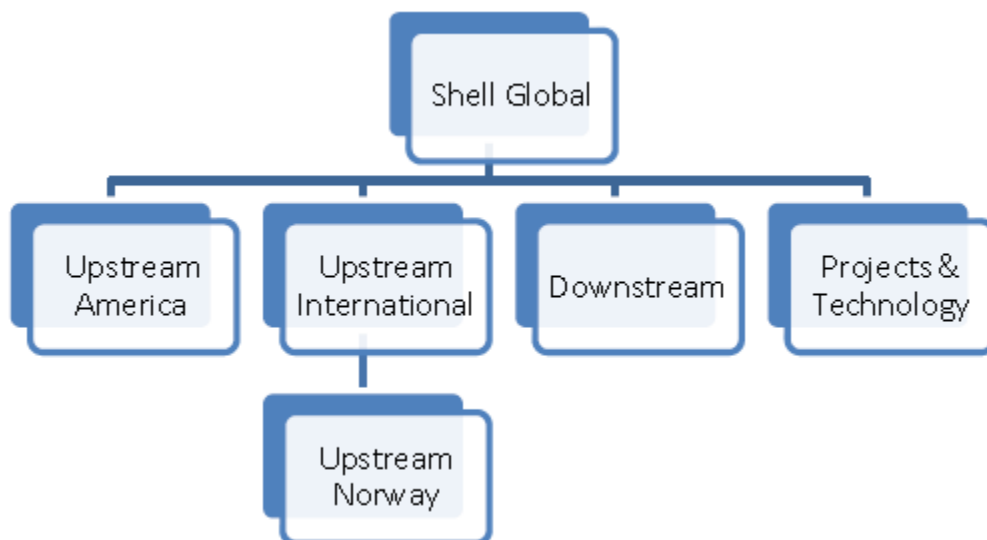
Figure 3-1 is made using information found on Shells homepage (Shell, 2010). It shows Shells business divided on four divisions and Upstream Norway is a part of Upstream

international. Shell describes the four divisions as (Shell, 2010):

- **Upstream America** and **Upstream International** searches for and recovers oil and natural gas
- **Downstream** refines, supplies, trades and ships crude oil worldwide, manufactures and markets a range of products, and produces petrochemicals for industrial customers.
- **Projects & technology** manages delivery of Shell’s major projects and drives the research and innovation to create technology solutions.

Based on Shells’ definition of the four business division Figure 3-1 was made.

Figure 3-1: Shell global



3.2 The material flow in Shell’s upstream supply chain

This thesis will be limited to the upstream supply chain for Shell and the end customer will be the rig. The thesis will neither go into the vendors’ vendors or customers after the rig. This means that this study will be conducted in a supply chain which starts at a vendor and ends at the rig, this is called the upstream supply chain.

The upstream part of the supply chain is an essential part of the supply chain. There exist

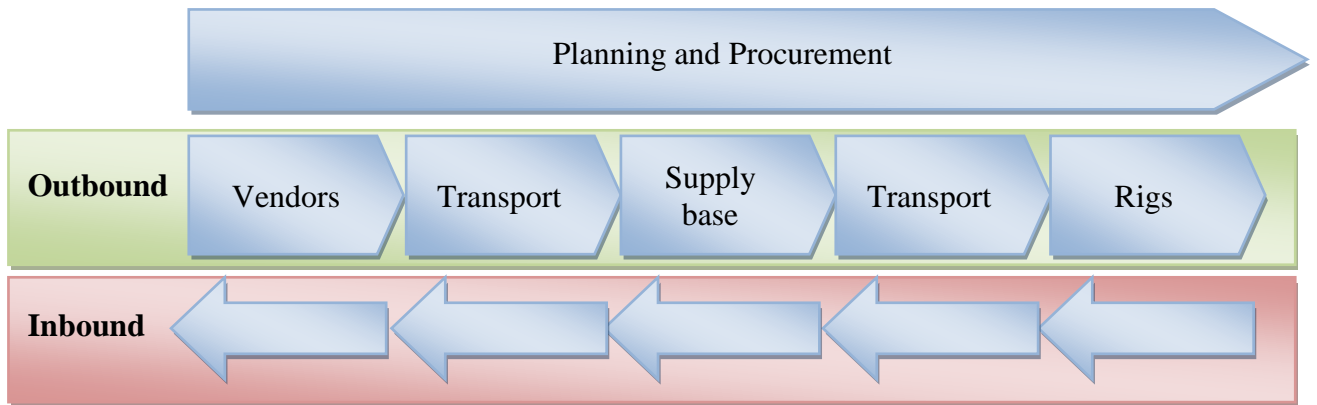
many different challenges in this chain and how the upstream supply chain should be managed to improve the entire supply chain performance. The sole magnitude of the upstream part of the supply chain in the oil and gas sector makes it a rather complex object to describe. It consists of many different internal and external parties such as:

- Well Engineering (WE), is in charge of the long term plan for drilling operations at rigs.
- Vendors, supply needed products to the rigs.
- Transporter, a third party service provider which transports products between vendors and the supply base.
- Supply base (Vestbase), coordinates the transport, controls received equipment and loads it on or off a supply vessel.
- Supply Vessels, transports needed material or equipment between rigs and Vestbase.
- Rig, end-customer and creates the demand for the supply chain.

The upstream supply chain is operated to provide supply of materials and equipments to and from the rig in order to meet the rigs requirements. Figure 3-2 is made by the authors, it illustrates the upstream part of the supply chain for rigs and drillships operated from the supply base Vestbase for Shell. Planning and procurement is an ongoing support-activity for the primary activities in the chain. The upstream part of the supply chain for drillship and rigs which are supplied from Vestbase got two directions:

- Outbound is when a product is transported from vendors to the rigs
- Inbound is when product is transported to the rig from vendors

Figure 3-2: Upstream part of Shell's supply chain



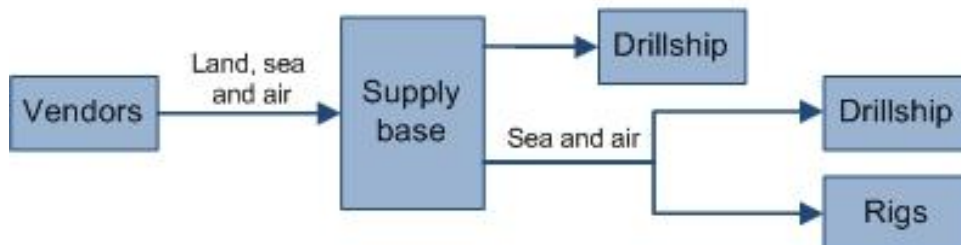
3.2.1 Material flow

The outbound and inbound material flow will be described in the following

3.2.1.1 Outbound material flow

The outbound part of the physical material flow starts when material is picked up at the vendors. Figure 3-3 illustrates this material flow. From the vendors it is transported by trucks, planes or boats to Vestbase. At Vestbase, the material is controlled and it is made sure that everything is how it should be, before it is transported by supply vessels or helicopters to the rigs or drillship. Even though it is rare, it may happen that the drillship has to dock at Vestbase. When this happens, equipment can be loaded on and off the drillship without the use of helicopters or supply vessels.

Figure 3-3: Outbound material flow



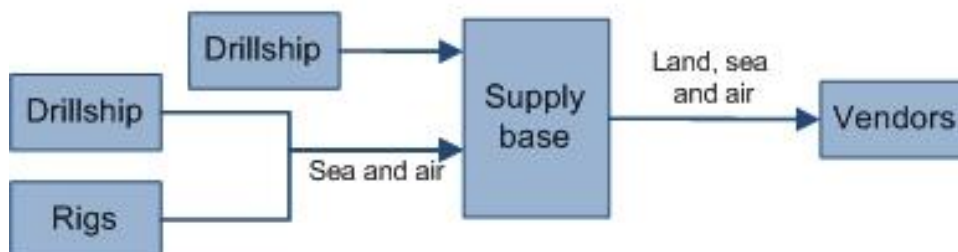
The time it takes to transport material in the outbound material flow is determined by:

- How long times the vendor use to prepare and make the unit ready to be picked up for transport after the order is received.
- The choice of transportation mode and how far it is between the vendors and the supply base.
- How long time Vestbase use to unload the truck, control the unit and belonging documents, prepare and load it onto a supply vessel.
- The length of the distance between Vestbase and the rig
- Weather/sea conditions
- If the supply vessel visit other rigs before the focal rig.

3.2.1.2 ***Inbound material flow***

After usage at the rig, it is necessary to transport equipment and waste, backward from the rig to make room for new equipment. Figure 3-4 illustrates this material flow. The differences between the outbound and inbound material flow is not that large. Transportation from rig to Vestbase is done by supply vessels or when the drillship lay at the quay. From Vestbase the equipment is transported by truck, planes or boats back to the suppliers.

Figure 3-4: Inbound material flow



The time it takes to transport material from the rig to vendors is mainly decided by the same factors as in the outbound material flow. But, the inbound material flow is not dependent on the time it takes for the vendor to prepare the unit.

The time it takes to transport a broken part between a rig and the supply base, also called lead-time, is dependent on the time it takes from a breakdown occurs and the part is ready

to be loaded onto a supply vessel, the arrival time for the next supply vessel and the transportation time between rig and Vestbase.

3.3 Parties operating in Shell's upstream supply chain

In this part the different parties in Shell's upstream supply chain will be described.

3.3.1 West Navigator

Shell operates many other platforms in Norway. But, as described in the limitations this thesis will only study West Navigator, the reason for this will be explained more thoroughly later. This chapter will therefore only be about West Navigator and its processes.

West Navigator is currently drilling in the Ormen Lange gas field which is a gas field located approximately 120 kilometers west of Kristiansund. Figure 3-5 shows an illustrative photo of the Ormen Lange gas field. The boat illustrates WN drilling, testing or making the completion of a well at one of the templates located on the seabed. When the well is completed it will transfer gas from the seabed to Nyhamna, at Aukra, where the gas will be processed before it is sent to Easington in the United Kingdom.

Figure 3-5: Illustrative photo of Ormen Lange³

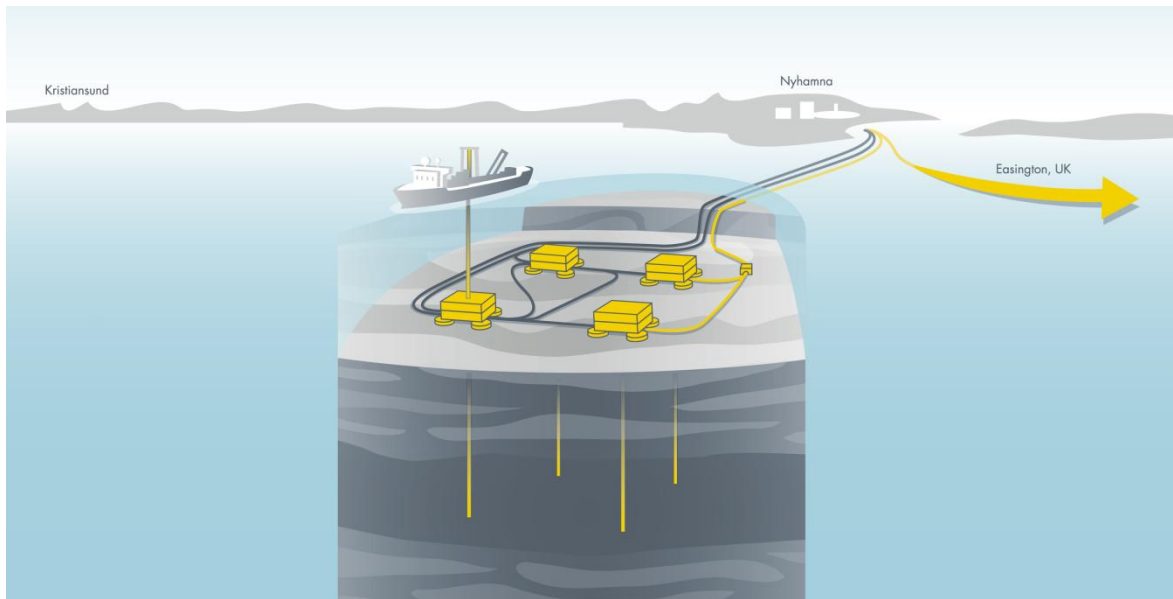


Figure 3-6: West Navigator

3.3.1.1 *Background*

Information about West Navigator (WN) is found on Seadrill's homepage (Seadrill, 2010). WN is a DP drillship owned by Seadrill. Shell is currently operating it and they have a contract until Dec-2012, with a day rate of 594,000 dollar. It has been operating at the Ormen Lange gas field since October 2005. WN is 253 meters long and 42 meters wide. It can drill in water depths up to 2500 meters and can drill 9000 meters deep. For more information about WN see appendix 4.



³ http://www-static.shell.com/static/nor/imgs/generalcontent/image_gallery_large/ormenlange/ormenlange_illustrasjon.jpg, cited: 2010.05.05 Illustration made by: Tor Edvin Strøm.

3.3.1.2 *Drilling operations*

Well Engineering is a department within Shell’s organization which is responsible for making the overall plan for drilling operations at the rig. They make a one year plan for the drilling operations for West Navigator. This plan is stored under the Ormen Lange Project in Livelink. Livelink is a web-based storage database used by Shell, which will be explained more thoroughly later.

The drilling of a well is divided into sections. One section is how deep they drill with a certain width. This is illustrated in Figure 3-7. Where the top is the seabed and the bottom is the reservoir. They start with the largest diameter and ends with the smallest diameter. Each section has specialized equipment and none of the rental equipment used in one section can be used in the next.

Figure 3-7: Sections in the drilling process



The drilling process at the Ormen Lange gas field differs from other fields drilled on the Norwegian Continental Shelf. There are mainly two reasons for this; firstly they only drill one type of wells, production wells. Secondly, WN work on the same section for several wells at the same time, while it is normal to work on just one well at the time for other rigs. This puts large requirements to the supply chain since it has to manage equipment for several wells at the same time.

Before they start to drill a section, they ship out all the equipment required to drill it and just before the drilling is completed they send out the equipment and material required to set the casing in the hole. When this is done they send out the equipment needed for the next section.

When the ship is in drilling mode they always send out one primary and one backup unit for the drilling equipment. The backup unit works as a spare-part for the primary unit at the rig. This is needed since it is quite common that the primary unit fails during a drilling operation. To have a backup unit at the rig allows the rig to quickly switch to the backup unit if the primary unit breakdown instead of waiting for a new unit to be shipped. When a unit breakdown, they immediately send a new unit out to the rig to be the new backup unit. Based on the interviews, this is always done by express transport.

3.3.2 The supply base

Vestbase is an industrial area located in Kristiansund. Today there are between 50-60 companies represented in the area. All companies operating out of Mid-Norway are currently established at Vestbase (Vestbase AS, 2010). Both platforms (Heidrun, Aasgard A, B and C, Njord, Kristin) and drilling ships (Aasgard A and West Navigator) receive supplies from Vestbase.

Although Vestbase is the name of an industrial area, is it also the name of a company providing logistical services. Vestbase AS has made a concept which includes all logistics relevant tasks which must be solved at or from Vestbase, for example efficient transport, shipping and customs solutions (NorSea Group, 2010). Vestbase possesses expertise with core activities of terminal operations including management equipment coordination, purchasing, rig coordination and transport/forwarding (NorSea Group, 2010).

Vestbase, which is run by NorSea Group, is the preferred supply base for the Ormen Lange project. Shell has a contract with Vestbase to use it as a supply base and Vestbase should supply transport services, which includes provision of personnel to manage required logistics. Responsible personnel at Vestbase have to check all outbound materials before it can leave Vestbase. When Vestbase is mentioned later in this thesis, we will refer to it as a logistical party in the supply chain, not an industrial area.

3.3.3 Transporter

WSR is cooperation between Waage Transport⁴ and SR-Transport⁵ to supply transportation services to the oil sector. WSR, as a third-party logistics participator also has ambitions to be the leading carrier in the transport and logistics services for the oil and offshore industry in Norway.

Waage SR AS, hereby denoted as WSR has for many years been the transporter used for

4 <http://www.waage.no/>

5 <http://www.sr-transport.no/>

Shell's operations at Vestbase. But a new tender has been out and WSR lost this, so from 1st of March 10, 2010 Grieg Transport is the new service provider.

3.3.4 Vendors

The vendors supply the needed material, equipment, and bulk to Vestbase, which is indented to be used on West Navigator. These vendors are mainly located in Stavanger and Bergen, but they are also located in other parts of Norway and abroad. Our study will be concerning the vendors located in Norway. It is the individual vendor's responsibility to provide suitable containers / baskets for the units they deliver for transport.

3.3.4.1 Contracts

The starting and ending time for when Shell has to pay rental for a certain equipment type to a vendor is determined by the contract between those two. The rent could start at the point in time when it is picked up at vendors place, when it arrive at Vestbase, when it is loaded onto a supply vessel, when it is loaded onto the rig or when it is put in use on the rig. The rent for the equipment could end when it is no longer in use at the platform, when it is loaded of the rig, when it arrives at Vestbase or when it arrives at vendor's place.

4 Theoretical framework

This chapter elaborates theories and concepts which we consider are related to the area of research in thesis. Initially demonstrating of possible applicable theories and concepts make up the basis to mapping and explaining the supply chain, conducting analysis on the supply chain and the organization inside and outside the focal enterprise.

4.1 Logistics

Logistics as a concept which often is difficult to separate from supply chain management. Harrison and Hoek define logistics as: (Harrison, et al., 2005 s. 7).

“Logistics is the task of coordinating material flow and information flow across the supply" chain”.

The material flow is the physical flow of goods from its origin until it arrives at its destination, while the information flow is the flow is the path the information takes from its originator to its customer. In addition, Harrison divides logistics into two parts, strategic (long-term planning) and managerial (medium-term planning and control) aspects: (Harrison, et al., 2005).

The coordination of the material and information flow is an essential part of Shell's, as the largest participator, responsibility in the upstream chain. And how this is conducted is vital in order to keep the performance high. Synchronism is often used as term to describe the ideal situation in material flow. The goal for this ideal situation is argued and explained by Bernie Knill (Knill, 1992 s. 54) as:

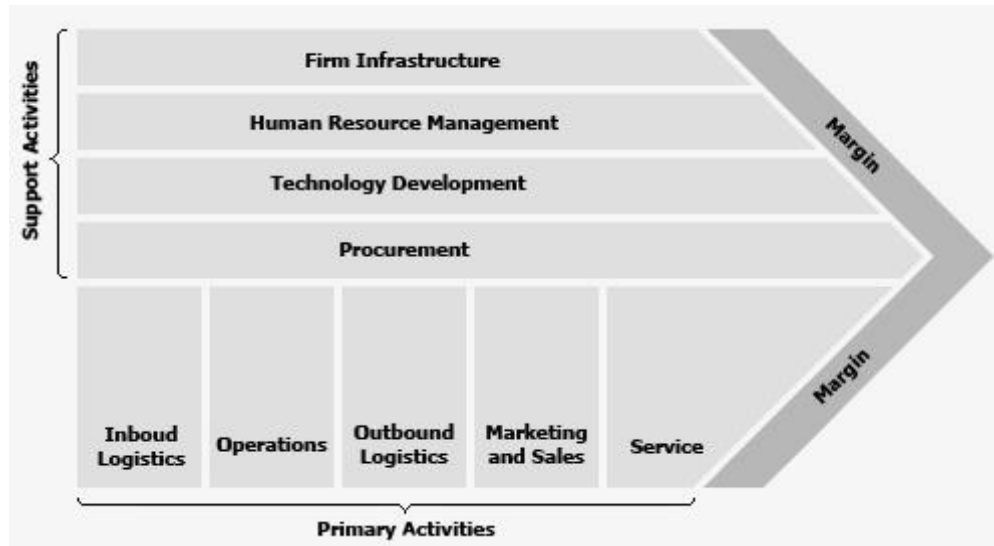
“The goal is continuous, synchronous flow. Continuous means no interruptions, no dropping the ball, no unnecessary accumulations of inventory. And synchronous means that it all runs like a ballet. Parts and components are delivered on time, in the proper sequence, exactly to the point they're needed”.

