Master's degree thesis

LOG950 Logistics

Evaluation of HOLD solution:

A case study of the upstream supply chain of Norne

Vegard Gudbrandsen

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Molde University College
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Preface

This master thesis represents the final part of the last semester of the Master of Science in Logistics program at Molde University College. The topic for the research was developed in cooperation with the Norne organization in Harstad, and it has been very interesting to work on a real case for such a big energy company as Statoil. This research has provided me with valuable insight and understanding of upstream supply chains in the oil and gas industry, and the challenges and the high pace environment they have to operate in.

This thesis would not be possible to write without the help and support from the Norne organization and I would like to thank them for the opportunity to write my thesis with them and to learn about the fascinating industry. I would especially like to express my sincere gratitude to my contact person at Norne organization, Supply Chain Coordinator Grete Nilsen for the introduction of the organization and for all valuable insight and help with the work of this research.

In addition I would like to thank those who contributed to the interviews both in Harstad, at Helgelandsbase and in Stavanger. And, finally I would like to sincerely thank my supervisor, associate professor Bjørnar Aas for the guidance and feedback during the process of writing this thesis.

Molde, 20 November 2014

Vegard Gudbrandsen

Summary

The purpose of this thesis has been to perform an evaluation of HOLD solution, which is a step in Statoil's Supply Chain Improvement Project (SCIP) that has been initiated due to different challenges that Statoil have identified in their supply chain. The project goal is to increase the efficiency in the upstream supply chain between the offshore installation, which in this thesis is Norne, and the supply base Helgelandsbase (HB). The main purpose with HOLD solution is to secure correct orders at correct requirement dates offshore at Norne.

For this thesis there has been chosen an exploratory, qualitative case study approach, which have collected data and information mainly through observations, archival records/documents and open ended interviews. The theory chosen are lean thinking, theory of constraints, collaboration and SCM.

The result from this thesis describes the situation before and after the implementation on areas that was expected to make an impact after the implementation. After the implementation, the findings in this research show that there have been improvements on some areas that HOLD solution were aiming to affect, while some areas did not show any significant changes. From a theoretical perspective, the process of identifying, implement and evaluate the project has been connected to the theory of constraints, with the goal of implementing a more lean approach to the supply chain.

During this research it was also revealed that Statoil could benefit from having more detailed internal measures of their logistic activities. This could give Statoil valuable and detailed information, and it could also provide with more accurate results of the analyses executed in this thesis.

The conclusion of this thesis is that there is indications on that HOLD solution have had a positive effect on the upstream supply chain of Norne. Some of the indications are stronger than others.

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1.0 Introduction

There have been big changes in the oil and gas industry in the recent years where the trend has been lower productivity offshore and increased costs. With an increasing number of aging offshore installations that requires more frequent maintenance, which in turn leads to less efficiency and increased costs. This combined with fewer findings of new oil and gas fields (Kon-Kraft 2014) and the fact that Norway is a high cost country have led to a situation where it has become necessarily for Statoil, and other oil and gas companies, to reduce costs and become more efficient.

Statoil have analyzed themselves and their logistic activities and have came to the conclusion that there are a lot of room for improvement, which have resulted in an increased focus on making their supply chains more efficient in order to reduce costs and utilize their resources better.

Statoil have created the Supply Chain Improvement Project – SCIP that is a project for identifying the challenges and bottlenecks that exists in the upstream supply chain. The upstream supply means serving the exploration and production lines of Statoil, and in this thesis a production ship called Norne is used for research and data collection. This thesis will be concentrating about one specific improvement project within the SCIP called HOLD solution and the effects of the implementation of this.

2.0 Research plan

This chapter will describe the research plan for this thesis

2.1 Research area

This thesis will describe how the upstream supply chain of Norne works, from a need occurs offshore and until the material needed has arrived offshore at Norne. This will give an understanding of how the supply chain works. This will give the necessary knowledge to understand how HOLD solution works, and what the purpose with the implementation was, which in turn provides with the knowledge needed to understand the analysis and the results in the thesis.