In the ideal situation there should be no waiting time for the equipment, no unnecessary inventory and the equipment should be delivered when it is needed.

4.2 Porter's value chain

In the following, more focus will be put on the upstream supply chain specifically relevant to Shell.

Figure 4-1: Porters Value Chain



The concept “Value chain” was introduced by Michael Porter in his ‘Competitive Advantage: Creating and Sustaining superior Performance’ (Porter, 1985). Recklies wrote in 2007 that a value chain analysis describes the activities an organization performs and links them to the organizations competitive position. (Recklies, 2001). Porter introduced primary activities and support activities as two different types of activities in a value chain. Primary activities create value exceeding relevant costs including inbound logistics, operations, outbound logistics, marketing & sales and service.

Primary activities related to support activities which support to maintain and develop efficiency and effectiveness. Support activities include four main areas that are procurement, technology development, human resource management and infrastructure. These activities are described by QuickMBA (QuickMBA, 1999-2007) as:

Primary activities

- Inbound logistics includes receiving, warehousing, inventory control of input materials, for example material carrying, vehicle coordination, return of goods and etc.
- Operations are value-creating activities that transform the inputs into the final product, for example, machining operation, packing, assembly, maintenance, detection and etc.
- Outbound logistics are activities required to get the finished product to the customer, including warehousing of finished products, order fulfillment, delivery vehicle coordination, etc.
- Marketing & sales are activities connected with getting buyers to buy the product, for example advertising, promotion, sales channel development, sales team management etc.
- Service is activities which maintain and increase product's value including installation, maintenance, training, accessories supply, etc.

Support activities

- Procurement is activities such as purchasing raw materials, equipment purchasing, material management and etc on behalf of function of value chain.
- Technology development means all relevant technology innovations on behalf of improving value chain.
- Human resource management is activities relevant to recruiting, training, development, etc. Human resource management is not only important to support primary activities but also enhance entire value chain.
- Infrastructure includes accounting, political process and so on.

In Porters value chain perspective, the upstream part of the supply chain for Shell includes all the support activities but only the inbound logistics from the primary activities. Inbound logistics includes all activities needed to coordinate the transport between vendors and rigs as well as drilling at the rigs. The value chain look at the problem could give valuable input, but as an overall theory it will be insufficient since it only looks at Shell's operations, not the other parties which influence how the chain works. In Porter's value chain, Shell's upstream and downstream is divided between the primary activities:

- Upstream is the inbound logistics and a part of the operations
- Downstream is a part of the operations and the remaining primary activities

Hence, the study in this thesis will be conducted in the “inbound logistics” part and the according support activities in Porter’s value chain.

4.3 Supply chain management

Supply chain management (SCM) is a concept where the entire supply chain is looked upon for a given product. This is from the gathering raw material, until the final product has reached the end-customer. There are many theories with the origin in SCM. Some of these which we think fit to answer our research problem are presented next.

4.3.1 Integrated supply chain and agile supply chains

Integrated supply chain

For successfully implementing supply chain management and making the supply chain more competitive, all the nodes in the supply chain should be regarded as an integrated process. Integrated supply chain is defined by Huo as: (Huo, et al., 2002 s. 23)

“All the supply chain parties and organizations create a ‘virtual organization’ based on same objective, in which all members commit themselves to optimize overall performance by information sharing

Agile supply chain

Harrison wrote in 2005 “that the agile mindset aims to align supply capabilities with end-customer demand” (Harrison, et al., 2005 s. 189). This means that the supply capabilities in the chain should be aligned to satisfy the end-customer’s demand. In same book Harrison also wrote in that, when the market is unpredictable and there is short lead time in the supply chain. The supply chain should have agile capabilities (Harrison, et al., 2005 s. 190).

We think these two classifications fit the requirements of what should be required by Shell’s upstream supply chain. This theory is therefore an important foundation for this

case study.

Harrison introduced the concept of agility in 2005, when he named four dimensions a supply chain ought to fulfill in order to be agile (Harrison, et al., 2005 s. 186). The two of these which we think is most important are:

- The supply chain ought to be customer responsive,
- The partners in the supply chain should cooperate in order to fulfill the end-customers' needs.

The latter of these two bullet points is quite identical to what the goal in an integrated supply chain should be. But in addition to the integrated supply chain, in the agile supply chain to fulfill the customers' needs should be the common goal.

These two theories build on almost the same parameters. The main difference between an agile supply chain and an integrated supply chain is that the agile supply chain in addition to what the integrated supply chain, adds that the chain should be responsive, and be designed to best fulfill the end-customers need. But the essence is the same. Both say that in order to maximize the overall supply chain performance, the parties (Shell, the transporter, the vendor and Vestbase) have to look at them self as one "virtual organization" with a common goal. When this is done the information sharing, capital and material coordinating and co-operation between the different parties would be designed so that they serve the supply chain, not the individual party.

We will use these theories as a basis for the future study in this thesis.

5 Classification of the problem

Shell has an assumption that they use too much express transport. To find out if there is proof in this assumption a quick interview round was conducted to get ideas of why express transport was used. It was clear that the general assumption was that express transport is an important contribution to the supply chain. The main issue all we talked with emphasized was the importance of ensuring a high utilization of the rig. Because of weather and downtime of equipment the rig often had issues which could halt the operations.

It seemed like the cost if a downtime at the rig occurs, is so huge that the extra cost for an express transport is insignificant in comparison.

It was also obvious that if it was expensive rental equipment it would be sent by express transport in order to reduce the rental costs.

5.1 The authors' comprehension about what express transport cause in the supply chain

After the interviews, we had build our own understanding of which problem the express transport might cause in Shell's upstream supply chain. These are as follows:

Reduced downtime for the rig

It is extremely expensive to have a rig. Rental cost or capital cost for the rig, storage and rental costs for inventory on and on its way to the rig, wages etc has to be paid even though the operation stops. For example, according to Seadrill's homepage just the day-rate for West Navigator is 594 000 USD (Seadrill, 2010). It is therefore crucial to keep this downtime at a minimum.

Reduced rental paid for equipment

The use of express transport reduces the transportation time and thereby the time Shell has to pay for rent of the equipment.

Decreased load per trip and increased number of trips

The use of express transport might make it harder plan/pack so that the truck is filled before leaves for its destination. This could mean that the average load per truck is higher with a normal transport contra an express transport.

If this is true, so if, the demand at the rig stays constant and if the use of express transport increases, the average load per truck will decrease. The amount of tons per trip will then decrease and they might need more trips to transport a certain amount of tons.

$$\Delta \frac{\text{Amount of tons transported onshore}}{\text{amount of trips onshore}} < 0 \quad \text{if express is used}$$

This could mean that they need a increase amount of trips to transport the same amount of tons between vendors and Vestbase. This will again lead to several things. Even though the risk of using trucks to transport material and equipment to Vestbase minimal⁶ an increase in number of trips will increase the risk of an accident occurring. More trips will also increase the fuel consumption for the transportation between vendors and Vestbase.

Increased transportation costs

The transportation cost will increase since an express transport costs more than a normal transport. For a normal trip Shell pays a certain amount based on a previous agreed price. This price is mainly dependent on the distance of the transport, but how heavy the load is also influence the price. In an express transport is used Shell has to pay a fixed fee which is only determined by the distance of the transport.

If the use of express transport also increases the total number of trips, the total transportation cost will increase further.

⁶ There have been no accidents on transports to or from Vestbase for Shell while the Ormen Lange project has been active

5.2 Use of on-land transport in 2008

Table 5-1 and Table 5-2 is made using the information found in Shells transportation report for 2008 and 2009 (Bjerkeseth, 2008) (Bjerkeseth, 2009). These reports show the number of land transport to and from Kristiansund divided between the different rigs.

In total express transport was used 130 times to Kristiansund and 48 times from Kristiansund in 2008. West Navigator (WN) had the highest demand and the 2nd largest share of express transports (21%) to Kristiansund. Leiv Eiriksson (LE) had the 2nd largest demand for transport and the highest share of express transports. LE with 7 % is the highest share of express transports from Kristiansund.

Table 5-1: Trips by land to and from Kristiansund in 2008

Outbound				Inbound			
Project	Trips	Express transport	Share of express transport	Project	Trips	Express transport	Share of express transport
LE	145	37	26%	LE	175	12	7%
WN	327	69	21%	WN	595	30	5%
Toa	100	21	21%	TOA	151	6	4%
DR	55	3	5%	DR	384	0	0%
Other	101	0	0%	Other	113	0	0%

In total, express transport was used 130 times to Kristiansund and 48 times from Kristiansund in 2008. West Navigator (WN) had the highest demand and the 2nd largest share of express transports (21%) to Kristiansund. Leiv Eiriksson (LE) had the 2nd largest

In 2009 LE, working on Ormen Lange, still had the highest share of express transport in the outbound and inbound material flow. WN has the second largest share in the outbound and the third largest in the inbound material flow. As in 2008, WN also has the highest amount of trips to and from Vestbase in 2009.

Table 5-2: Trips by land to and from Kristiansund in 2009

Outbound in 2009				Inbound in 2009			
Project	Trips	Express transport	Share of express transport	Project	Trips	Express transport	Share of express transport
LE.OL I and II	139	49	35%	LE.OL I and II	204	41	20%
WN	413	96	23%	GRO	170	28	16%
GRO	159	31	19%	WN	572	73	13%
DR	71	7	10%	Other	188	15	8%
Other	141	8	6%	DR	397	15	4%

Of the two projects with a highest share of express transport in 2008 and the projects with the highest share of express transports in 2009, it is only WN which is still in operations for Shell from Vestbase. It could also be valid to note that LE also worked on the Ormen Lange project when it had the highest share of express transports. WN was amongst the projects/rigs with the highest share of express transport, and the major contributor to the amount of trips in 2008 and 2009. A solution found for WN could therefore be more valid than a solution found for a rig with a lower demand. And it could be applicable to the other rigs.

Based on this we chose to limit our study to the part of Shell's supply chain which can be related to WN.

6 Description of the logistics processes

In this chapter the key logistics processes within Shell's upstream supply chain will be presented.

6.1 Key logistical personnel in Shell's upstream supply chain

Before we start to search for the reason for why express transport is generated, it is significant to have the knowledge of the key personnel and their responsibilities in Shell's upstream supply chain. The information in this section is about the relevant key personnel from different parties in the Shell's upstream supply chain. The key personnel, which company they belong to and where they are located is shown in the bullet points below.

Key personnel in Shell's upstream supply chain

- Shell
 - Onshore coordinator for West Navigator in Stavanger
- NorSea Group at Vestbase or at WN
 - Offshore coordinator for West Navigator in West Navigator
 - Logistics coordinator for West Navigator at Vestbase
 - Logistics supervisor at Vestbase in Kristiansund
 - Transport coordinator at Vestbase in Kristiansund
- Waage SR
 - Transport manager in Kristiansund

Figure 6-1 show where the different persons mention in the bullet points above are located. The next sections will elaborate more about the personnel and their responsibilities.

Figure 6-1: Key logistics-personnel and where they are located



6.1.1 Lines of communication

In Shell’s upstream supply chain, the related parties have been found in Chapter 3.

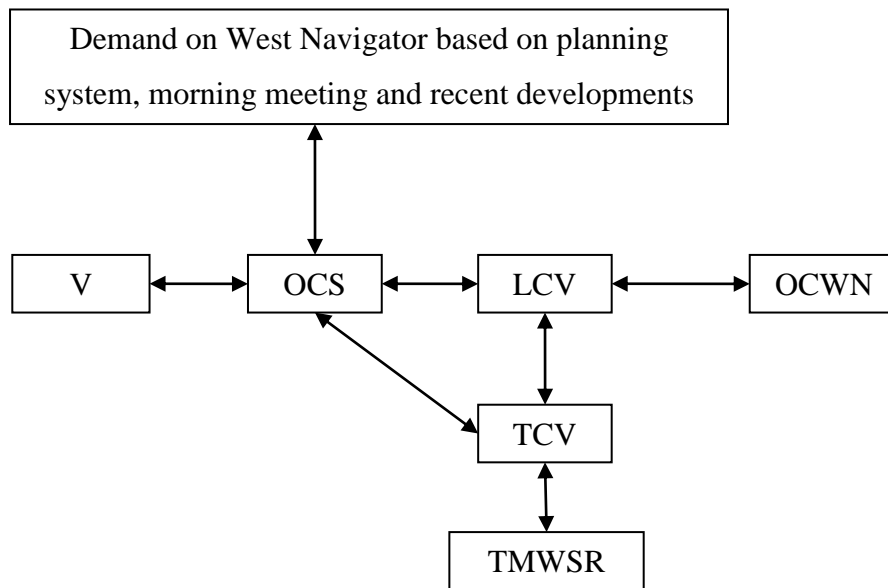
Before we begin to introduce the key personnel, a map of the lines of communication between these the different logistics personnel will be put forward. All the communications between the key personnel are highly related to outbound and inbound logistics in Shell’s upstream supply chain.

Figure 6-2 illustrates the lines of communications in Shell’s upstream supply chain. The square with letter represents the abbreviation of the key personnel in Shell’s upstream supply chain. Except, “Planning system and recent developments” does not stand for key personnel, but a fact that the demand on West Navigator is created based on the planning system, the morning meeting and the recent development on WN. We will elaborate it in “section 6.2.1”. The arrow stands for the main flow of information between the relevant personnel in his or her department. There are six key personnel in Shell’s upstream supply chain included as followings:

- V- Vendors
- OCS- Onshore coordinator in Stavanger

- OCWN- Offshore coordinator for WN
- LCV- Logistics coordinator for WN at Vestbase
- TCV- Transport Coordinator at Vestbase
- TMWSR- Transport manager in WSR

Figure 6-2: Lines of communication



The detailed information of personnel and their responsibilities for outbound and inbound logistics will be elaborated respectively.

6.1.2 Onshore coordinator for West Navigator in Stavanger

The onshore coordinator for WN is located in Stavanger. He is responsible for calling of all materials heading to WN from all vendors. He receives the information about the activities such as drilling, testing and completion from the planning system and the morning meeting. Based on this and discussions in the morning meeting (will be described in section 6.2.1) the material needed at the platform is decided.

For outbound logistics, the processes for the onshore coordinator is

According to the “Wells Logistics Work Process 20090910”, see appendix 5, the onshore coordinator should coordinate with the vendor to make initial equipment list.

- Make two phone calls to transport coordinator at Vestbase
 - In the first call he informs the transport coordinator that a transport will be needed between a location and Vestbase, and which
 - In the second call he give more detailed information, such as the equipment type, location of the vendor, width of the equipment, if it is ADR etc.
- Send the order to the transport coordinator with the detailed information
 - Mostly the same information as in the second call. But when the equipment should be arrived at Vestbase is also included.
- Receive confirmation from the transport coordinator with the expected pickup-time at vendor's location and expected arrival time at Vestbase
- Coordinate with the vendor to finish equipment list
- Send a message to the logistics coordinator at Vestbase with information about the expected arrival time of the transport at Vestbase
- Has contact with the transport coordinator if needed

For inbound logistics, the processes for the onshore coordinator is

- He can contact the transport if information about when a broken equipment will arrive at the vendor, so that the vendor can start to plan to repair it.

Vendors are contacted and told by the onshore coordinator in Stavanger when the material is going to be picked up. After this the onshore coordinator for West Navigator contacts the transport coordinator at Vestbase to inform about which material it is, when the material is planned to be ready to be picked up and when the material should arrive at Vestbase. If the onshore coordinator in Stavanger wants to know more information during the transport, information could be attained from the transport coordinator at Vestbase.

6.1.3 Offshore coordinator for West Navigator

The offshore coordinator for West Navigator is located at the drillship. The offshore coordinator is mainly responsible for planning for material arriving or departure from the rig. Before the supply vessel arrives with cargo, the cargo on WN has to be arranged so that that it is room for the new cargo. There is also often needed to unload some equipment before the loading to WN can begin. The materials which is planned to be transported to

Vestbase is also called ‘‘Backload of cargo’’. The backload of cargo will be described in section 6.4.2.1.

The offshore coordinator has contacts with Logistics coordinator, if there is a transport for the materials to or from West Navigator. He will receive a preliminary manifest for the outbound material at least 1 hour before the supply vessel leaves Vestbase. The manifest will be into the Operational lookahead (section 6.3.1.1) and be stored in Livelink (section 0).

For outbound logistics, the processes for the offshore coordinator for West Navigator is

- Receive a preliminary manifest from the logistics coordinator at Vestbase
 - Information of impending equipments planned to ship to West Navigator
- Start preparing backloads of cargo (e.g. packing) , the manifest for backload of cargo (referring to 6.4.2.1)
- Receive a final version of the manifest from the Logistics coordinator
- Update manifest and put into it into the Operational lookahead and store it in Livelink

For inbound logistics, the processes for the offshore coordinator for West Navigator is

- Prepare manifest before supply vessel reach West Navigator (will be elaborated next to the bullet points)
- Update manifest and put into Operational lookahead and store it in Livelink

For the outbound logistics, if a transport for materials from Vestbase to West Navigator have been planned to be done in the near future, the offshore coordinator will first receive a preliminary manifest. Preliminary manifest is a first version of manifest just to inform about the impending transport of the materials to the offshore coordinator. The offshore coordinators will receive a final version of manifest from the logistics coordinator right before the transport is virtually starting. The final version includes information of all the material on the supply vessel outbound for the rig.

For the inbound logistics, there is another situation must be emphasized. It can be derived that when the offshore coordinator receives the preliminary manifest from the logistics

coordinator for West Navigator at Vestbase, the offshore coordinator will start preparing manifest for “Backload of cargo” at once. The manifest for “Backload of cargo” must be finished before the supply vessel with the supply materials arrives at West Navigator.

6.1.4 Logistics coordinator for West Navigator at Vestbase

Logistics coordinator for WN at Vestbase has all the responsibilities for all material, connected to WN, from it arrive to it leaves Vestbase. In Shell’s upstream supply chain on behalf of West Navigator, the logistics coordinator is the link between the onshore coordinator in Stavanger and the offshore coordinator.

For outbound logistics, the processes for the logistics coordinator for West Navigator at Vestbase is

- Receive a cell phone message from the onshore coordinator in Stavanger
 - Information in message: relevant information about the equipment, such as the expected arrival time at Vestbase
- Prepare the base operation and manifest
- Send preliminary manifest to the offshore coordinator for West Navigator
- Send the final version of manifest to the offshore coordinator for West Navigator

For inbound logistics, the processes for the logistics coordinator for West Navigator at Vestbase is

- Prepare the base operation for “backload of cargo”
- Decide the onshore transport type and request the transport coordinator to arrange the transport

According to the outbound logistics, when the transport order has been made, the logistics coordinator is going to receive a message by cell phone. The message in this phone call states the equipment type and relevant information about the equipment, the time when the equipment is ready to be picked up at the vendor’s place, and the time when it is expected to arrive at Vestbase. After that the logistics coordinator will prepare base operation and equipment manifest for the arrival of equipments. When the equipment is loaded off the truck, the logistics coordinator for West Navigator at Vestbase will send the preliminary

manifest based on the plan to offshore coordinator in West Navigator.