2.2 Research question

The challenges that exist in the supply chain have created a need to make changes in order to improve Statoil's upstream supply chain. The implementation of HOLD solution is such measure that aims to improve the efficiency of their supply chains.

This thesis will look on both how the situation is before and after the implementation of HOLD solution, to be able to get a comparable picture that will be the basis for the result of this research. It will therefore be important to describe the solution itself and look at what the effects of the implementation have been, if there are any.

"What are the effects of implementation of HOLD solution for the offshore installation Norne?"

There have also been developed three sub-questions to get a more detailed plan when answering the research question.

1. How are the present situation vs before the implementation?
2. How are the effects of HOLD, if there are any, improving Nornes supply chain?
3. Are the effects according to the expectations of the implementation, and if not why so?

The first-question sub question focus on describing the situation before and after the implementation. The mapping of the before situation will also reveal why HOLD was implemented and what the challenges that led to the implementation was. By mapping the after situation it will be possible to compare the before and after situation, which provides with the results of the implementation.

The second sub-question focuses on the effects of the implementations, and how they are improving Nornes supply chain. This will provide with effects of the implementation on areas that are being investigated and assumed to be affected.

The third sub-question focuses on how the results of the implementation match the expectations to the implementation. There might be other effects from the implementation then first assumed, or the degree of the effect might not be as assumed.

To solve the research problem, the following hypothesis was made:

"Nornes upstream supply chain will increases its efficiency as a result of the implementation of HOLD solution"

This hypothesis indicates that the implementation of HOLD solution will provide with results that increases the efficiency in the upstream supply chain of Norne.

2.3 Research design

Every empirical research has some form of research design, either implicit or explicit. The design works as a logical sequence that connects the empirical data with the research questions, and in the end, the conclusion.
(Yin, 2009, p. 26) defines a research as:

"A logical plan for getting from here to there, where "here" may be defined as the initial set of questions to be answered, and "there" is some set of conclusion about these questions"

There are several major steps between "here" and "there", including the data collection and data analysis.

2.3.1 Exploratory design

To be able to answer the research question, the HOLD solution needs to be analyzed and the activities of how it works need to be identified. An exploratory design basic purpose is to provide information that assists the research in such way that the research problem is better understood. A key characteristic of the exploratory design is flexibility, meaning that with more information and better understanding of the problem, the focus of the research may change direction. (Ghauri & Grønhaug, 2002). According to Ellram (1996) research questions in exploratory research is usually based on "how" and "why" something is done.

This thesis is descriptive because it describes a phenomenon, or in this case, the supply chain for Norne. This is also an exploratory research because it goes in depth of the research and explores the relationships between the variables in the research. This is necessary in order to understand the problem before it is solved.

2.3.2 Case study

Case studies are often used in research where one or more organizations or groups within the organization are investigated in detail. This is to provide analyses of the environment and processes in the phenomenon that is being investigated. (Meyer, 2001)
According to (Hartley 1994) case studies are made for exploring new processes, behaviors or ones that is not fully understood, so this approach is especially useful when answering *why* and *how* questions.

Meyer (2001, cited in Yin 1989:22–23) define a case study as:
"The essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions, why they were taken, how they were implemented, and with what result."

The exploratory case study aims to explore phenomenon in the data that the research is investigating. The exploratory case study is usually based on general questions that serve as a door opener to further examination of the phenomena being investigated (Zainal 2007). Yin (2009) has identified five components that are especially important for a case study, and they are: Research question, propositions, if any, Unit(s) of analysis, Logic linking the data to the prepositions and Criteria for interpreting the findings.

The case study was chosen because it looks at one individual installation, and the empirical nature of the research is in a qualitative form. Also, Ellram (1996) claims that if the data used in the research and the analysis is qualitative, the most logical methodology is to apply the case study.

2.3.3 Data collection

This section will show how the data collection was conducted. The first part will give an overview of how the data was collected, and which methods that was used. The second part will describe the analysis of the data collection.

Yin (2009) made a list of the six major sources of evidence that are most common in case studies: Documentation, archival records, interviews, direct observations, participant-observation, and physical artefacts. Although this is the most common ones the complete list is quite extensive e.g.: photos, videos, videotapes etc.

2.3.3.1 Interviews

During this research, unstructured conversational interviews with key personnel have been conducted were the interviews purpose was to get an understanding and overview of the HOLD solution. This means the expectations to the solution before the implementation, the implementation itself, and the results of the implementation.

According to Yin (2009) interviews is one of the most important sources that case studies can collect data from. In case studies the interviews are more of a guided conversation than structured queries. This means that throughout the process there are two things that is important: 1 – Follow the line of inquiry reflected from the case study protocol, and 2 – ask the questions in a conversational, unbiased, manner which reflects the line of inquiry.

The interviews in this research has been in-depth interviews and according to Yin (2009) key informants can in many cases be critical for the success of the case study, and the more a respondent contributes in this process the more this role can be considered as an informant rather than a respondent.

Meyer (2001) says that trust between researcher and interviewees are very important for the interviews to become successful. And to help establish trust with the respondent, one could explain upfront what the key features of the project, and which topics you would like to address in the interview. This will also give the interviewees time to be better prepared and can give better and extensive answers.

There are three different types of interviews that can be conducted, structured, semi-structured and unstructured. In this research there has been conducted unstructured interviews. This is because the respondents get the opportunity to elaborate on the subject without much interruption from the interviewer. The structure for the interviews was limited to some main questions that were prepared to be the basis for the interview.
The questions differed depending on who was interviewed.

The benefits with an unstructured in-depth interview is that the respondent can answer questions in as much detail as they want, and that you can get more valid information about the respondents attitudes, values and opinions, and especially how they explain and contextualize these issues. In an informal atmosphere the respondents can be encourage to be open and honest. In these kinds of interviews the interviewer can also adjust the questions and adapt the direction as the interview is taking place.

The disadvantages with in depth-interviews are that because of the time frame, only a small number of interviews can be conducted and small samples is less likely to give an representative for an population. It can also be difficult to compare the results of the interviews, as each interview can be unique. Unstructured in-depth interviews are time consuming both in form of data collection and data analysis.

2.3.3.2 Recording

According to Gillham (2005) it is strongly recommended to use a tape recorder when interviewing, as long as the interviewee agree and gives permission to this. The benefit by recoding is that nothing that is said will be missed and it is possible to listen to the tape over again. Also if the interviewer is writing and making notes under the interview it is easy to get distracted from what is being said, and the interviewer has to be selective in what is written.

When making recording of interviews, all focus can be directed on the person being interviewed, and it is possible to give eye contact and follow non-verbal communication e.g. body language. Even though the interviews are recorded it is still important to take notes so it is possible to check if all questions have been answered in case of malfunction on the recorder or other errors. (Opdenakker 2006)

In this case some of the respondents at Statoil acted as informants as the data collection was an ongoing process the time I was doing this research at Statoil, while others acted more of the traditional respondents e.g. personnel at Helgelandsbase (HB).

2.3.3.3 Written sources

Governing documents for logistical guidelines have been used to describe the structure and how the supply chain for Statoil are organized. A lot of the information about Statoil and the HOLD solution comes from Statoil's own homepage, and from their intranet and and their own web portal of logistics, called logistikkportalen. Here is information about how Statoil's supply chain is organized and how it works, and some basic presentations about the HOLD solution. Archival records and internal documents were also used in this process.

In addition to this, several previous master dissertations about the oil and gas industry was found both Molde University College, and other colleges.
None of these was addressing this specific topic, so they were not used as specific sources but as general information, and to gain useful knowledge about how the oil and gas industry and how Statoil run their operations.

2.4 Construct validity

The importance of whether a test is actually measuring what it is suppose to measure, or not. For case studies Yin (2009) have provided with three different tactics to construct validity:

- Use of multiple sources of evidence
- A chain of evidence
- Key informants reviews draft the case study report.

Use of multiple sources of evidence:
Also called triangulation of data sources, meaning using evidence from different types of data sources, both primarily and secondarily.
This research responds to the requirements of multiple sources of evidence, and the sources are described earlier in the thesis. The benefit with multiple sources of evidence is that it provides with different viewpoints within and across the data sources.