For the inbound logistics, the logistics coordinator must decide which type of transport is going to be used, then request the transport coordinator at Vestbase to arrange the transport. Ormen Lange logistics guidelines say that:

- The Logistics Coordinator Vestbase should take any daily rental charges into account when deciding on how the cargo is forwarded to the respective owners.
- The logistics coordinator Vestbase will request the transport coordinator to arrange all necessary transport back to the vendors.

6.1.5 Logistics supervisor at Vestbase

He has the overall responsibility for all the logistics coordinators at Vestbase. All the logistics coordinators at Vestbase report to the logistics supervisor. The logistics Supervisor is not directly involved in the base operations. He is responsible for planning base logistics issue with taking all the factors into account. The factors are enormous, such as the contracts, base equipments, information systems, Norwegian law and regulations and etc. In fact, in Shell's upstream supply chain, the planning horizon issue for Vestbase base logistics is mostly decided by the logistics supervisor at Vestbase.

6.1.6 Transport coordinator at Vestbase

Transport coordinator is responsible for arranging the onshore transport with directly contacting the transport manager in WSR. The processes in the outbound and inbound logistics for the transport coordinator at Vestbase are showing as following.

For outbound logistics, the processes for the transport coordinator at Vestbase is

- Receive two phone calls from Onshore coordinator in Stavanger
 - Get informed that a transport today is needed from the first call
 - Get the equipment type, location of the vendor, width of the equipment, Is it a dangerous unit
- Receive a Email from Onshore coordinator in Stavanger with more detailed information

- Detailed information with more information such as when the equipment should be arrived at Vestbase
- Order the transport
- Confirm the time with transporter
 - Time when the transport truck arrived at vendor's place and pick up
 - Time when the transport truck arrived at Vestbase
- Confirm the transportation with Onshore coordinator in Stavanger
- Has contact with the logistics coordinator at Vestbase if needed

For inbound logistics, the processes for the transport coordinator at Vestbase is

- Receive information of equipment and
- Arrange transport for “backload of cargo”
- Contact the transport manager of Waage SR to order transport
- Has contact with the onshore coordinator in Stavanger and the logistics coordinator for West Navigator at Vestbase if more information is needed to show to them

6.1.7 Transport manager in Waage SR

Transport manager of transporter WSR is responsible for onshore transport arrangement. The transport manager in WSR also report to Transport coordinator at Vestbase about information during the transport if needed. The processes for the transport manager in WR for outbound and inbound logistics are similar.

For outbound and inbound logistics, the processes for the transport manager in WSR is

- Receive transport order from the transport coordinator
- Arrange the transport and notify the transport coordinator.
- Is contacted by the transport coordinator if more information is needed during the transport.

6.2 Daily meetings

6.2.1 Morning meeting

This is a daily meeting held at 8.30 am. The purpose of this meeting is for the different parties to get an overview over what has happen during the previous 24-hour period, if something has occurred at the rig which has caused deviations from the plan and affected the progress at the rig. In addition to this the plans are made for WN operations in the next 24-hour period. During this planning, the weather-update is of immense importance. During the morning they will discuss how the weather in the next 24-hour period affect the transportation to, delivery of cargo to or the operations at WN?

The participants in this meeting are

- Logistics coordinator Vestbase
- Onshore coordinator in Stavanger
- Project manager in Stavanger
- SeaDrill rig manager
- Other 3rd parties

In the morning meeting they go through

- OBS cards, they contain information about what has happened on the rig the last 24 hours
- Weather updates
- Logistics, which kind of equipment is going to and from the rig. New requests often come up if anything is needed to be moved in or out of the rig.
- How the rig's operations has been in the last 24-hour period, and if there is something important to notice in the previous period.
- Third party service vendors have to inform what they are doing and how much time they need on the operation.
- Equipment and personnel requirements

They discuss and agree on the best most likely outcome, and plan for this. The plan for WN is based on the activity and the status at that point in time, but this plan can change rapidly if something happens. The offshore coordinator has to know all the plans made

during the morning meeting

6.2.2 Logistics meeting

The logistics meeting is held at 9:45 am every morning except Saturday and Sunday. The purpose of this meeting is to go through, and plan the logistics operation, and make the parties aware of what is happening in the supply chain. In this meeting the onshore coordinator in Stavanger tells the participants what he anticipates will happen the next day or two based on what is known. What he knows is mainly based on the morning meeting.

The participants in the logistics meeting are:

- Logistics coordinator for WN at Vestbase
- Onshore coordinator in Stavanger
- Representative for the supply vessel
- Offshore coordinator for WN

6.3 Information interchange

In this chapter, we are going to describe the information interchange systems which are used by the persons in the different parties to share information. All vendors, the offshore coordinator for West Navigator and those needed have access to the Livelink plan for Ormen Lange project.

6.3.1 Livelink

Livelink is a web-based storage database used by Shell. Livelink as an e-application is mainly used by Shell. Livelink should contain all plans needed. The operational lookahead and POB was stored in Livelink which are elaborated next.

6.3.1.1 Operational lookahead

All with access to Livelink can see the Operational Lookahead which is an excel document posted in the Livelink plan for the Ormen Lange project. It contains 3 excel sheets; POB and materials, operational time breakdown and Dual derrick.

The Dual derrick is not in use, but it contains data from the beginning of the Ormen Lange project to July 2008. It contains data such as, dates, starting and ending time for the activities. An example of the information found in the Dual derrick is shown in appendix 6.

Operational time breakdown contains almost the same data as the Dual derrick, but it contains planned events, not only historical data. An example of this can be found in appendix 7.

6.3.1.2 *POB and materials*

POB and materials is a 7-day personnel & equipment plan for the rig. In addition to have the amount of personnel onboard and their positions, the personnel part contains position and name for each person schedule for arrival/departure from WN. The materials part contains a one weeks plan over material planned to be shipped out or transported of the rig. The rig is told when equipment has arrived Vestbase outbound for the rig, and the materials part of the plan is updated. Because of uncertainties in the drilling and weather conditions the POB and materials is often updated/altered.

6.3.2 **Equipment tracker**

This is a new web-based system added to the chain in 2010 which is used to track all equipment delivered to the rig. It gives an overview over where all equipments dispatched from vendors are located in the chain. The equipment tracker is owned by Shell. In addition to track the equipment the Equipment tracker also stores certain useful information about it, such as:

- Planned to be used on the rig
- Quantity
- Is it rental
- Times for transportation to rig:
- Equipment description
- Container number
- BR number
- Departure from vendor:
- Arrived base
- Shipped from base
- Arrived rig
- Times for backload transportation
- Transported of the rig
- Arrived base
- Departure time from base

Appendix 8 is a screenshot of the Master Equipment List (MEL). It shows equipment in chain delivered by one of the vendors (Schlumberger) 18th march 2010.

6.4 Transportation

The limited storage capacity at the rig and the high cost of much of the equipment makes it vital for Shell to be able to transport needed equipment fast, efficient and cost effective to and from WN. This transportation can be divided into two parts, transportation between the vendors and Vestbase and transportation between Vestbase and WN.

6.4.1 Transportation between Vestbase WN

Transportation between Vestbase and West Navigator can be divided into two, transportation of material, and transportation of people. Helicopters are used to transport people while transportation of material and equipment is mainly done by supply vessels. But if WN is in urgent need of a unit and the unit fits in the helicopter air transport might be preferred over transportation with the supply vessel.

6.4.1.1 *Supply vessel*

Under normal conditions the plan is that the supply vessel should leave Vestbase every Tuesday, Thursday and Saturday, but this might not always be possible and if WN has a higher demand in a certain period the supply vessel needs to take more trips. In some occasions two supply vessels has been needed for WN

In most cases, the supply vessel load the cargo at Vestbase and ship out to WN to unload the cargo and load the backload of cargo. But it could happen that, the supply vessel ships out to the rig without any load. This could be if e.g. WN is in dire need of getting some units transported back so that it can be fixed before it is transported back out to WN. This happens extremely rarely.

The cost for using the supply vessel to transport to WN varies dependent on many factors, but the price start on 40000/50000 NOK for an empty vessel.

6.4.1.2 *Helicopters*

Items transported to WN by helicopters are restricted by the following, According to Ormen Lange logistics guidelines (Shell, 2008):

- Too large items have to be cleared by the helicopter operator in advance.
 - Gross weight: max 40kg
 - Height / depth / length: 50 / 40 / 80 cm

Flight time is 01:25 hours (Shell, 2008)

Helicopter operations will not be performed to WN (in sea state above 7 meters significant wave height. Exceptions in this rule could be made if an event such as a medical evacuation of personnel is needed.

6.4.2 Transportation between vendors and Vestbase

Today, there are three different transportation methods used to transport equipment and material between Vendors and the supply base. These are land, air and sea. Land transport, also known as onshore transport is used when equipment is transported by trucks between vendors and the supply base. Air transport is when the equipment is transported by plane or helicopter from an airport located close to a vendor to Kristiansund airport. Transportation by sea means that the equipment and material are transported from a harbor close the vendors to Vestbase.

Decision on when the materials needs to be loaded to be in Kristiansund is based on the plan in Livelink for the Ormen Lange project, morning meeting, discussions with the drilling supervisor offshore and recent developments.

6.4.2.1 *Backload of cargo from WN*

Before the equipment is loaded of WN, a RAM is made (Retur Av Materiel, translated into English “Return of Material”), see appendix 9. A RAM holds information about materials and drilling equipment which is scheduled to be transported back from WN to Vestbase, and it contains:

- PO Number (or other unique number)
- The return address (owner) and date leaving the rig
- The dimensions and weight of the equipment
- Container/basket number and slinging details
- Details of how the equipment is packaged
- The shipping documents following the equipment shows if the equipment is rental or not.
- Bulk products for disposal or return to supplier in accordance to buy-back agreements

Before the equipment arrives at Vestbase the logistics coordinator at Vestbase should prepare to receive it according to the Base Ops Manual (Shell, 2008). He is also responsible for deciding which transportation method ought to be used for the transport between Vestbase and vendors. When he does this he should take rental costs if there are any into account. Logistics coordinator at Vestbase requests the transport coordinator to arrange all necessary transport of materials back to the vendor or to organize disposal if needed.

6.4.2.2 *Onshore transport*

The onshore transport to and from Vestbase is carried out by a service provider. The service provider, WSR will organize the transport between the vendors and Vestbase. The contract between Shell and Vestbase gives delegates the power to Vestbase the responsibility to handle this transport. To do so, Vestbase has a contract with WSR which should carry out all onshore transport. All communication with the transporter should go through Vestbase, not Shell. The communication between Shell and the WSR about what is needed to be transported goes through the transport coordinator at Vestbase. The transporter receives a phone call from the transport coordinator the same days as the transport should be carried out. In addition to an order this call consists of:

- What to pickup
- Location for pickup and delivery
- Information about the transport
 - Size
 - Weight
 - Whether is it dangerous goods (ADR) or not?

Transportation times

Transportation time for onshore transport to and from the supply base varies dependent on local traffic conditions, frequency on ferries, weather conditions (snow or icy roads) and etc. Time of departure is also important since it affect if the truck will meet rush traffic and waiting time for ferries (reduced frequency during the night).If a truck e.g. leaves from a vendor located in Stavanger at the time so that they meet the rush traffic around Bergen the transportation time will increase.

When normal transport is used between Stavanger and Kristiansund the transport should have arrived it location no later than 48 hours after its departure and no later than 24 hours if it is an express transport.

The pricelist contains the prices for certain distances in Norway. GoogleMaps was used to find the expected driving time and distance between these locations and Kristiansund (GoogleMaps, 2010). This data is shown in Table 6-1, and Figure 6-3 show where the different locations are in Norway.

Table 6-1: The distance between Kristiansund and cities mention in the pricelist

City	Number of ferries	Distance in kilometer	Expected time
Stavanger	5	728	13 hours 39 minutes
Bergen	3	521	9 hours 25minutes
Sandnessjøen	1	656	10 hours 21 minutes
Hammerfest	6	1633	27 hours
Florø	3	348	6 hours 37 minutes

Figure 6-3: Locations of the distances found in from the pricelist



Rules and regulations concerning onshore transport

(Regulation concerning driving and resting time etc, 1993) is a regulation made by the Ministry of Transport and Communication which amongst other includes regulation of working hours for drivers. We can find that:

- Art 6.1 The allowed driving time each 24 hour is 9 hours, but this can be extended to 10 hours twice a week
- Art 7.1. After 4.5 hours driving the driver has to take at least 45 minutes break.
- Art 8.1. In each 24-hour period the driver should have a daily rest of at least 11 consecutive hours. This can be reduced to 9 consecutive hours three times a week, provided that equivalent resting time is given as compensation in following week.

Obviously, WSR has to comply with these rules. A transport with longer transportation

time than 4.5 hours will therefore have a delay of 0.75h because of the resting time. If the driving time e.g. was 7 hours the transportation time would be 7.75 hours⁷. If the driving time is above 9 hours the driver has to take a total of 11.75 hours rest⁸. When Shell uses express transport they can avoid this resting time and greatly reduce the transportation time.

Costs

The prices (appendix 1) Shell has to pay Vestbase differ, dependent upon distance and how heavy the load is. This can briefly be summarized as follows:

- Lighter or equal to 1000 kg, price is calculated by unit.
- Weight above 1000kg, but not a full truck, price is calculated by tons.
- If the vehicle is full, the price is calculated per trip

Additional to these prices Shell has to pay an extra 15% if the carrying unit/s is:

- Broader than 2.55 meters
- Longer than 13.6 meters
- Categorized as dangerous goods

The extra cost for express transport is calculated out from the transportation distance.

⁷ Driving time + resting time = transportation time, $7h + 0.75h = 7.75h$

⁸ Drive (4.5h) – rest(0.75h) – drive(4.5h) – daily rest(11h) = 11.75h

Order policies for express transport

Today, there are two main order policies for when express transport should be used. These state that express transport should be used:

- On expensive rental equipment
- To transport the new backup unit to or the old primary unit from Vestbase
- To follow the overall plan. This means that the decision maker is told that something has to be at Vestbase at a certain time; sometimes the only available option then is to use express transport.

The first of these two policies takes into account the rental cost into account, while the second takes into account the cost for a downtime at WN. The third one takes taken into the account when the decision maker is told that something has to be at Vestbase or at vendor's location at a specific time. If this is not possible to achieve with a normal transport, express transport is obligated to should be used.

6.4.2.3 *Air transport*

When it is urgent smaller items can be sent by helicopter or plane to Kristiansund airport, Kvernberget. If West Navigator has a extremely urgent situation, e.g. the breakdown of drilling equipment occur, this type of item could be transported by helicopter directly to West Navigator.

6.4.2.4 *Sea transport*

There is one vessel (Aberdeen) which leaves Stavanger every Tuesday and Thursday. This vessel transport goods between these Stavanger and Kristiansund. This ship is mainly used to transport large or bulky items which are not possible or practical to transport on a truck. The vessel uses several days between the two cities. The cost for using this ship is so high so they need at least the amount of tons equivalent to 6 or 7 truckloads to benefit from using this option.

7 Analysis of the use of express transport in Shell's upstream supply chain

In this chapter, we dig deeper into the reasons for why express transport is used. We will propose the potential reasons for why express transport is generated by taking all the parties in the upstream supply chain into consideration. The reasons for why express transport is generated are built on interviews with key personnel working within the upstream supply chain and the descriptions of the logistics parties and processes in Shell's upstream supply chain. Theories and formulas will be used to analyze and demonstrate the reasons proposed by us.

First we analyzed the historical data for the use of transportation in 2008 and 2009 and tested if there was a connection between amount of trips by express and the level of operations on WN.

Secondly we explain the main reasons leading to the generation of an express transport. These are rental cost, utilization at the rig, uncertain demand for land transport, low availability in the market and delay of material at vendor. These five reasons will be elaborated next.

7.1 A statistical analysis of the connection between the activity and the amount of normal and express transports for WN

In this section we will use historical transportation data to describe the transportation pattern for normal and express transport in the previous two years. This will give us an understanding of the usage of onshore transportation to WN. Secondly, we will use historical data to describe how the operations at WN have been in the same period.

This is done to get a foundation which we can be used to help answering our hypothesis, which states that "features in the supply chain, cause Shell to use an incorrect amount of express transport". One feature we think it is important to study is if the activity in the supply chain affects the use of normal versus express transport.

To explain this, we will analyze the amount of onshore trips and the operational activity

connected to WN, in order to find out, if the supply chain, under periods with high operational activity at the rig acts any differently than from periods with lower activity. This could be due to bottlenecks in the chain, flaws in the information systems etc.

To do this, data gathered from the transportation reports for 2008 and 2009 will be used to describe and analyze how the amount of land transport increases when the demand increases.

Tables found in this section is made from using data found in Shell’s transportation report for 2008 (Bjerkeseth, 2008) and 2009 (Bjerkeseth, 2009).Table 7-1show the data set which will be used in the analysis later in this section.

Table 7-1: Data for transportation to and from WN in 2008 and 2009

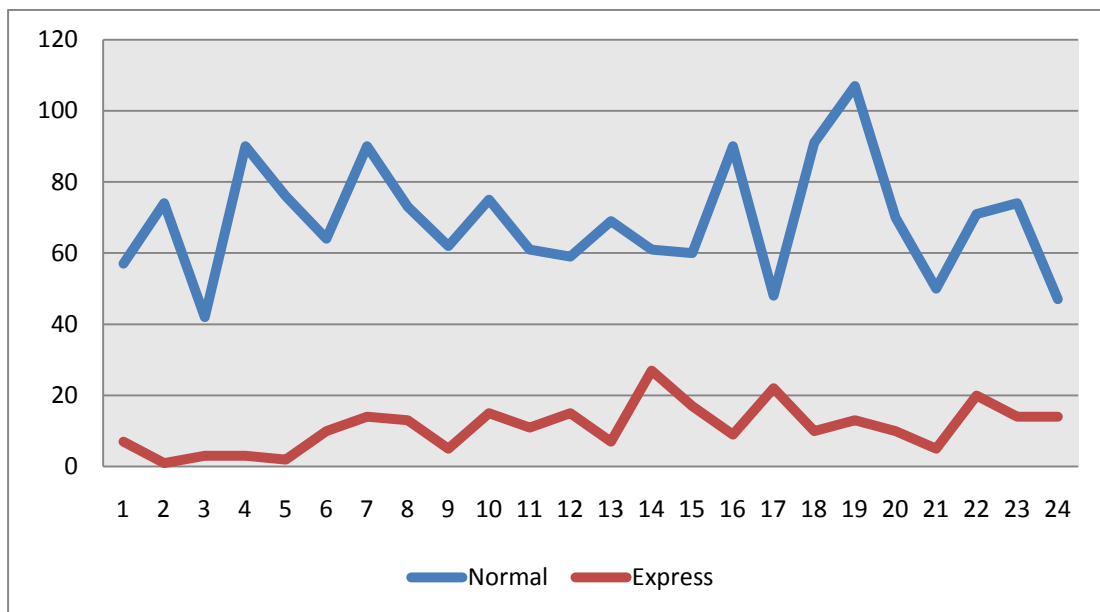
	Month	Tons	Normal	Express
2008	Jan	613.9	57	7
	Feb	1025.8	74	1
	Mar	0	42	3
	Apr	478.4	90	3
	May	601.5	76	2
	Jun	1177.7	64	10
	Jul	1433.5	90	14
	Aug	1960.1	73	13
	Sep	541.2	62	5
	Oct	2319.1	75	15
	Nov	1784.9	61	11
	Dec	1082	59	15
2009	Jan	1587	69	7
	Feb	2240.8	61	27
	Mar	1269.8	60	17
	Apr	2001.8	90	9
	May	1535.4	48	22
	Jun	2254.4	91	10
	Jul	1635.7	107	13
	Aug	1689.9	70	10
	Sep	1129.1	50	5
	Oct	2327	71	20
	Nov	1510.76	74	14
	Dec	1931.8	47	14

7.1.1 Onshore transportation usage between vendors and Vestbase

To get an understanding of the problem it is essential to know how much transportation has been used between vendors and the supply base and how it is divided amongst normal and express transport.

Based on the amount of trips by normal and express transport found in Table 7-1, Figure 7-1, was made. Figure 7-1 is a graph showing the historical development of trips by normal or express.

Figure 7-1: Number of trips to and from Kristiansund for WN in 2008 and 2009



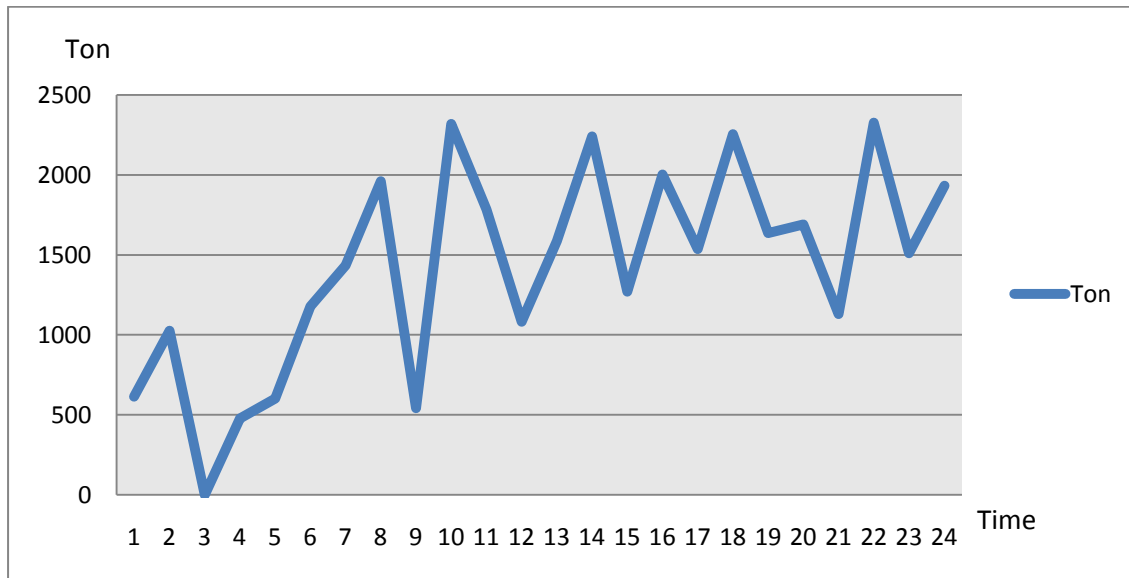
The amount of trips has been under constants changes from month to month. We can see that the amount of trips per month has been fluctuation between 42 and 107. The average per month is 69 trips. The amount of trips carried out as an express transport in the same period has been fluctuating between 1 and 27 with an average of 11 per month in this 2 year period. Both the amount of trips by normal and the amount of trips by express transport has been changing a lot from month to month. The reason for this is most likely that a trip is ordered when the rig needs it.

7.1.2 Activity on WN

To describe the activity on WN for a certain period the amount of tons will be used. Since there are no available data for the amount of tons transported by onshore transport, the

amount of tons outbound and inbound to WN will be used. Figure 7-2 show the amount of tons transported between Vestbase and WN operated from Kristiansund in 2008 and 2009.

Figure 7-2: Amount of tons outbound and inbound to WN in 2008 and 2009



If the level of activity on a rig increases the rig need more personnel, equipments, material and necessities transported out to it. When the activity increases the probability that a breakdown of equipment occurs will stay the same, but the amount of equipment used will increase and therefore the amount of breakdowns should increase. As said before, when a breakdown occurs the backup unit will be put in use and a rush order for a new backup unit will be generated. Naturally, the rig demand for material increases. This leads to the assumption that there is a positive correlation between the level of activity on a rig and the amount of on-land transport used, which means that both the amount of normal and express transport should increase when the level of activity on a rig increases.

7.1.3 Correlation between the amount of trips and activity on WM

Microsoft excel 2007 was used to draw the scatter-plot, trend line and to find the r-squared in Figure 7-3 and Figure 7-4. Figure 7-3 show the correlation between the amounts of tons transported between rig and Vestbase and the amount of normal transports between Vestbase and vendors. The trend line (linear) show that there is a positive correlation between these two variables, if one increases so will the other. But the r-squared is only 0.0718, which means that the direction of this trend line is not very solid. And it is hard to

firmly confirm that there is a correlation between ton and the amount of trips based on this data sample. This could mean that the amount of trips used on normal transport is not dependent on the amount of tons transported to and from to the rig which is rather strange

Figure 7-3: Scatterplot showing the relation between the amount of tons transported out WN and the amount of trips by normal transport

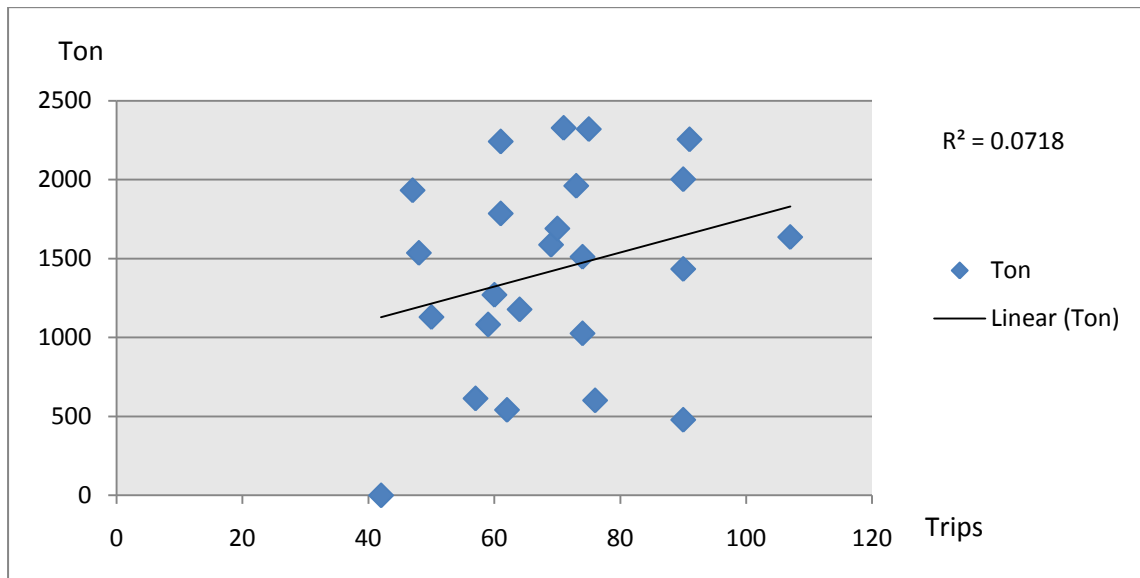
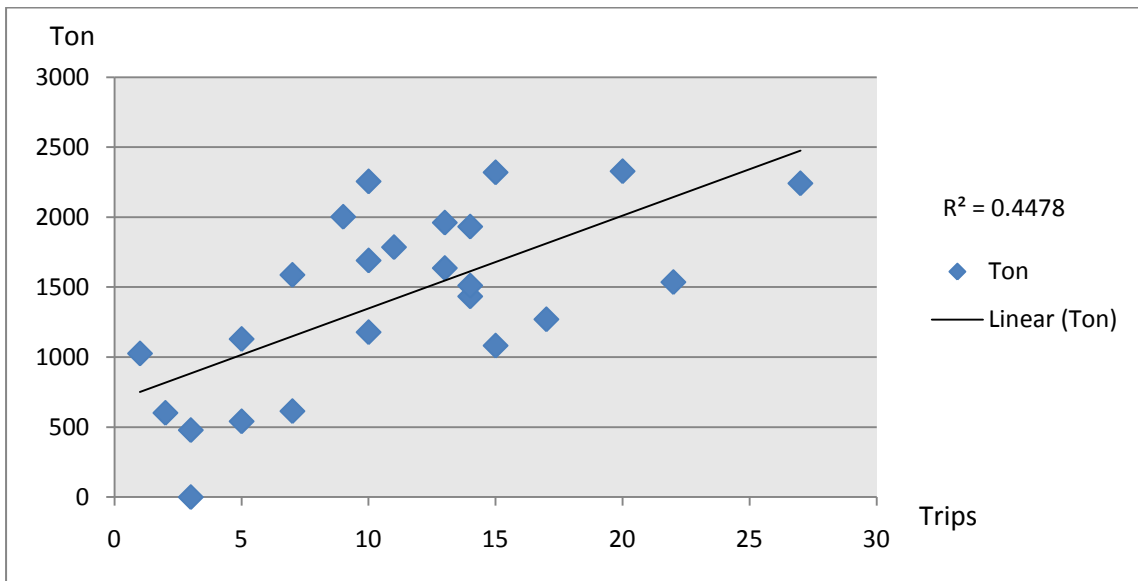


Figure 7-4 show the correlation between the amounts of tons transported between the rig and Vestbase and the amount of express transports between Vestbase and vendors. The trend line shows a positive correlation between these two. We can also see that the plots for the amount of trips by express are located closer to the trend line than it was in the scatter plot in Figure 7-3 This is confirmed by the higher r-squared value. It also seems like the correlation between ton and express transports is higher than the correlation between ton and normal transports

Figure 7-4: Scatterplot between amounts of tons transported out to WN and the amount of express transport



Pearson’s correlation coefficient is used to determine the linear correlation between two data sets. When the coefficient is calculated it becomes a number between -1 and 1. The coefficient can be interpreted as follow:

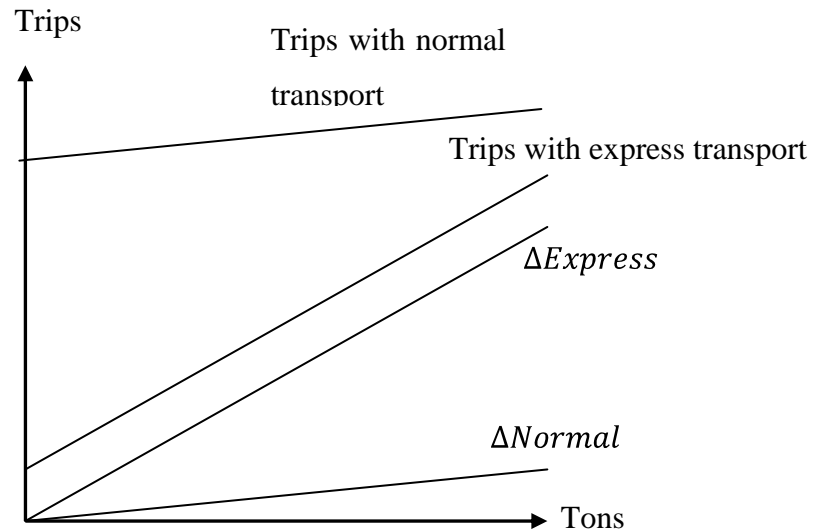
- There is a perfect correlation between the two variables if it is 1, e.g. if A increase by 10%, B increase by 10%
- There is a perfect negative correlation between the two variables if it is (-1), e.g. if A increase by 10%, B decrease by 10%
- There is no correlation between the two variables if it is 0.

Pearson’s correlation coefficient between trips by normal or express transport and tons transported to or from the rig for West Navigator is shown in Table 7-2. This coefficient is calculated by using the “correlation” formula in excel. The amount of trips with normal and express transport both increase if the demand for the platform increases, which is an expected result. It also shows that if the operations WN increases, the amount of express transport will increase more than normal transport. Figure 7-5: illustrates as the change in express and normal transport when the amount of ton increases. Figure 7-5: also shows the amount of trips with express and normal for a certain amount of tons.

Table 7-2: Pearson's correlation coefficient between trips by normal and express and ton

	<i>Express</i>	<i>Normal</i>
Ton, WN	0.67	0.27

Figure 7-5: Trips and operational activity



The fact that, there is a stronger correlation between the operations at WN and the amount of express transport than the amount of normal transports and express transport is not an expected result.

It could be that when the operations increase, the demand for units requiring express transport increases more than the demand for units not requiring express transport. It could also be that there are some features in the supply chain which makes them order more as express when the activity is high. It could be that a high pressure on the chain leads to an increased amount of express transport contra normal transport

The relation between the amount of normal transports and the amount of tons is almost non-existing. This could be because of the amount of tons transported is the total amount not only the amount for onshore transports.

This analysis is therefore unable to answer if there is a difference between the operations

at WN and the share of express transports out to the rig. To be able to do this the amount of tons transported in the onshore transport should be used. But this amount is not available today. As a result, we chose to disregard to use the operational activity at WN as an explanatory variable in the future study.

7.2 Analysis of the reasons triggering an express transport

7.2.1 Utilization at WN

All the interviewees said that one of the most important reasons for why express transport is used is to avoid downtime for the rig, or to keep the utilization high. But what do they mean by this? Utilization is a measurement over how much of the total time something is in use in one time period. For the rig the utilization in one period (t) can be described as:

$$Utilization_t = \frac{\text{Time the rig is in drilling or testing mode in period } t}{\text{Total time available in period } t}$$

When a downtime occurs the time spent on drilling or testing mode decrease, while the total available time stays the same. When this happens, the numerator in the fraction is reduced while the denominator stays constant. A downtime is therefore something which affects the utilizations of the rig.

7.2.1.1 Operational and non-operational downtime

Downtime can be divided into two parts operational downtime and non-operational downtime. Operational downtime is a stop in the drilling or testing operations because of operational needs such as to sail between different subsea templates, start drilling on a new well, start drilling on a new section and etc. This downtime is a part of the day-to-day operations at the rig and is not a part of what the interviewees meant by downtime at the rig.

Non-operational downtime is when an accidental or a stochastic event occurs. These events could be caused by e.g. weather or sea conditions which are possible to predict. The problem with the weather conditions is that it is hard or even impossible to change the effect it will have on the operations. Non-operational downtime is also caused when events

which are not possible to foresee, like a breakdown of drilling equipment or a breakdown of a thruster at the rig, is going to occur

This could be weather and/or sea conditions which are possible to predict, but it is hard or impossible to change the effect it will have on the operations and events with a high level of uncertainty and not possible to foresee like when a breakdown of a drilling equipment or breakdown of a thruster at the rig is going to occur.

Uncertain weather conditions

The weather conditions at the Ormen Lange gas field and the path between the supply base and the gas field varies between more or less unproblematic to incredibly harsh conditions, such as high wave height, sea currents, high wind speeds, lightning storms, fog etc.

For the supply vessel these conditions could lead to a delayed departure time from Vestbase, increased sailing time to and from the gas field, waiting time at the gas field for the weather to calm down before the loading/unloading can begin and delayed arrival time at Vestbase. A helicopter is prohibited to fly under certain weather conditions like high wind speeds, lightning storms, fog, ash clouds etc. It is also not allowed to land if the wave high is too high. This will result in an increased transportation for equipment between Vestbase and West Navigator and therefore an increase in the total transportation time in the outbound and inbound material flow.

For West Navigator, harsh weather conditions can result in that the drilling operations have to be put to a halt. It also means that the cargo scheduled to be loaded/unloaded from the rig is delayed, which can result in a stockout. The reasons for this is that the drilling operations are more robust than the process of load/unload cargo between the supply vessel and the rig. Each time West Navigator has to stop its drilling operations due to weather conditions affecting the rig or weather conditions affecting the delivery of supplies results in a change in the POB planner.

How often the rig has to put its drilling operations to a halt because of bad weather can be found in the planning tool “operational lookahead”. The time this event occurs and how long the rig has to wait because of weather conditions is marked in this planning tool as

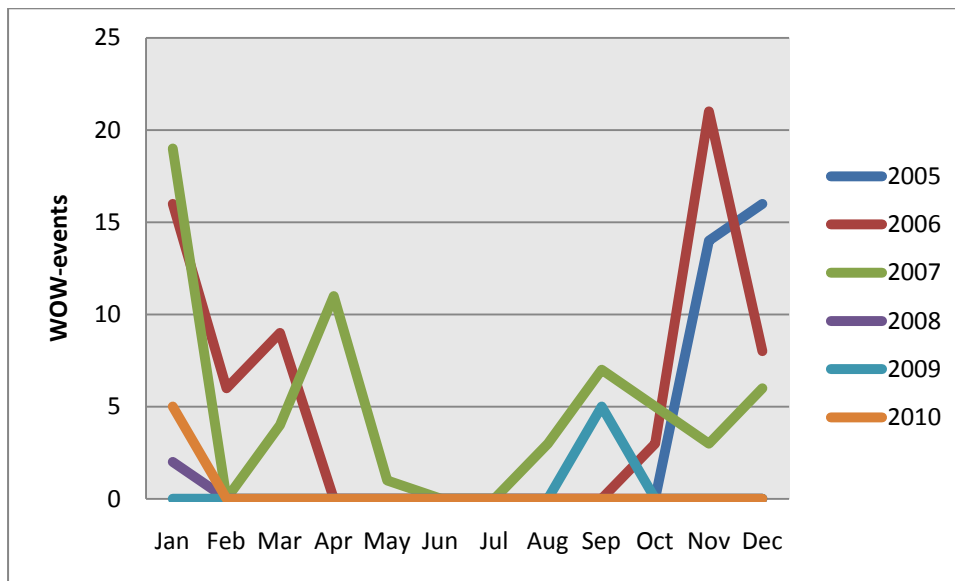
waiting on weather (WOW). When operations at the rig are put at a halt because of a WOW-event it will cause a non-operative downtime. This stop at its own does not create an express transport, but the fact that it may occur creates uncertainties in the drilling operations and consequently, uncertainty in the demand for equipment. Since the operations at the rig can be carried out under worse weather than the transfer of cargo between the supply vessel and the rig, the amount of times a supply vessel has to wait at the rig to unload its cargo is larger than the amount of WOW-events a rig encounter.

The planning tool also contains the actual time the rig had to wait when a WOW event occurred. This planning tool does not contain data for the operational activity from 21/07/08 to 25/09/09. The incomplete data sample for 2008 and 2009 makes it hard to compare it with the historical data found in the transportation reports. But, it can still be used to describe a part of the uncertainty in WN's demand, which is caused by the sudden stops in the operations.