Chain of evidence:
The principle of this tactic is that it should be possible for an external observer to follow the evidences in the research from the research question and all the way through to the conclusion. In this research this is done through documentation of the data collected, citation of theories and scientific articles, and recordings and transcription of interviews.

Case study report review:
The case study analysis and results from the data collection was reviewed and consulted by key informants at Statoil. The final result of the research was, however not reviewed due to time constraints by the thesis.

2.4.1 Internal validity
The internal validity test measures whether the independent variables is the reason to the changes made in the dependent variables being studied in the research.

This result from this research have identified independent variables that is the reason to changes made in dependent variables, but there is also some variables that can not be identified as the reason to the changes made. These will be presented and explained later in the thesis

2.4.2 External validity
This test tells whether it is possible to generalize the study's findings. This issue has lead to criticism for the case study, because it is claimed that single case studies cannot offer a good basis for generalizing. However there is one factor to take under consideration here. What regards generalizing findings from studies, survey research relies on statistical generalization with the intention to generalize to a larger universe, while case studies relies on analytical generalization where the researcher tries to generalize a particular result or set of results to some broader theories. (Yin 2009)

This research goes in-depth for the Norne installation and the results should be possible, to some degree, to transfer to other installations. This is because the upstream supply chain for Norne is in general the same as for all other installations and it is this standardized supply chain that have been the basis for the HOLD solution, so therefore it should in theory work similar for other installations.

There is however some differences regarding geographic location and the size of the installations and the supply bases. Norne and HB are relatively speaking small compared to many of the other installations and supply bases. This means fewer departures of supply vessels, and usually longer distances for the materials to travel to reach HB.

2.5 Reliability

The goal for this test is to make sure that if later researchers were to follow the same procedures and conducted the same tests as done by the origin researcher, the later investigator should end up with the same results and conclusions as the origin. (Yin 2009)

For this research the documents, tables and graphs will stay the same and available for the future. For the interviews it is plausible to think that the outcome would be alike, but it will depend on if there is the same people in the same positions in Statoil. There is a challenge that the interviews were in-depth and unstructured. This could cause some differences in the interpretation of the interviews and the result, and if structured interviews had been conducted the reliability would be improved.

2.6 Limitations

This research has limited the focus of the research to one offshore installation Norne, and one supply base, Helgelandsbase. This is because it would not be possible to conduct the research for all Statoil installations with the resources and time frame that is set for this thesis. Also by using one installation it is possible to go more in-depth than it would by using several installations.

Secondly, it is not all kind of cargo that is been focused on in this research, only materials that are affected by the HOLD solution. That means that materials that are transported with helicopter, bulk cargo or service deliveries has not been focused on in this thesis. Since the hold solution is in a beginning phase of the supply chain improvement project it is only valid for Statoil's own material, and not their suppliers. The plan was that if this were a success for Statoil, then it would be implemented for their suppliers at a later time.

Thirdly, the data used in this research is limited. The HOLD solution for Norne was implemented in November 2013 and the data collection was performed up to April 2014.

To get a comparable result from the before and after situation a time interval from November – April for 2013 and 2014 was used.

Fourth, due to time restriction on the research there was chosen some specific measures to analyze the effects of the HOLD solution, as it would not be able to perform measures of all effects of the solution.

3.0 Organization

To give the reader an overview of the scope of the thesis, there will be given a presentation of the Norne organization, the offshore installation itself, and the supply base that is described in this paper.

First there will be an introduction of the organizations involved in Norne operations. Norne, as every other offshore installation, have many organizations involved to support their offshore operations. This thesis has only included those organizations relevant and that will be affected by the HOLD solution. The presentation of the organization starts with Statoil ASA and the 7 business areas that exist included the business area that this research will be focusing on.