- The “Dual Derrick” contains data for the activity for WN from it started to drill at the Ormen Lange gas field to 21/07/08.
- The Operational Time Breakdown” contains data for the activity on the rig from 25/09/09 to 16/03/10. The rig had a
- No data is found for the activity on the rig between these two time periods is found in the planning tool.

Figure 7-6 show how the WOW-events are divided in the time period. WN did not start to work on the Ormen Lange gas field before October 2005.

Figure 7-6: Amount of WOW-events from 2005-2010



Amount of WOW-events per month varies a lot during his 5 year period. The peak was in Nov 2006 with 21 WOW-events. From the table it seems that the highest amount of WOW-events occurs in January, November and December.

WN, which is looked upon as the customer in the upstream supply chain has all the power in the supply chain, and all the other parties does what they can in order to satisfy the customer. West Navigator has a high level of uncertainties in the demand pattern and therefore requires an agile supply chain in order to keep the utilization high. This demands that the planning horizon from a demand is created at the rig until it is satisfied by the supply chain is low.

7.2.1.2 *How does a downtime at WN affect the upstream supply chain?*

A reduced utilization of a rig affects many aspects of the upstream supply chain as well as the profitability for Shell. A downtime for the rig causes it to use more days to perform a task than it would without the downtime. In other words, the production output from the rig decrease if it encounters a downtime.

Even if a breakdown of equipment results in a short downtime for the rig the transports towards Vestbase might not stop. As a result a larger inventory of both non-rental and rental equipment may be held at Vestbase which will increase the rental and inventory

holding cost.

If the downtime is longer, for instance when WN needed a new thruster and was laying at quay in Kristiansund some of the equipment was sent back to the vendors to reduce the inventory and rental cost for it. This leads to an increase in the number of trips and consequently increased transportation costs for Shell.

Costs associated with operating a drill rig is enormous, just the daily rent for WN is 594,000 dollar a day (Seadrill, 2010) the additional logistical costs as well as the reduced productivity at the rig makes it of immense importance to keep the productivity at the rig as high as possible.

The unpredictable weather conditions at Ormen Lange gas field, along with the probability of a breakdown of drilling equipment, makes the planning for WN's operations difficult, and changes in the plan is often made. This is confirmed by looking at the "POB and materials" which changes many times within a week, or even within a day. This makes it hard for Shell to be in an ideal situation. One of the goals needed to be fulfilled to be in this situation is explained by Knill in 1992 as: "Parts and components are delivered on time, in the proper sequence, exactly to the point they're needed" (Knill, 1992).

For Shell to be able to fulfill this goal they need to deliver the equipment to the rig exactly when it is needed. To do this when the demand for the rig can change after the order for equipment is made is not achievable. There either nothing to do to avoid the affect weather or breakdown a breakdown has in on the activity on the rig. Consequently, Shell has to deviate from this goal and settle with the second best.

The second best can be achieved by having the best supply chain performance. For shell, this means to have an integrated and agile supply chain with a low lead time is a must. The use of express transport helps Shell to reduce the lead time needed. The use of express transport is therefore necessary to achieve a good supply chain performance, and satisfy the customer.

Shell has several procedures to help prevent a downtime-event at the rig. One of these is

to always have a safety stock of one unit per type of drilling equipment while the rig is in drilling mode, one primary and one secondary. If the primary unit has a breakdown the secondary unit will be put in use and an order will be put out for a new secondary unit. The rig's downtime will then be decided by the time from a breakdown occurs until the backup unit is in use and how long it takes for a new backup unit to be shipped out to the rig. The specific unit will not cause any downtime for the rig as long as the new primary unit does not have a breakdown while the new secondary unit is in transit to the rig. Consequently, the time between the order is generated and the new secondary unit has arrived the rig is essential since an increase in time here will increase the probability of downtime at the rig. As a result the probability of a downtime at the rig is dependent on the transportation time in the outbound and inbound material flow.

Today, express transport is used to decrease this transportation time. If the rig is using the backup unit a new backup unit is sent by express so that the rig gets it as fast as possible. This means that express transport is independent of what the probability of that specific unit breaking down is. This rule also does not concern about the remaining time that specific equipment type is needed on the rig. As a result, the new backup unit might be shipped out to WN. But, when it arrives at e.g. Vestbase WN's demand has been altered so that they no longer need that unit. The supply chain has then generated an unnecessary express transport.

7.2.1.3 *Uncertain demand for onshore transport*

The transport coordinator at Vestbase does know when equipment planned to be used at the rig is supposed to be at Vestbase before a specific order is received from Shell.

For example, the transport coordinator may receive an order for equipment that should be at Vestbase tomorrow. The time from the transport coordinator receives this order to the equipment ordered should be at Vestbase could be lower than the transportation time with a normal transport. An express transport could then be the only available option to fulfill the order.

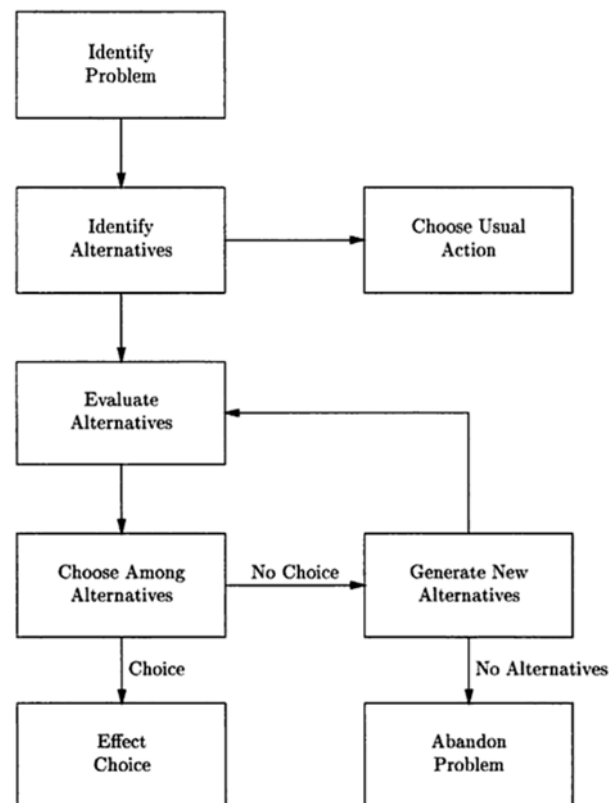
Decision making process

We have chosen to use a decision-making process to analyze how Vestbase decides to use express transport when a short time period occurs. In the following, firstly a model for a decision-making process is going to be introduced. Secondly, it will be demonstrated how the decision-making process at Vestbase is being conducted when an order for a transport is received.

Slade introduced a decision making process in 1994 (Slade, 1994). This process is shown in Figure 7-7 and it consists of different steps which have to be taken in account in order to make a decision. The model is elaborated below.

Effect choice: Once a choice has been made, it needs to be put into action (Slade, 1994). The next step is to execute the plan meaning that an agent can perform an action that will achieve the goals of the choice (Slade, 1994). The agent may be expected to provide an explanation for the decision if the action is unexpected or has adverse consequences for others (Slade, 1994). This will be when the transport coordinator tells the transporter which transportation alternative they should use and when material is going to be picked up.

Figure 7-7: Decision-Making Process (Slade, 1994)



Generate new alternatives: The best alternative may be not good enough so the agent may wish to try again by generating new alternatives which will be evaluated as the same as before (Slade, 1994). In the long term basis new alternatives can be developed, but for the instance when the transport coordinator receives an order the choice has to be done between the given alternatives, express or normal.

Abandon problem: If no satisfactory alternative is selected, the agent may choose to abandon the original problem (Slade, 1994). This is not be an option since the goods has to be transported.

In addition to be made to convey as a wide and general scope for decision making this model can be used in an isolated analysis which reduces the alternatives to one solution (Slade, 1994).

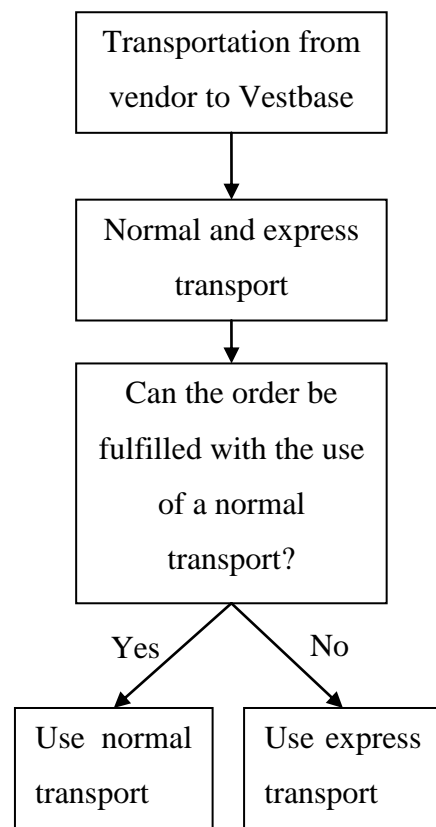
With regard to uncertainty in the environment, the agent may most likely choose to keep mind open and plan for more than one alternative at the same time.

Decision-making process for transportation for Vestbase

In the following the model introduced by Slade (1994) will be used to create figure illustrating Vestbase’s decision making process after receiving an order. This process only looks at the time an order is received, the transportation time between a vendor and Vestbase and the delivery time at Vestbase. The decision process for the transport coordinator is:

From the graph it can be seen that, Vestbase evaluate two transport alternatives before they make a decision.

The decision is highly dependent on how long in advance Vestbase receives the order and the transportation time between vendor and Vestbase. If Vestbase receive an order and the transport coordinator in Vestbase find out that normal transport may not let equipment reach Vestbase in time, express transport would be chosen as the only available transport alternative which can satisfy Shell’s order. For example between Stavanger and Kristiansund, if Vestbase receives an order from Shell two days before the equipment has



to be at Vestbase, as it is known the driving time is 13.65 hours, with the breaks a driver needs for this distance (11.5 hours) this time will approximately 25.15 hours. Waiting time for ferries is not included. The transport coordinator will use a normal transport for this situation. But if the equipment need to be at Vestbase in 24 hours, then express transport is the only available option to be used.

7.2.2 Rental cost

The oil and gas industry in Norway is built so that the oil company which operates the rig rents expensive rental equipment from a third-party supplier. This gives the oil companies a reduced initial investment cost and they do not have to worry about the maintenance of the equipment, but in return they have to pay a rental cost to be allowed to use it. The rental cost in this case is what Shell has to pay to rent equipment from a vendor.

The daily rent during transport is the number one reason for why express transport is used within this supply chain on some of the equipment is the main reason to why express transport is used within this supply chain. The rental cost is determined by three parameters. Firstly, the rental cost depends on the rent per unit of time for the unit. This parameter varies between the different unit types and for which section it is going to be used in. it can be all from a couple of thousand to above 60 000 NOK a day. Secondly, the rental cost depends on how long time Shell uses the unit while it is under rent. Thirdly, the rental cost depends on when the rent is counted. On this area the contracts are designed differently between vendors, so the time when a rental start and stop vary. The starting time can be all from when the equipment is picked up at vendors place, arrive at Vestbase, arrive at rig to it is put in use on the rig. The ending time can be when usage stops at the rig, it is loaded of the rig, arrive at Vestbase or when it arrive at vendor. Because of this, shell sometimes has to pay rental for equipment on a land transport.

Today's rule for transportation of rental equipment states that express transport should be used to decrease the transportation time for costly rental equipment. As a result an express transport is used for costly rental equipment to reduce rental paid for it.

7.2.2.1 ***Order policy for rental equipment***

Currently, there exists no concrete value for what expensive rental equipment is. This means that the decision maker for express or normal transport has to take this decision based on an assumption on what this value is. In addition to this, the documents sent with the container, shipping manifest or the new equipment tracker, only show if the equipment is on rent, not the rental price. Thus, the decision maker does not know how much the daily rent is for the equipment. This information has to be obtained by a call to either the onshore coordinator in Stavanger or the offshore coordinator at WN. This could lead to that the decision maker will base his knowledge about the rental cost on a previous call to one of these two. This could be summarized as:

- The decision maker does not know the value for highly expensive rental equipment
- The knowledge about rent is based on previous knowledge about the rental price

Consequently the decision for the use of normal or express transport will be based on decisions made prior to the current. The problem with this situation is when a decision should be made for equipment with neither low nor high rent, or the decision maker does not know the newest daily rent for the equipment when a decision is made. The decision maker then has to assume that the rent is either lower or higher than the limit for “expensive rental equipment”. This could lead to that an express or normal transport is generated when it would have been beneficial to use a normal or an express transport, which could cause the supply chain to use too many or too few express transports.

More information at the decision maker could help reducing this affect in the supply chain.

7.2.3 **Low availability in the market**

Low availability in the market means that a vendor is not ready to deliver a unit when he receives the order from Shell.

To be able to transport a unit out to the rig Shell need a vendor to supply them with the unit. For the vendor, to be able to do so they first need to have it in the inventory, this is not always the case. Drilling equipment is often associated with a costly investment and

the vendor does not always have a unit of the same type available, the availability in the market is therefore low.

If this is the case Shell can send the broken unit back to the vendor so that the vendor can repair it. After it has been repaired the unit can be sent out to the rig following the normal transportation channels.

When the availability in the market is low, Shell has to wait for the vendor to receive a new part or send it back to the vendors and wait for them to repair it. Hence, the time between the order is generated and the new secondary part arrives at the rig is therefore dependent on:

- The time it takes to transport the unit back to the vendors
- The time it takes to repair it at vendor's place
- Transportation time out to the rig

Thus, the utilization of the rig is dependent on the transportation time in the inbound material flow which puts a pressure on the on-land transport to be carried out as an express transport instead of a normal transport.

7.2.3.1 *Why is it low availability in the market?*

Vendor's goal is to maximize annual profit as the same as other parties in upstream supply chain. Cost benefit analysis and inventory theory with relevant formulas are going to be used to analyze the reasons for low availability at the vendor.

Cost benefit analysis (CBA) is a method developed for the evaluation of policy issues. In this methodology, potential gains and losses from a proposal are identified, measured, and compared during a lifetime of a project (F.Nas, 1996). In the same book, Nas (1996) introduces the formula of measuring net present value with discount rate as a variable:

$$NPV = -I_0 + \sum_{n=1}^N \frac{NB_n}{(1+r)^n}$$

NPV Net Present Value

I_0 Initial investment cost in period 0

N Lifetime of the investment

NB_n Net benefit in each period

r Discount rate

In this analysis the initial investment cost must be lower than the net present value of the future cash flow generated by the investment for the NPV to be positive. A positive NPV says that the company will get more back from the investment than just keeping the money in a bank account, or give it as a dividend to the owners.

Operating profit and inventory turnover

In the Cost Benefit Analysis above, utilization and inventory holding cost have been mentioned, but there are other factors which more directly affect the vendor to cut the inventory holding cost and raise equipment utilization.

According to Silver 1998 income statements stand for the flow of revenue and expense for a given period (Edward A.Silver, David F.Pyke and Rein Peterson, 1998). In the same book they introduced a formula for how to measure operating profit which can help to explain decisions made by the vendors. This is as follows:

$$\textit{Operating profit} = \textit{Revenue} - \textit{Operating expenses}$$

For a vendor, gaining higher operating profit is one of the main objectives. The operating profit formula indicates that, if a vendor wants to have a higher operating profit, the revenue must be increased or operating expenses must be decreased or both. Increasing the revenue means having more sales, or to sell the same amount for to a higher price. Allocating inventory among different items in an improved way may also result in an increase of revenue (Edward A.Silver, David F.Pyke and Rein Peterson, 1998). For a vendor this means that they would like to have the part as a rental as much of the time as

possible.

Lowering the operation expenses is possible by cutting the inventory costs by lowering the inventory level, which is a significant component to the operation expenses (Edward A.Silver, David F.Pyke and Rein Peterson, 1998). This can be done by keeping fewer parts in the inventory at a certain time.

A vendor supplying Shell with equipment will only invest in new equipment if he thinks that it will generate a positive NPV. If vendor purchase too many equipments the utilization of the equipment will decrease. As a result there will be idle equipment in the vendor's inventory and the income in period n from one unit will decrease while the inventory holding cost will stay the same. This will reduce the NPV of the investment. In this analysis the initial investment cost must be lower than the net present value of the future cash flow generated by the investment. An investment generates a profit if the NPV is positive.

When a vendor invests in a new unit it will cause consequences such as

- Utilization units in of the same equipment type will diminish, so that it reduces the rental income per type of equipment.
- Inventory holding cost increase considerably, since utilization of equipments decreases. If new purchasing makes rental equipment idle in the inventory, it may be a huge loss for vendor.
- High capital cost for the purchasing value of the unit.
- Increase in income

How to reduce the effect?

Shell uses express transport to decrease the transportation time in the inbound material flow so that the vendors receive the equipment faster and are able to deliver it more rapidly back to Shell. After that Shell can choose to use either normal or express transport to rig.

The low availability makes the amount of express transport increase for Shell. But to do something with this option will be rather hard. It could be possible for Shell to help the vendor to invest in new equipment, but many unknown will arise with such an

arrangement.

- How much do Shell actually save is hard to know
- How much and how should Shell help the vendor?
- Do the vendor have to do something in return
 - Should the equipment be reserved so that only Shell can use it?
- Should shell cooperate with other operating companies to help the vendor purchase the unit?

The sum of these unknowns will most likely make this arrangement unfeasible for Shell, and this study will not go deeper into this issue.

7.2.4 Delay of material at vendor

If the transporter is told to pick some equipment up at a vendors place, and the package is not ready when it should be the driver has to wait. And the waiting time count as working time for the driver. Hence the allowed driving time is reduced. Dependent on the distance and how long the driver has to wait they might have to switch drivers before the transport can start or switch on the road to Kristiansund.

7.2.4.1 *How does it affect upstream supply chain?*

When a delay occurs, the transporter might have to change driver before the vehicle arrives at Kristiansund. Since waiting time counts as working time for the driver, the allowed driving time can be found by subtracting the waiting time from the allowed driving time for one day.

$$\textit{Driving time} = 9 \textit{ hours} - \textit{Waiting time}$$

For distances close to 9, 18 or 27 hours the waiting time is crucial. The reason for this is that the waiting time can easily make the available driving time so low that the driver has to take his first, second or third daily rest before he arrives Kristiansund. This will cause a delayed arrival time at Vestbase and might lead to a non-operational downtime at the rig. To solve this, it is possible to change the driver of the vehicle during transport. The cost Shell pay for this is the same as when an express transport is ordered.

Express transport diminishes transportation time from vendor to Vestbase in order to make equipments arrive at Vestbase on time. To some extent, for reducing the effect caused by ‘delay of material at vendor when driver has arrived’, express transports have been seen as a last resort which has to be taken to ensure equipments arrive at Vestbase on time. Shell is supposed to use normal transport for delivery of equipments, however delay of material at vendor situation forces Vestbase to use express transport.

7.2.4.2 *Low level of information sharing between Shell, vendors and Vestbase*

An agile supply chain need companies to share the information, cooperate with each other on logistic issue, etc. Especially, in an upstream supply chain like the one in the oil and gas sector, sharing information of between Shell and vendor is of importance to relevant parties to make an agile upstream supply chain with high efficiency and effectiveness.