3.1 Statoil Development Production Norway (DPN)

Statoil ASA consists of seven different business areas, staff and support divisions and corporate communication. The seven different business areas are: Development Production Norway (DPN), Development Production International (DPI), Development Production North America (DPNA), Marketing Processing and Renewable energy (MPR), Technology Projects and Drilling (TPD), Exploration (EXP), Global Strategy and Business Development (GSB)

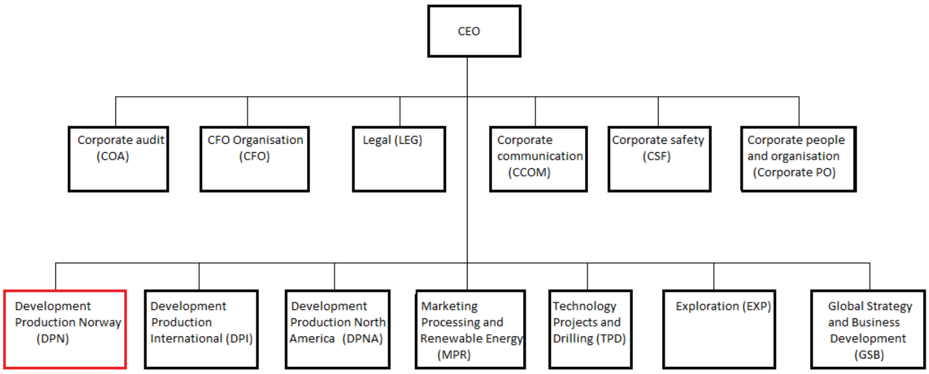


Chart 3-1: Organizational chart for Statoil 1

Statoil's Development and Production Norway (hereby denoted as DPN) are responsible for developing and producing oil and gas resources on the Norwegian continental shelf, and today they are responsible for more than 80% of the oil and gas production in Norway. Today there is 36 Statoil operated fields on the NCS with 34 fixed installations, and about 15-20 mobile rigs that is hired depending on the operations. UPN has approximately a total number of 8 100 employees. Operations in DPN are divided into 8 business units, and supporting organizations as Communication, Finance and Control, Human Resources, and Health, Environment and Safety.

The 8 operating units are:

Field development, Strategy and Business Development, Operations Mid-Norway, Operations North Sea West, Operation North Sea East, Operation North, and Joint Operations. The focus of this thesis will be on Operations North.

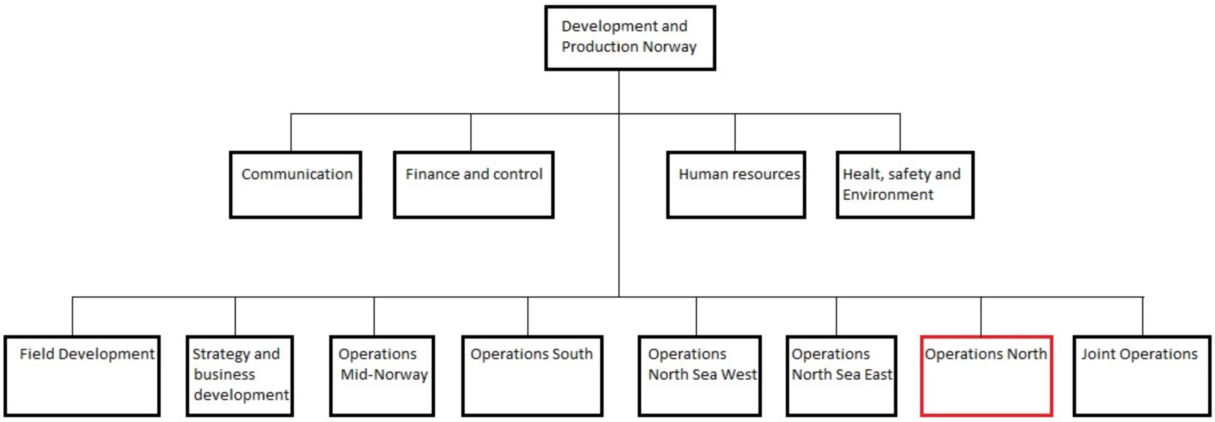


Chart 3-2: Organizational chart for Statoil 2

3.1.1 Operations North

The producing fields in Operations North are Åsgard, Mikkel, Heidrun, Kristin, Norne, Urd, Njord, and Snøhvit. Characteristics of the region Operations North operates in, is that the water depths the petroleum reserves are located in is between 250 – 500 meters. This leads to conditions where the reserves are under both high pressure and temperatures that complicate the development and production. These have challenged the participants to develop new types of platforms and new technology, such as floating processing systems and subsea production templates. The planned future for Operations North is to increase the efficiency by coordinating their operations to stopping the declining tail-production through increasing seismic activity and well maintenance. Which in turn will demand more materials/equipment and an increased material flow between on- and offshore.

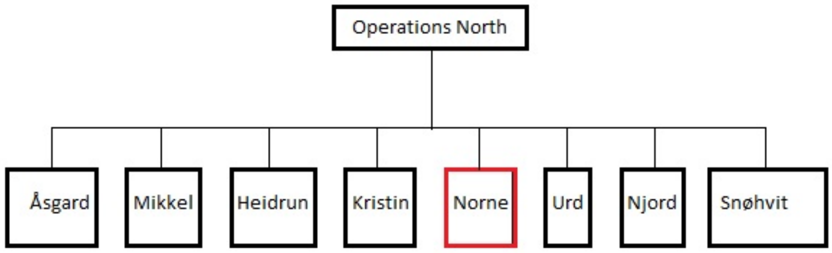


Chart 3-3: Organizational chart for Statoil 3

3.1.1.1 Norne

Norne is an oil and gas field located in the Norwegian Sea 200 km outside Helgelandskysten, and about 80 km north of the Heidrun field. Norne is placed at 380 meters water depth and 2500 meters below the seabed, and the field was proven in 1992, and the production was first started on 6. November 1997. Norne belongs to “Drift Nord” and the administration of the field is located at Statoil’s office in Harstad. Statoil’s office in Harstad was in 2013 established as a new area of operation for the Operations North, and got the responsibility for Norne-, Snøhvit and the new Aasta Hansteen field. Today there are about 300 employees at this office, and they are also responsible for Figure 3-1 Norne field exploration activity and field development in the far north. The exploration environment in Harstad has been considerable enhanced in recent years, and it is going to expand further in the years to come.

Figure 3-1: Norne field

The field has been developed with a production and storage ship called Norne ship, which is a FPSO - Floating Production, Storage and Offloading installation. Norne is that is tied to subsea templates and the well stream is transported to the ship through flexible risers, and the ship itself can rotate around a cylindrical turret mounted to the seabed so that it can cope with wind and weather conditions. The ship also got a processing plant on deck and storage tanks for stabilized oil.

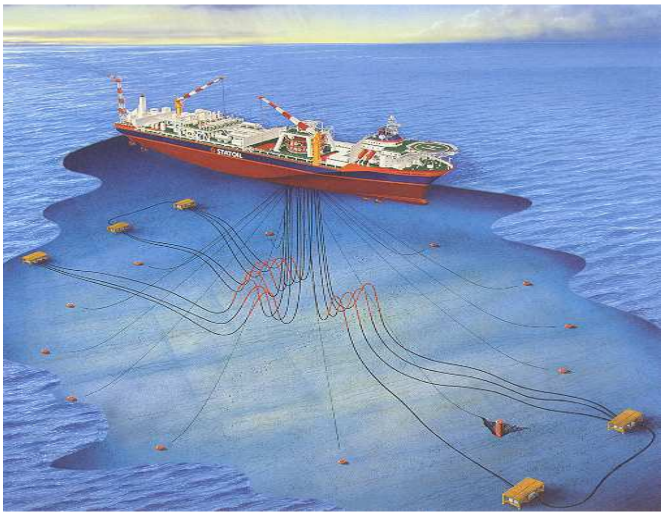


Figure 3-2: FPSO Norne

3.2 Helgelandsbase (HB)

Helgelandsbase AS (hereby denoted as HB) is a supply base for the petroleum sector located on Horvnes in Sandenessjøen. Since 1983 HB has been providing services for most of the oil companies that operates in the Norwegian Sea, as Phillips (PPCO), Exxon, Mobil, BP, Elf, Amoco, Chevron, BP Amoco, ENI, Shell, Saga, Hydro, Det Norske and Statoil. Today HB is serving as an important supply base for Statoil, and is responsible for materials, terminal services, and the maritime coordination for Norne, URD, Alve and Skuld fields in the north of the Norwegian Sea. They are also serving the ENI operated Marulk-field. HB is also serving search and exploration in the Norwegian Sea. The base is performing daily planning/scheduling and coordination of load operations of supply vessels.