Currently, there is no exchanged information system used by Shell and vendors which can display equipment readiness. Shell is not able to know exactly how far in the future a vendor will make equipment ready to be rented out, and there is no real-time monitoring system that can let Shell observe the progress of equipment maintenance and repairing. So it is hard for Shell and vendors to make the information flow fluent between the two parties in term of rental equipments’ readiness. The level of information sharing is fairly low. Therefore, a situation may occur that when a driver has arrived at a vendor’s location, and is about to pick up the equipment, the driver is told that the equipment is still in the process of repairing.

The low level of information flow between Shell and vendors may generate and aggravate a ‘Delay of material’ situation. That is, Shell makes an order and the vendor confirms that it will be ready for pickup at a certain time. But if it is not ready when the driver arrives it may cause extra working time for the driver and generate an express transport.

Comments associated with newly introduced system

A new booking system for transports was introduced when the new transporter was selected at 1st of March 2010.

The new system for Vestbase is a web based booking system, instead of the old system

using emails and calls. It makes it easier to store and export historical data, it is also better for collecting of historical data of transportation for future research on express transport. The new process is

- A: The transport coordinator at Vestbase receives mail from ‘Admin-booking’ which is an automated system where suppliers communicate the information about equipment that is ready to be picked up. All relevant logistics information such as weight, pick-up address, delivery time etc can be found there.
- B: The transport coordinator Vestbase puts this information into a WEB booking system. The information goes directly to the new provider of transportation services which is Greig Transport.
- C: The transport coordinator at Vestbase receives a confirmation that the order is being processed.
- D: If it is necessary to follow up the transport the transporter will send the transport coordinator emails with updated information. The transport coordinator can also follow the transport in the Track & Trance system

Still, there is one problem that the current system cannot display the progress and readiness for the equipment at the vendor. Hence Vestbase cannot make a plan until the new order message from Admin-booking has arrived. The new system does nothing with the old issue where the transport coordinator gets an order the day before the equipments should be at Vestbase.

7.2.5 Do these reasons answer or hypothesis?

From the reasons discussed above it seems like there are some truth in our hypotheses. The causes described in this chapter are summarized below:

- The decision maker does not know what the exact value for expensive rental equipment is.
- The current order policies does not care about the fact that it might be possible to not use express on some of the new backup units, or not transport it at all. This could be if:

- There is a low probability of a downtime occurring caused by the specific unit
- There is a low remaining demand for the specific unit at WN. This means that that the rig could stop using the primary unit before the backup unit has arrived. The transport for the new backup unit would then be unnecessary.

It is also the strange that the amounts of express increases, while the amount of normal transports stay more or less the same when the amount of tons transported out to the rig increases.

Based on these causes we will assume that our hypothesis is correct. Hence, Shell uses an incorrect amount of express transport, and the supply chain performance could be improved.

8 Suggestions to increase the supply chain performance

The goal with this chapter is to give suggestions to how the supply chain performance for Shell can be improved, based on the reasons which cause the supply chain to use an incorrect amount of express transports.

First will a decision tool which can be used by the decision maker for when express transport should be used or not presented. Afterward a suggestion to how the contracts between Shell and the vendors can be improved is presented.

8.1 Development of a decision making tool for the decision maker

To remove some of the effects caused by high rental equipment an option could be to implement some sort of a decision tool for the decision maker. This chapter will present such an idea. This chapter will discuss how the current order policies affect the system and how the tool can be used to improve the system.

When a choice to either use normal or express transport arises, the goal for the decision maker should be to minimize the logistical costs. Logistical cost is a term describing the cost associated with transporting something from A to B. This cost often includes aspects such as

- Inventory carrying costs are the cost for carrying an inventory from period t to period $(t+1)$
- Transportation costs are associated with the transport of units between different locations.
- Administrative cost which is the costs of managing the logistics, these costs can among other be the cost for placing an order, controlling the products and etc.
- Stockout costs are costs which occur because of stops in the production or lost sales due to a stockout for a unit type.

The relevant logistical costs when Shell has to choose between using express transport or not, is the cost for:

- A downtime at the rig,
- The rental cost during transportation between a vendor and Vestbase
- The increase in transportation costs.

If the decision maker is able to minimize the logistical costs when he makes the decision to use express transport or not he will act according to Shell's best interest. But this is not always that easy. To make the correct decision requires that the decision maker has all available information, at the correct time and is able to use this to make the best decision. To have this, real life setting without the help of a decision is hard.

8.1.1 Current order policies

The model will be based on two of the three order policies mentioned in section 0. The third order policy is affected by the time from the decision maker receives the order and how long it is until the transport should be at Vestbase or the vendor. The decision maker cannot reduce the amount of express transport caused by this reason. It will therefore not be included into the decision tool.

The first two of these policies are directly affected by a cost element. These are that express transport should be used on expensive rental equipment and on the transportation of the new backup unit. Why these two is chosen and the importance of being able to make the correct decision is elaborated below.

8.1.1.1 *Backup units shall be transported by express transport*

This order policy is based upon the daily downtime cost for the rig. It assumes that the cost is so immense that express transport should always be used to decrease this cost.

1. New backup unit will be sent by express to keep the utilization at the rig high.

This decision is made independent of the "expected downtime cost" and the fact that this varies across the different unit types. And can cause express transport to be used too much in the supply chain.

But is this true that the cost of a daily downtime is so immense that it is beneficial to send

all backup units with express? If this cost were so immense, why doesn't Shell send out one primary, one backup and a second backup unit? One obvious reason is that the rig's storage capacity is too low to store two backup units. But this could be avoided by storing it at Vestbase or at a supply vessel laying in the proximity of the rig. The second reason is that the cost of doing so is too large. If this is true shell has valued the benefits (reduced downtime cost) less than the increase in costs for the extra storage capacity. Based on this, it could be valid to use the expected downtime cost as a decision variable, even though it might give a solution when express transport is not used to transport the new backup unit out to the rig.

8.1.2 Logistical costs connected to onshore transportation

This chapter will present relevant logistical costs with the order policies. By relevant means, cost that will change if a normal or and express transport is use. Hence, other costs like e.g. the cost for a supply vessel will not be included since it does not influence the decision. The first two costs are influenced the order policies described above, while the third affect the transportation costs.

8.1.2.1 *Expected downtime cost for the rig*

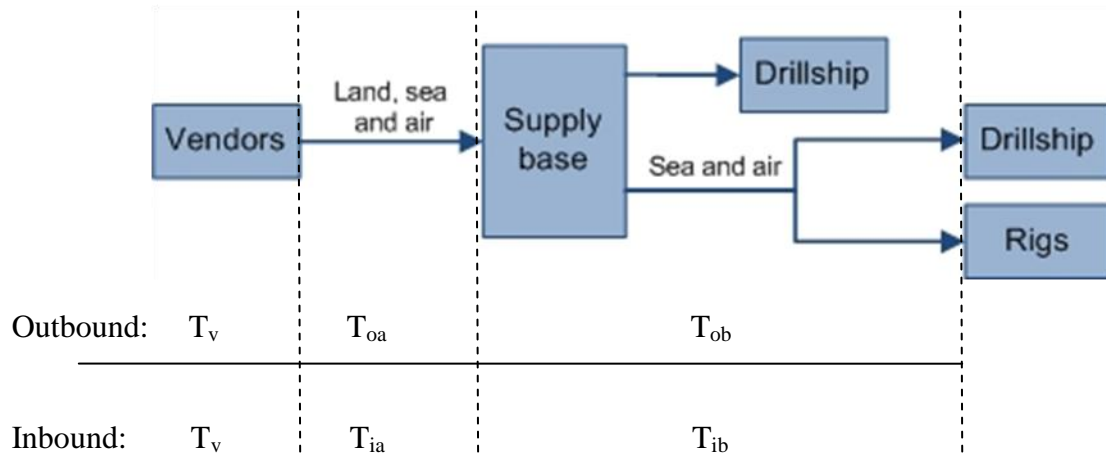
If Shell should prefer to use a normal transport to transport a new backup unit out to the rig, the expected benefits in doing so has to be higher than the costs. Costs associated with this option are the expected cost for a downtime at the rig, logistical costs and rental costs. Denotations used:

o	If it is in the outbound material flow
i	If it is in the inbound material flow
T	Time in days
ao	From a truck leave a vendor until it arrive at Vestbase
ai	From a truck leaves Vestbase until it arrive at a vendor
bo	Everything after a truck arrives Vestbase
bo	Everything before a truck departure from Vestbase

v	At Vendor
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Figure 8-1 Illustrates where the different notations in the material flow

Figure 8-1: Outbound material flow



Transportation time for a spare part transported from vendor to the rig can then be written as:

$$(1) (T_{oa} + T_{ob})$$

The transportation time in the inbound material flow can be written as:

$$(2) (T_{ia} + T_{ib})$$

The transportation time for a new unit is only dependent on the time in the inbound material flow if the availability in the market is low. To describe this δ_A is multiplied with equation (2). δ_A . It is a binary variable which can be either [0,1]. If it is 0 the unit is available in the market and if it is 1 the unit has to be sent back to the vendors before it is transported back to the rig. The transportation time in days is then the transportation time in the outbound material flow plus the transportation time in the inbound material flow if it is a shortage in the market.

To find the total time from a unit leaves the rig until a new backup unit has arrived the time a vendor uses to prepare the broken unit is also of importance, and, is denoted as T_v . The total time before a new backup unit has arrived the rig, if the unit must be sent back for repair, is then:

$$(3) \text{ Transportation time in days for a new unit} = (T_{oa} + T_{ob}) + (T_{ia} + T_{ib} + T_v)$$

A downtime at the rig caused by the lack of a backup unit could occur if the un-use backup unit has a breakdown while the new backup unit is on its way to the rig. To describe this, P_j is used as the probability of a breakdown occurring on unit j during one day. The probability of a downtime at the rig can then be written as probability of a breakdown occurring on unit j multiplied with the number of days without a spare part:

$$(4) \text{ Probability of a downtime at the rig} = P_R = [(T_{oa} + T_{ob}) + \delta_A(T_{ia} + T_{ib} + T_v)]P_j$$

An express transport will in most cases only reduce the transportation in the inbound and outbound material flow T_{i1} and T_{o1} between vendors and Vestbase with one day. For the sake of this model it will be assumed that the time used at T_{i2} and T_{o2} stays constant no matter which transport alternative between vendors and Vestbase that is used.

The question is then how much the cost increases if the probability of a downtime for a rig increases? This could be described as the expected cost for a one day downtime. To find this value equation (4) is multiplied with the cost for a daily downtime (C_R).

Expected cost for a one day downtime $E(C_R)$

$$(5) E(C_R) = [(T_{oa} + T_{ob}) + \delta_A(T_{ia} + T_{ib} + T_v)]P_j C_R$$

Equation (5) shows that the expected cost for a one day downtime at the rig is decided by the transportation time in the inbound and outbound material flow, availability in the market, the probability of a breakdown for the backup unit and the daily cost for a downtime at rig R .

8.1.2.2 *Rental cost between vendors and Vestbase*

It is not certain that equipment transported from a vendor to Vestbase with rent has a rent when it is transported back from Vestbase to the vendor. Two decision variables will therefore be needed, one to describe if rental starts at vendor in the outbound material flow (δ_{or}) and one to describe if rental ends at vendor in the inbound material flow (δ_{ir}). These two variables are 1 if rent start or end at vendors place, 0 otherwise. The daily rental cost for the equipment will be denoted as (R). It will be assumed that the cost is constant from rent start until it ends. Rental cost will then be transportation time in days multiplied with daily rent and the decision variable. The rental cost during transportation in the outbound and inbound material flow becomes:

$$T_{oa}R_{sv}\delta_{or} \quad \text{and} \quad T_{ia}R_{ev}\delta_{ir}$$

- R_{sv} the rental in the outbound material flow which starts at vendor
- R_{ev} is the rental cost in the inbound material flow which ends at vendor

Expected rental cost between vendors and Vestbase (C_r) is:

$$(6) C_r = T_{oa}R_{sv}\delta_{or} + T_{ia}R_{ev}\delta_{ir}$$

8.1.2.3 *Transportation costs*

To use a normal or an express transport between different vendors and Vestbase also depends on the extra cost an express transport adds to the logistical costs.

Table 8-1 show the cost for a trip done by normal or express transport between Kristiansund and 5 other locations in Norway. These costs will be inserted into the model as C_{tn} or C_{te} . C_{tn} is the cost if a trip is done by normal transport and C_{te} will be the cost if a trip is done by express transport.

Table 8-1: Transportation costs between Kristiansund and other locations in Norway for normal and express transports

From Kristiansund to:	Normal	Express
Stavanger	17690	24641
Bergen	12004	16428
Florø	10741	13900
Sandnessjøen	12004	15794
Hammerfest	35380	54334

A decision variable δ_{oe} and δ_{ie} will be used to denote if an express transport is used on the outbound or inbound material flow. It will be 1 if express transport is used, 0 otherwise. Outbound and inbound transportation costs can then be written as:

Outbound transportation costs: $C_{tn}(1 - \delta_{oe}) + \delta_{oe}C_{te}$

Inbound transportation costs: $C_{tn}(1 - \delta_{ie}) + \delta_{ie}C_{te}$

The first term is the transportation cost if express transport is not used, if express transport is used it will become zero. The second term is the transportation cost if express transport is used.

Transportation costs for an equipment transported from and back to the vendor can then be written as:

$$(7) C_T = C_{tn}[(1 - \delta_{oe}) + (1 - \delta_{ie})] + C_{te}(\delta_{oe} + \delta_{ie})$$

8.1.2.4 **Total logistical cost**

If the three cost elements elaborated above is added together they become the logistical costs for Shell. This is shown in Figure 8-2. The logistical costs presented in this figure, will be used as the basis for the creation of a decision tool.

Figure 8-2: Logistical costs

Expected downtime cost for the rig	$(5)[(T_{oa} + T_{ob}) + \delta_A(T_{ia} + T_{ib} + T_v)]P_j C_R$
+ Rental cost during transportation	$+ (6)T_{oa}R_{sv}\delta_{or} + T_{ia}R_{ev}\delta_{ir}$
+ Transportation costs	$+ (7) C_{tn}[(1 - \delta_{oe}) + (1 - \delta_{ie})] + C_{te}(\delta_{oe} + \delta_{ie})$
= Logistical costs (LC)	

8.1.3 Development of a decision tool for the use of express transport

The decision for the use of express transport or not should be taken so that the logistical costs is minimized. Hence, the objective for the decision tool will be to decide between express or normal transport in order to minimize the logistical costs.

8.1.3.1 *Change in cost parameters if express transport is used*

To minimize the logistical costs

To use express transport or not is the only variable which is altered in this model. If express transport is used the transportation time will be altered and the decision variable for the use of express transport will become 1.

If an express transport is used between a vendor and Vestbase instead of a normal transport the transportation time will decrease. Time for normal and express transport will be denoted as

$$T_{oa} = T_{on} \text{ or } T_{oe}$$

$$T_{ia} = T_{in} \text{ or } T_{ie}$$

The time it takes for a transport from vendor to Vestbase is the same as it takes to transport something from Vestbase to the same vendor. The transportation time with a normal transport is always larger than the time it takes with an express transport. The change in transportation time if an express transport is used instead of a normal transport will be:

$$\Delta T_{oa} = T_{on} - T_{oe} \quad \text{and} \quad \Delta T_{ia} = T_{in} - T_{ie}$$

The change in transportation time if an express transport is used instead of a normal transport in the inbound or outbound material flow will be negative equal to the difference in transportation time between normal and express transport ($T_{on} - T_{oe}$). As a result the change in rental cost and expected downtime cost will be negative if an express transport is used instead of a normal transport. The use of express transport will increase the transportation costs. The changes in logistical costs can be summarized as follows:

Changes in costs in the outbound material flow		
Expected downtime cost:	$0 >$	$\Delta E(C_R) = (T_{oe} - T_{on})P_j C_R$
Rental cost:	$0 >$	$\Delta C_r = (T_{oe} - T_{on})R_{sv} \delta_{or}$
Transportation costs:	$0 <$	$\Delta C_T = (C_{te} - C_{tn})\delta_{oe}$

Changes in costs in the inbound material flow		
Expected downtime cost:	$0 >$	$\Delta E(C_R) = (T_{ie} - T_{in})P_j C_R \delta_A$
Rental cost:	$0 >$	$\Delta C_r = (T_{ie} - T_{in})R_{ev} \delta_{ir}$
Transportation costs:	$0 <$	$\Delta C_T = (C_{te} - C_{tn})\delta_{ie}$

Figure 8-3 illustrates the changes in logistical costs when an express transport is chosen instead of a normal transport. This is a theoretical figure and proportions between the different lines can vary in the real case. The logistical cost is in this figure divided in transportation costs C_{tn} or C_{te} and rental and expected downtime cost added together as $[C_{rn} + E(C_R)_n]$ and $[C_{re} + E(C_R)_e]$ for normal and express transport. T_n and T_e is the transportation time for normal and express transport.

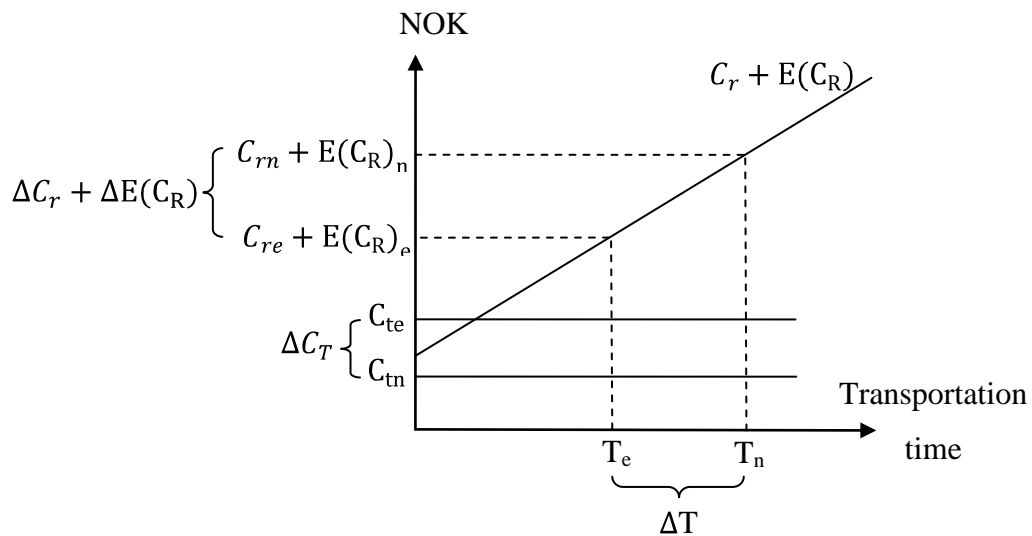
The starting point in Figure 8-3 is when the trips are done with a normal transport. The transportation time is T_n . When an express transport is used instead of the normal transport the transportation time goes from T_n to T_e , the cost for rental and expected downtime goes from $[C_{rn} + E(C_R)_n]$ to $[C_{re} + E(C_R)_e]$ and the transportation cost change from C_{tn} to C_{te} .

It will be beneficial for Shell to use express transport as the reduction in $[E(C_R) + C_r]$ is larger than the increase in C_T . To use express transport would then be beneficial when:

$$(C_{te} - C_{tn}) > [C_{rn} + E(C_R)_n - C_{re} + E(C_R)_e]$$

$$(8) \Delta C_T < [\Delta E(C_R) + \Delta C_r] * (-1)$$

Figure 8-3: Total logistical costs



8.1.4 The decision tool

From Equation 8, a rule for when express transport should be used in the outbound and inbound material flow can be designed. The decision variable for the use of express transport or not is not needed in this rule. Rules for when express transport should be used in the outbound and the inbound material flow could then be made. These two rules are shown in Equation 9 and 10.

Outbound: $(C_{te} - C_{tn})\delta_{oe} < (T_{on} - T_{oe})P_j C_R + (T_{on} - T_{oe})R_{sv}\delta_{or}$

Inbound: $(C_{te} - C_{tn})\delta_{ie} < (T_{in} - T_{ie})P_j C_R \delta_A + (T_{in} - T_{ie})R_{ev}\delta_{ir}$

These two equations can be written as Equation (9) for the outbound material and

Equation (10) for the inbound material.

$$(9) \quad \frac{(C_{te} - C_{tn})}{T_{on} - T_{oe}} < P_j C_R + R_{sv} \delta_{or}$$

$$(10) \quad \frac{(C_{te} - C_{tn})}{T_{in} - T_{ie}} < P_j C_R \delta_A + R_{ev} \delta_{ir}$$

The prices for a normal or express transport are dependent on the prices between the transporter and Vestbase. These prices are decided by a tender or negotiations between them. These costs are therefore constant in a short time horizon. As a result, Shell cannot alter C_{te} or C_{tn} in Equation 9, transportation times T_{on} and T_{oe} is also a constant and is not affected by the choice. The left side will therefore be a constant number which depends on the distance and costs between Kristiansund and the location of the vendor.

8.1.5 How does the tool work

If Equation 9 is used to make a decision between using normal or express transport from Stavanger to Kristiansund the model would say that:

If e.g. the choice is between using a normal or express transport from Stavanger to Kristiansund the left hand side of the equation can be found by inserting costs for normal and express transport. These costs can be found in

Table 8-1, and when these numbers are inserted into the equation the left hand side become:

$$\Delta C_T = (C_{te} - C_{tn})\delta_{oe} = (24641 - 17690) * 1 = 6951 \text{ NOK}$$

The reduction in transportation time between these two cities depends on the resting time between the two options. A normal transport has to take two obligated resting period on 45 minutes each and a minimum of 10 hours daily rest. The total resting time and the decrease in transportation time is then 11.5 hours or 0.479 days.

$$\Delta T_o = (T_{on} - T_{oe}) = 0.479 \text{ days}$$

When these numbers are inserted into equation 9, the result become:

$$\frac{6951}{0.479} < P_j C_R + R_{sv} \delta_{or}$$

Express transport should then be used when the sum of the expected downtime cost and the rental cost is higher than (6951/0.479=14511) NOK. This tells us that express transport should always be used if the daily rent a unit is larger than 14511 NOK. And that, dependent on the expected downtime cost, express transport may be beneficial to use if the daily rent is less than 14511 NOK.

8.1.6 How can the tool affect the system performance?

Today, the decision maker is only interesting in if the transport is going to be sent by express transport or not, so a smaller mark in the order stating if it should be sent by express transport or not should be sufficient. Shell then does not have to share confidential information to other parties operation in the chain.

The model will give a simple yes or no answer for the decision about the express transport, based on the rental cost, the expected downtime cost for the rig, the difference in transportation time between the two methods and the difference in transportation costs. This could make it easier for the decision maker when a decision should be made.

8.1.7 Implementation issues

Today, to our knowledge, there exist no records or measurements of how often a breakdown occurs on the different unit types available to find this probability. This could be possible to find out by conducting a study at the rig. This study had to contain observations per equipment type on how long the equipment is in use at the rig and how often it has a breakdown. This could be used to generate the probability P_j . Today, there also exists no exact cost for the daily downtime at the rig. This would also be needed before the decision tool can be implemented. When this is done the P_j and C_R will become a constant and can be used to make the correct a decision for if an express transport should be used or not.

To implement the tool without these two variables will be of use, but the usefulness will be decreased since it will consider rental cost, not the expected downtime.

8.2 Contracts

As described in section 7.2.2 and elaborated in 8.1.2 the rental cost is the main reason for why express transport is used. This chapter will look at how the contract between the vendors and Shell can be designed on the rental cost issues so that the overall supply chain performance is increased.

So far we have put forward a few reasons which affect Shell's upstream supply chain performance and cause express transport. When Shell start and stop paying rental for the different equipment, is decided by the contract between Shell and vendors. We decided to look into the start and end rental parameter in the contract between Shell and vendors, to see, if the change in starting and rental time could affect the upstream supply chain performance.

8.2.1 Current situation

Today, the contracts vary across vendors and are also dependent on the different types of equipment. These contracts have different starting and ending time. For the express transport, it is only these two starting and ending point which are important:

- Does the rental start at vendor's location, or after the truck has arrived at Kristiansund in the outbound material flow.
- Does the rental end before the truck leaves Kristiansund, or when it arrives at the vendor's location in the inbound material flow.

The rental cost during transportation creates a huge cost incentive Shell to use express transport compared to normal transport, and is the main reason for why express transport is used in the outbound and inbound material flow. This incentive could be taken away by changing the contracts. If the starting and ending time of the rental was altered so that the rental starts no sooner than after the equipment arrives at Vestbase outbound to rig and stops no later than when it leaves Vestbase inbound to vendors, this would greatly reduce this incentive.

8.2.2 How will it affect the supply chain?

The alteration in contract conditions between Shell and a vendor, so that the rental incentive to use express transport is removed will mainly affect those two, but other parties such as the transporter and Vestbase will also be affected.

The alterations in the contract for Shell, will firstly remove the main contributor to the generation of express transports. Hence, the amount of express transportation will be reduced and thereby the transportation costs will decrease. Secondly it will increase the lead time for the order, and the equipment will arrive later at the rig which could increase the probability of a downtime at the rig. This feature is taken care of by other aspects in the supply chain. If they believe that the unit could cause a downtime at the rig it will be sent by express transport.

For the vendor, the reduction in the amount of express transport could mean that the utilization of the equipment is reduced because of the increase in transportation time. but if the equipment is not broken and does not need to be controlled, or it can be controlled at the supply base, the vendor can start to rent it out again without transporting it back, which would increase the utilization of the equipment. To say which of these two factors affect the utilization of the equipment the most inside information about the vendor has to be known.

The alteration of a contract between Shell and a vendor also results in a reduced rental cost paid from Shell to the vendor. This will decrease Shell’s rental costs and the vendor’s revenue. The pros and cons for Shell and the vendor is in summarized Table 8-2.

Table 8-2: Pros and cons for altering the contract

	Shell	Vendor
Pros	<ul style="list-style-type: none"> • Reduced transportation cost. • Reduced rental cost paid for the equipment. 	<ul style="list-style-type: none"> • Could lead to an increase in the utilization of the equipment. • <i>New contract term</i>
Cons	<ul style="list-style-type: none"> • Could lead to an increase in the probability of a downtime at the rig. • <i>New contract term</i> 	<ul style="list-style-type: none"> • Reduced rental income • Could lead to a decrease in the utilization of the equipment.

For the vendor to have an incentive to agree on the new contract, the pros must be higher than the cons. This can be done by adding a new contract term which has to give a pro larger than the difference between the pros and cons in the current contract.

$$Pros[New\ contract\ term] > (Current\ pros - Current\ cons)$$

If this is true the vendor would accept the new contract.

8.2.3 Ideas to new contract terms

In the following, ideas to new contract terms which can be used to give the vendor an incentive to change the contract are pre presented.

8.2.3.1 *Transfer payments*

The cons for the vendor weigh higher than the pros for altering the contract. To make the vendor willing to alter the contract, Shell must give the vendor an incentive to do so. As an absolute minimum the vendor wants the same as he had under the old contract. Most likely he also wants something in return to allow for the alteration in the contract. Hence, the pros have to be equivalent or higher than the cons under the new contract. There are several option Shell could offer the vendor if he agrees to alter the contract. There are several methods Shell can use to get this contract through.

There are several ways of transferring the money, but all of them have in common that the money transfer has to be so high that the vendor agrees to the new contract. This could e.g. be a fixed sum each month, an increase in the rental for the remaining part of the supply chain so that the income total rental stays the same. The vendor would then have the incentive he needs to agree to the contract.

To design a method for transferring of money from Shell to the vendor is easy in a theoretical model, but to design this method in the real world will get complicated pretty fast. This is because it is hard to find out how much the rental income to the vendor is reduced in the current state, and how much it will be reduced in the future. But, historical data for how long the equipment has been on in an onshore transport while under rent could be used. If Shell paid a fixed cost equal this time multiplied with the rental cost each time the unit is in use, the pros and cons could become equivalent for the vendor, and he might agree on the contract.

8.2.3.2 *Increase the vendor's benefits*

It could also be that the vendor wants to increase the time horizon of the contract. This could give the vendor a safer demand pattern, since they know that Shell will have to go to them instead of another vendor if they need that equipment type. This could also reduce some of the investment risk a vendor has for purchasing a unit, which also could help reducing the availability for Shell.

It is also possible to decrease the cons created by the new contract for the vendor. This could be done by e.g. give an upper limit to the amount of days Shell has the unit without paying rental. If this is done the benefits the vendor give to Shell is reduced. The vendor then do not need a that strong incentive from the payment transfer method.

8.2.4 Is it a good idea?

If it is a good idea depends on for whom you ask. In the supply chain methodology we can look at the entire supply chain as a “virtual organization”. And this organization should have a common goal. How today’s contracts are designed create a situation where an extra transportation cost is added to the supply chain, without any of the parties gaining from it.

As a result the cost to satisfy the customer increases while the customer's satisfaction stays more or less constant. An alteration in the contract would take away this sub-optimality, and the main incentive for the use of onshore transports is taken away.

8.2.5 Implementation of the contracts

The vendor does not know how much the savings from the alteration of the contract is, since this is information only Shell, Vestbase and the transporter has. The negotiation about the new contract term is therefore affected by asymmetric information. Asymmetric information could make the vendor feel that they try to cheat him by altering the contract, and he will ask for a larger incentive than if he had all the information. This asymmetric information could lead to a situation where the contract is not altered, even though they both could have earned from it.

8.2.6 How will the contracts affect the different parties?

If this suggestion is a good idea or not for Shell depends on how large the incentive they have to give to the vendor is. If the vendor settles with the same revenue as he had before, the contract would be beneficial for Shell. Differently, if the vendor demands most of the savings, the alteration of the contract might not be of Shell's best interest.

This suggestion will be beneficial for the "virtual organization" as long as the benefits gained by the all the parties in the supply chain is larger than the costs to implement this suggesting. Consequently, as long as payments or benefits Shell has to give to the vendor in order to get this contract through, is smaller than the decrease in transportation costs, this will be a preferable situation.

9 Conclusion

The two main research objectives in this study are to describe and analyze the amount of express transport in Shell's upstream supply chain. To find out if features in the supply chain, cause the supply chain to use an incorrect amount of express transport has been the main issue during this study. The third objective was to suggest improvements for how Shell could improve supply chain issues related to express transport.

To solve these two problems an exploratory research method and mainly a qualitative approach has been used. The first issue was to get an understanding over Shell's upstream supply chain and the complexity of it. Based on this description, the theoretical framework and without doubt the interviews, this study have discovered several reasons for why express transport is generated. These reasons are:

- Keep the utilization at WN high
- Equipment is not available in the market
- Delay of material at vendor
- Reduce the rental costs

The cost aspect with a downtime at the rig is of immense importance. The demand for equipment is attended with high uncertainty for when the demand is needed, because of weather and breakdown probabilities of the equipment. Accordingly WN requires an agile supply chain with a short lead time. To cope with the low lead time other processes are affected. Uncertain demand is one of these, this uncertainty cause orders for the outbound material are not sent before it is absolutely sure if and when it is needed at the rig. Consequently the order may be sent so that express is the only available option to avoid a downtime at the rig.

If an express transport is used in order to keep the utilization at WN high, it is not an unnecessary express transport. But this is not always the case. To solve a problem occurring when a drilling-equipment has a breakdown they immediately order an express for the new drilling equipment. This order policy does not take the probability of a breakdown occurring on a specific unit into account, or the remaining time the unit should be in use at the rig. This could generate an above necessary level of express transports.

If the equipment is not available in the market or the equipment is not ready when the transporter should pick it up has the same effect on the supply chain. They both make the lead time from an order is made until it is fulfilled is longer. Express transport will decrease the lead time and the effect such a low availability has on the supply chain. There is not much Shell can do about this case. The express transports generated by this cause then necessary to keep the supply chain performance high.

The express transport to reduce the rental cost is also necessary, since it can reduce logistical cost. But the lack of the value for how much such a rent should be per day, for a certain distance in order to make the right decision, is not available for the decision maker. Consequently this reason for why express transport is used could make the supply chain to use either to many or too few express transports.

Based on the two of the reasons which create an incorrect amount of express transport to be generated in the upstream supply chain two suggestions were introduced. These are to introduce a decision tool to the decision maker and/or change the contract terms. These two suggestions could help to improve the overall supply chain performance.

10 Weaknesses and future research

10.1 Weaknesses of our thesis

10.1.1 Research plan

The main issue of our research is to explore a formerly untouched area. We have been dedicated to try to dig out the reasons which may cause the supply chain to generate an incorrect amount of express transport, and maintain the alternatives open to be able to facilitate future research. An exploratory research gives us an opportunity to explore a number of fields within our research area. Moreover, our research plan has helped us to stick to our research problem and keep our research on the correct path. We have not only analyzed the causes, but also put forward two recommendations. Still, it unavoidably ends to a situation that our research might not be thoroughly enough into every area.

Still, it is unavoidable for us to have some weaknesses in our research. Firstly, the scarcity of relevant academic sources on express transport issue in the oil and gas upstream supply chain makes some difficulties to our academic sources collection. The short of strictness leads to distraction and decreased focus. We may have been to some wrong ways of studying the case since we were lack of experience on upstream supply chain in oil and gas sector. Secondly, for the data collection, we chose to collect data mostly based on the interviews, historical data and internal guidelines. But during the interviewing process, we admit we were unavoidably influenced by the interviewee to some extent. Furthermore, some incomplete historical data resource we got from Shell might affect the quality of the statistical analysis in our thesis. For the methodology in our research, the method used for data analysis on West Navigator may not be entirely applied on other operational projects.

10.1.2 Our recommendations

We have tried our best to propose several recommendations to not only diminish times when using express transport is used when it is not beneficial, but also improve the performance of Shell's upstream supply chain. However the recommendations are still not as detailed as we expected. And the recommendations we put forward is based on academic analysis without a real world test. Especially, the contract change between Shell

and vendors is hard to test. Still, we believe Shell's upstream supply chain has a large space to improve and proper move can make improvements real. We also hope future research make more progress in this area in order to let our recommendations be more detailed and real.

10.2 Further research

We believe three potential researches could be made to deal with the express transport issue and improve Shell's upstream supply chain.

- Communications amongst relevant parties and personnel in Shell's upstream supply chain
- Oil and gas companies share cost of vendor's new purchasing equipment
- Expected downtime cost at the rig and the probability of a downtime caused by a unit.

10.2.1 Communications study on personnel for the logistics parties

From the interview with the onshore coordinator in Stavanger, low level of communication between the transport coordinator at Vestbase and the logistics coordinator for West Navigator at Vestbase where on issue. But in fact, these two coordinators at Vestbase are working for the same company, but they contact Shell's person more than they contact each other. So it may be a good angle to see how to improve the Shell's upstream supply chain performance by improving the communications between the personnel in the logistics parties. There is also an issue where delay from the demand is created until it reaches the transporter could generate express transport. This is of interest to look closer into..

10.2.2 Oil and gas companies share cost of vendor's new purchasing equipments

Purchasing new equipment for the vendor is a decision that hard to make. If oil and gas companies which have contract with the vendor could share the cost, the vendor will be more willing to buy new equipment in order to diminish the bad effect of low availability. But is it a good idea? How much percentage the companies should share for the new

equipment? These questions may be answered from a research on the qualitative study or quantitative one.

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Appendix 1 - Transportation report April 2009: All transport

Materiell til Kristiansund						Materiell fra Kristiansund					
Prosjekt\ Antall	Utgående tonn	Bilfrakt	Sjøfrakt	Flyfrakt	Kostnad	Prosjekt\ Antall	Inngående tonn	Bilfrakt	Sjøfrakt	Flyfrakt	Kostnad
1. WN	1124	44	0	5	272,410	1. WN	878	55	0	13	214,035
2. DR	837	9	0	0	38,812	2. DR	469	30	0	0	69,000
3. LE	0	0	0	0	15,000	3. LE	0	0	0	0	374,152
4. GRO	1295	62	0	2	164,993	4. GRO	1264	60	0	10	158,521
5. DALSNUTEN	0	0	0	0	0	5. DALSNUTEN	0	0	0	0	0
6.	0	0	0	0	0	6.	0	0	0	0	0
7. Andre	679	9	5	0	103,275	7. Andre	1236	11	0	4	191,796
Totalt	3934.44	124	5	7	594,490	Totalt	3846.9	156	0	27	1,007,504
Måltall	2000	50	2	15	850,000	Måltall	1800	50	2	15	850,000
Avvik i %	96.7	148.0	150.0	-53.3	-30	Avvik i %	113.7	212.0	-100.0	80.0	19
Kommentar til rapporten: Kostnadsfordelingen mellom frakt til og fra Kristiansund er fordelt ut i fra % utregnet på tonn. LE fordelt på skjønn						Kommentar til rapKostnadsfordelingen mellom frakt til og fra Kristiansund er fordelt ut i fra % utregnet på tonn. LE fordelt på skjønn					

Appendix 2 - Transportation report April 2009: Onshore Transport

Frakt landeveien til Kristiansund												
Prosjekt\ Antall	Utgående tonn	Antall sendinger Bilfrakt	Kostnad	Ekspresser	ADR transporter	Transporter med innleid utstyr	Transporter med eget utstyr				Antall km langs vei	Diesel forbruk
WN	1124	44	272,410	4	1	5.40%	28.20%				18020	1,081.20
DR	837	9	38,812	0	0	0.00%	0.90%				508	30.48
Leiv Eriksson	0	0	15,000	0	0	0.00%	0.00%				0	0.00
GRO	1295	62	164,993	12	2	5.10%	60.40%				35168	2,110.08
DALSNOTEN	0	0	0	0	0	0.00%	0.00%				0	0.00
	0	0	0	0	0	0.00%	0.00%				0	0.00
Andre	679	9	103,275	0	3	0.00%	0.00%				0	0.00
Totalt	3934.44	124	594,490	16	6	10.50%	89.50%				53696	3,221.76
Måltall	2000	50	850,000	6	4	10.00%	90.00%				30000	1700
Avvik i %	96.7	148.0	-30	166.7	50.0	5.0	-0.6				79.0	89.5
Kommentar til rapporten:												
Frakt landeveien fra Kristiansund												
Prosjekt\ Antall	Inngående tonn	Antall sendinger Bilfrakt	Kostnad	Ekspresser	ADR transporter	Transporter med innleid utstyr	Transporter med eget utstyr				Antall km langs vei	Diesel forbruk
WN	878	55	214,035	5	2	5.00%	24.00%				17064	1024
DR	469	30	69,000	0	0	0.00%	0.50%				245	15
Leiv Eriksson	0	0	374,152	0	0	0.00%	0.00%				0	0
GRO	1264	60	158,521	8	3	6.80%	59.10%				38746	2325
DALSNOTEN	0	0	0	0	0	0.00%	0.00%				0	0
	0	0	0	0	0	0.00%	0.00%				0	0
Andre	1236	11	191,796	2	0	0.00%	4.60%				2732.5	163.95
Totalt	3846.9	156	1,007,504	15	5	11.80%	88.20%				58787	3527.22
Måltall	1800	50	850,000	5	4	10.00%	90.00%				28000	1500
Avvik i %	113.7	212.0	19	200.0	25.0	18.0	-2.0				110.0	135.1

Appendix 3 – Domestic pricelist for the use of onshore transport in 2009

PRISLISTE INNLAND

2009	0-25 kg	26-100 kg	101-500 kg	501-1000 kg	1001-3500 kg	3501-7500 kg	7500 kg - over	Full Semi	Lastebil	Pickup	Express-tillegg
Fra Stavanger til:	Pris pr. sending				Pris pr. tonn			Pris pr. tur			Ekstra Sjafer
Bergen	164	235	284	442	379	361	322	7582	6318	5687	1896
Florø	235	418	418	695	632	568	505	12004	10741	9477	5054
Kristiansund N	252	530	695	1106	1017	871	822	19586	17690	13899	6951
Sandnessjøen	316	645	1024	1189	1169	1157	1131	24640	23377	18323	18954
Hammerfest	353	822	2779	2653	2653	2274	2148	58124	40435	35380	25271
Fra Bergen til:											
Stavanger	164	235	284	442	379	361	322	7582	6318	5687	1896
Florø	152	284	347	442	410	379	322	6318	5687	5687	3159
Kristiansund N	227	418	695	853	790	759	740	17438	12004	9478	4424
Sandnessjøen	284	481	1024	1189	1169	1157	1131	22744	14531	12004	18954
Hammerfest	354	670	2022	2401	2653	2274	2148	48016	39170	31590	25271
Fra Stavanger til: Florø											
Stavanger	221	418	568	695	632	568	505	12004	10741	9478	5054
Bergen	152	284	347	442	410	379	322	6318	5687	5687	1896
Kristiansund N	189	418	418	568	537	512	487	12004	10741	9478	3159
Sandnessjøen	316	759	1024	1189	1169	1157	1131	18954	18323	15163	9478
Hammerfest	354	708	2022	2401	2653	2274	2148	45489	36643	29063	18954
Fra Kristiansund N til:											
Stavanger	252	530	695	1106	1017	871	822	19586	17690	13899	6951
Bergen	227	418	695	853	790	759	740	17438	12004	9478	4424
Florø	189	418	418	568	537	512	487	12004	10741	9478	3159
Sandnessjøen	266	619	568	695	853	822	790	14531	12004	10109	3790
Hammerfest	354	710	2022	2401	2653	2274	2148	45489	35380	27798	18954
1 lastemeter = 1850	Breddetillegg = 15% over 2,55		1m3 =333 kg		Farlig gods = +15% på overnevnte priser			Lengdetillegg = 15% på lengder over 13,6 mtr			

Appendix 4 - West Navigator



West Navigator

For further information contact:

Marketing - Contract

Phone: +47 51 30 90 00

E-mail: business.development@seadrill.com

www.seadrill.com



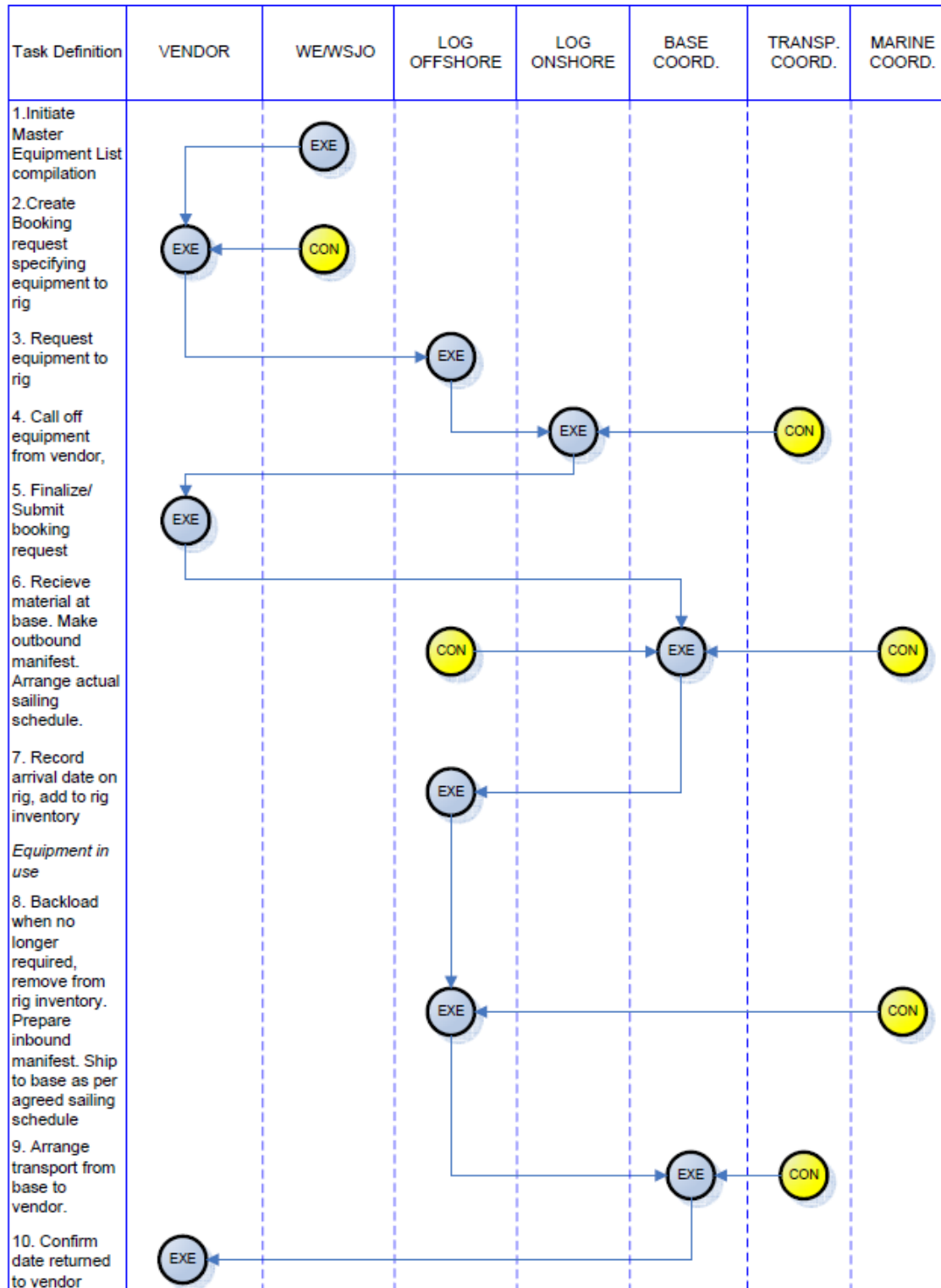
Design	DP Drillship
Built/year	Samsung/2000
Modified	2000
Flag	Panama
Classification	DNV, 1A1 Ship-shaped Drilling Unit (N) - Drill (N), E0, HELDK(SH), OPP-F, F-AM, CRANE, DYNPOS AUTRO
Length	253 m
Breadth	42 m
Water depth	2,500 m
Drilling depth	9,000 m +
Variable load	9,000 mT
Propulsion	40,760 (BHP)
Prime movers	49,402 (BHP)
Cranes	2 x MAN 35 mT at 15 m and 10 mT at 50 m 1 x MAN 70 mT at 16 m and 15 mT at 50 m 1 x Norlift 10 mt at 23 m
Derrick	MH Double Ramrig
Top drive	Main rig MH 750 t hydr. unit Aux rig MH 650 t hydr. unit
Rotary table	60.5"
BOP	Hydril, Compact BOP 18-3/4" - 15K
BOP control system	Hydril, Multiplex
Marine riser	Dril-Quip, QMF spilt lock ring, 3,500,000 lbs - 2500 m
Riser tensioners	2,560,000 lbs (160,000 x 16)
Heave Comp	Integral in ramrig, 7.6/15,2 m stroke compensator (passive mode), max stroke 36 m in active mode
Mud pumps	3 x 2, 200 kW, AC drive
Shale shakers	6 x Thule VSM 300
Drillpipe	5,500 m 5 1/2" FH S-135 3,500 m 3 1/2" IF S-135
Mud/cement bulk	840 m3 (8 x 105m3)
Liquid mud	1,050 m3
Brine/oilbased mud	2 x 200 m3
Helicopter deck	23 D, EH101 helicopters
Accomodation	117 beds, 59 cabins

Appendix 5 – Work process

WORK PROCESS:

Updated: 10.09.2009

MATERIALS MOVEMENT TO AND FROM DRILLING INSTALLATION INCLUDING INVENTORY AND RENTAL TRACKING



Appendix 6 – Dual Derrick

Date	Start time	End time	Duration	Activity in auxilliary derrick	Main rig activity
12/1/2007	4:45	12:00	7.25	Std By	POOH with BHA
12/1/2007	12:00	15:00	3.00	Move rig over template and stab in stinger.	Move rig over template and stab in stinger.
12/1/2007	15:00	18:15	3.25	RIH with cement stinger to 1693m	RIH with cement stinger to 1693m
12/1/2007	18:15	19:45	1.50	Displace well to 1.35 SG mud	Displace well to 1.35 SG mud
12/1/2007	19:45	22:45	3.00	Place balanced cement plug and circulate clean	Place balanced cement plug and circulate clean
12/1/2007	22:45	0:15	1.50	POOH from 1580m to 870m with stinger.	POOH from 1580m to 870m with stinger.
12/2/2007	0:15	0:45	0.50	Move rig to safe zone	Move rig to safe zone
12/2/2007	0:45	2:30	1.75	POOH stinger to surface	POOH stinger to surface, RIH 26" BHA to 870m
12/2/2007	2:30	8:00	5.50	Std By	Continue RIH with drillstring to 870m
12/2/2007	8:00	9:45	1.75	Std By	Move rig over template and stab in 26" BHA
12/2/2007	9:45	13:45	4.00	Std By	RIH to 1593m and tag cement
12/2/2007	13:45	15:30	1.75	Std By	Dress cement plug to 1580m.
12/2/2007	15:30	17:00	1.50	Rigged up to run casing, 1 hour.	Circulate hole clean and displace to 1.3 sg RDIF
12/2/2007	17:00	19:30	2.50	Std By	POOH to 870m
12/2/2007	19:30	20:00	0.50	Std By	Move to safe zone
12/2/2007	20:00	14:00	18.00	RIH with 20" Casing to 800m, cont. POOH 26" BHA	POOH 26" BHA
12/3/2007	14:00	16:15	2.25	Move rig over template and stab in 20" casing to 30" WHH	Rigged up to L/D SFT
12/3/2007	16:15	20:45	4.50	RIH to 1564m	Rigged up to L/D SFT
12/3/2007	20:45	21:15	0.50	Make up cement head	Rigged up to L/D SFT
12/3/2007	21:15	21:30	0.25	RIH to 1572m	Rigged up to L/D SFT
12/3/2007	21:30	22:15	0.75	Circulate well prior to cement job	ROV work on template
12/3/2007	22:15	3:30	5.25	Perform Cement job	ROV work on template
12/4/2007	3:30	4:30	1.00	Release running tool, recover RT	ROV work on template
12/4/2007	4:30	7:15	2.75	Inspect conduit hoses	Recover R/T, meanwhile ROV work continues
12/4/2007	7:15	22:15	15.00	Inspect conduit hoses	Complete ROV work, recover basket and CCDS pump.

Appendix 7 – Operational time breakdown

Insert Row Delete Row		West Navigator Operational Lookahead								
Start of Project		00:30 Thu 27 Oct		Printed=		5/23/2010 15:38				
Phase	Start Time	Operation Description	Budget Time	Rig Est Time	Actual Time	Actual vs. Budget	Cumulative Days	Finish Time	Remar	Short Description
	12:30 Mon 25 Jan	Pull riser		13.50	11.50	11.50	1551.98	00:00 Tue 26 Jan		Perform Repair
	00:00 Tue 26 Jan	Recover LMRP and secure in moonpool		1.00	0.50	0.50	1552.00	00:30 Tue 26 Jan		Perform Repair
	00:30 Tue 26 Jan	Recover and secure hoses		0.00	2.00	2.00	1552.08	02:30 Tue 26 Jan		Perform Repair
Kristiansund	02:30 Tue 26 Jan	Sail to Grip		6.00	5.00	5.00	1552.29	07:30 Tue 26 Jan		Perform Repair
	07:30 Tue 26 Jan	Sail to Bremsnesfjorden		0.00	2.75	2.75	1552.41	10:15 Tue 26 Jan		Perform Repair
	10:15 Tue 26 Jan	Sail to quayside		3.50	3.50	3.50	1552.55	13:45 Tue 26 Jan		Perform Repair
	13:45 Tue 26 Jan	Moore along quayside		1.00	1.00	1.00	1552.59	14:45 Tue 26 Jan		Perform Repair
	14:45 Tue 26 Jan	Remove Thruster no 6 and send to RR		89.25			1556.31	08:00 Sat 30 Jan		Perform Repair
	08:00 Sat 30 Jan	Wait on new thruster to arrive		120.00			1561.31	08:00 Thu 04 Feb		Perform Repair
	08:00 Thu 04 Feb	Lift in new Thruster no 6		24.00			1562.31	08:00 Fri 05 Feb		Perform Repair
	08:00 Fri 05 Feb	Mount new thruster to turning gear.		24.00			1563.31	08:00 Sat 06 Feb		Perform Repair
	08:00 Sat 06 Feb	Remove mooring		3.00			1563.44	11:00 Sat 06 Feb		Sail to D template
	11:00 Sat 06 Feb	Sail to Grip		3.00			1563.55	14:00 Sat 06 Feb		Sail to D template
	14:00 Sat 06 Feb	Sail to template D while running in thruster no 6		7.00			1563.85	21:00 Sat 06 Feb		Sail to D template
Run LMRP	21:00 Sat 06 Feb	Run LMRP and riser. Thuning thruster		55.00			1566.15	04:00 Tue 09 Feb		Run LMRP
	04:00 Tue 09 Feb	Connect to BOP		8.00			1566.48	12:00 Tue 09 Feb		Run LMRP
Re-enter and drill 17 1/2" section on D-7 H	12:00 Tue 09 Feb	Perform BOP test		16.00			1567.15	04:00 Wed 10 Feb		BOP test
	04:00 Wed 10 Feb	M/up 17 1/2" BHA		6.00			1567.40	10:00 Wed 10 Feb		Drill 17 1/2" hole
	10:00 Wed 10 Feb	RIH to 2070 m		12.00			1567.90	22:00 Wed 10 Feb		Drill 17 1/2" hole
	22:00 Wed 10 Feb	Circulate and condition mud		3.00			1568.02	01:00 Thu 11 Feb		Drill 17 1/2" hole
	01:00 Thu 11 Feb	Drill from 2070 to TD at 2284 m.	8.00	24.00			1569.02	01:00 Fri 12 Feb		Drill 17 1/2" hole
	01:00 Fri 12 Feb	Circulate clean 2 x btms up, flow check	3.00	4.50			1569.21	05:30 Fri 12 Feb		Circ clean
	05:30 Fri 12 Feb	POOH wet to 20" shoe (back ream if required)	3.00	6.00			1569.46	11:30 Fri 12 Feb		Backream out
	11:30 Fri 12 Feb	Circulate until returns are clean if back reaming required		0.00			1569.46	11:30 Fri 12 Feb		Circ clean
	11:30 Fri 12 Feb	RIH to TD	2.00	0.00			1569.46	11:30 Fri 12 Feb		Wiper trip
	11:30 Fri 12 Feb	Circulate bottoms up	2.00	0.00			1569.46	11:30 Fri 12 Feb		Wiper trip
	11:30 Fri 12 Feb	POOH from shoe and L/D BHA	5.00	12.00			1569.96	23:30 Fri 12 Feb		POOH with BHA

Appendix 8 Equipment tracker – Master equipment list

Equipment tracker - Master Equipment List

Edit mode

Contact list Master Equipment List Supply bases Rig inventory Vendors & Contracts Rig setup Help

Well: OL D7

Export to Excel Export to Word Export to Pdf Show consumed

26" section 17,5" section 8,5" pilot/coring 12,25" section Install XT 8,5" section Lower Completion Upper Completion

Well test & Clean up

▶ [BJ Services AS Cementing](#)

▶ [Odfjell Casing Services AS](#)

▶ [Seawell Oil Tools AS](#)

▼ [Schlumberger Norge Holding AS D&M](#)

	QTY	Description of equipment/material	BR num	Container	Rental		Depart. Vendor	Arrival base	Shipment from base	Arrival rig	Shipment from rig	Arrival base	Dep. base
2457	1 ea	8" PowerPulse W/Lifting Sub	567	BL-12-06	<input checked="" type="checkbox"/>	0,00	11/03/2010	13/03/2010	13/03/2010	14/03/2010			
2458	1 ea	8" PowerPulse	567	BL-12-06	<input checked="" type="checkbox"/>	0,00	11/03/2010	13/03/2010	13/03/2010	14/03/2010			
2459	0 ea	8" NMDC Collar	567	BL-12-06	<input checked="" type="checkbox"/>	0,00	11/03/2010	13/03/2010	13/03/2010	14/03/2010			
2460	1 ea	8" NMDC Collar W/Lifting Sub	567	BL-13-24	<input checked="" type="checkbox"/>	0,00	11/03/2010	13/03/2010	13/03/2010	14/03/2010			
2461	1 ea	PowerDrive W/Lifting Sub And Bit	567	BL-13-24	<input checked="" type="checkbox"/>	0,00	11/03/2010	13/03/2010	13/03/2010	14/03/2010			
2462	1 ea	PowerDrive 900	567	BL-13-24	<input checked="" type="checkbox"/>	0,00	11/03/2010	13/03/2010	13/03/2010	14/03/2010			

Appendix 9 - RAM

RETURN OF MATERIAL

RAM
NO.

TO:		
NAME/COMPANY:	PHONE:	
.....	
ADDRESS:	FAX:	
.....	
ATT:	
FROM:		
NAME/COMPANY:	PHONE:	
.....	
DEPARTMENT:	REF:	
.....	
SHIPMENT REF.:		
UNIT:	MR:	
.....	
MANIFEST	NO.:WELL:	
.....	
MATR. COORDINATOR:	DATE:	
.....	

ITEM	QTY.	UNIT	DESCRIPTION

Appendix 9 – Interview schedule

Trip number	Date	Interview location	Interviewees	Interview type	Recording available
1	27th October 2009	Shell Driftsorganisasjonen in Kristiansund	Head Business Support and Liaison, ISCL Contract Holder	Face-to-face	No
2	2nd December 2009	Vestbase, Waage SR in Kristiansund	Transport coordinator at Vestbase, Transport manager in WSR	Face-to-face	No
3	3rd February 2010	Shell Driftsorganisasjonen in Kristiansund	Onshore coordinator in Stavanger, Offshore coordinator for West Navigator	Telephone	Yes
4	9th February 2010	Vestbase in Kristiansund	Logistics coordinator for WN at Vestbase, Logistics supervisor at Vestbase	Face-to-face	Yes