HB is today performing loading/unloading of supply vessels, internal transportation, and assists on deliveries of shipments of bulk, MGO and waste, and project activities. They also offer a broad variety of logistical services:

- Administration of materials
- Rental of storage and office facilities,
- Inspection of shipments
- Customs warehouse
- Purchasing services.

They are also facilitating for, and following up both for in and outgoing material flow in the supply chain. The base area consists of 150 000m^2, where 30 000m^2 consist of storage location, service areas and office facilities. They also got tank facilities of approximately 23 000m^2 for wet-/drybulk and MGO (Marine Gas Oil.

Today there is 35 companies operating within Horvnes industry area with approximately 250 employees, where 25 of these companies are established or rent services of HB.

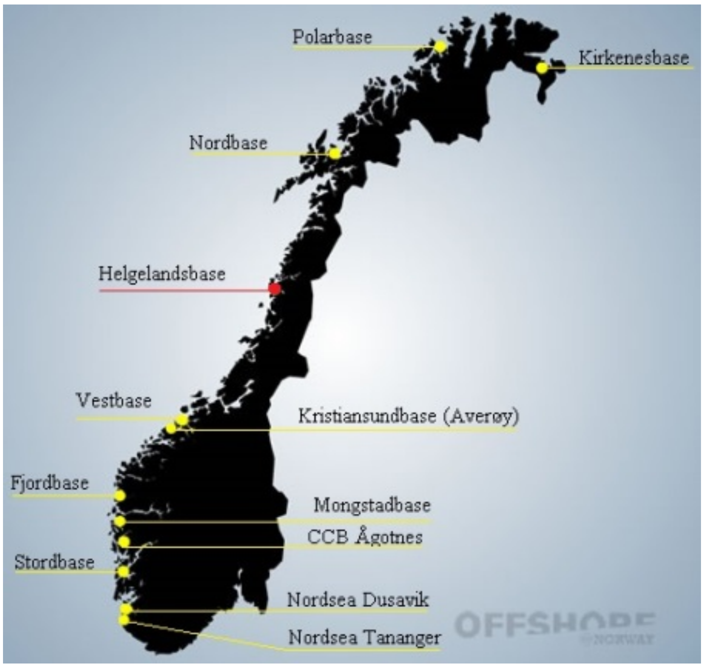


Figure 3-3: Helgelandsbase

4.0 Upstream Supply Chain

This section will describe the current supply chain structure for the supply chain of Statoil and Norne. First there will be presented an explanation of how Statoil have structured their logistic and later there will be a presentation of the supply chain of Statoil and Norne.

4.1 Logistic

Statoil describes logistic as a part of their supply chain management (SCM) and covers: Planning, execution and follow up of logistics demands for helicopter services, transportation, supply base activities and vessel operations, including related supporting information throughout the logistics chain.
Statoil got an overall objective to provide cost effective logistic solution and complete deliveries and services on time. Existing logistical solutions and new global solutions should be improved and developed, with a focus on handling risk with constraints related to sustainability and the environmental impact.

The supply chain solutions are developed so that they intergrate with each other, where planning and follow up activities related to logistics and material management are executed in close relations with procurement and services related to D&W (Drilling and Well) and O&M (operation and maintenance) and project activities. To find the best and most efficient solution can be a challenge, but it is essential to have efficient supply chains especially when a considerable amount of the costs of Statoil are linked to their supply chains. That is why they are now trying to identify and realize improvement measures to be able to increase the supply chain quality, and to secure their competitiveness.

4.2 Supply Chain

Harrison & Van Hoek (2005) defines a supply chain as a "Network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage".
The figure below illustrates a supply chain, and it shows how an entire supply chain is structured and how it consist of both up and downstream supply chain activities.

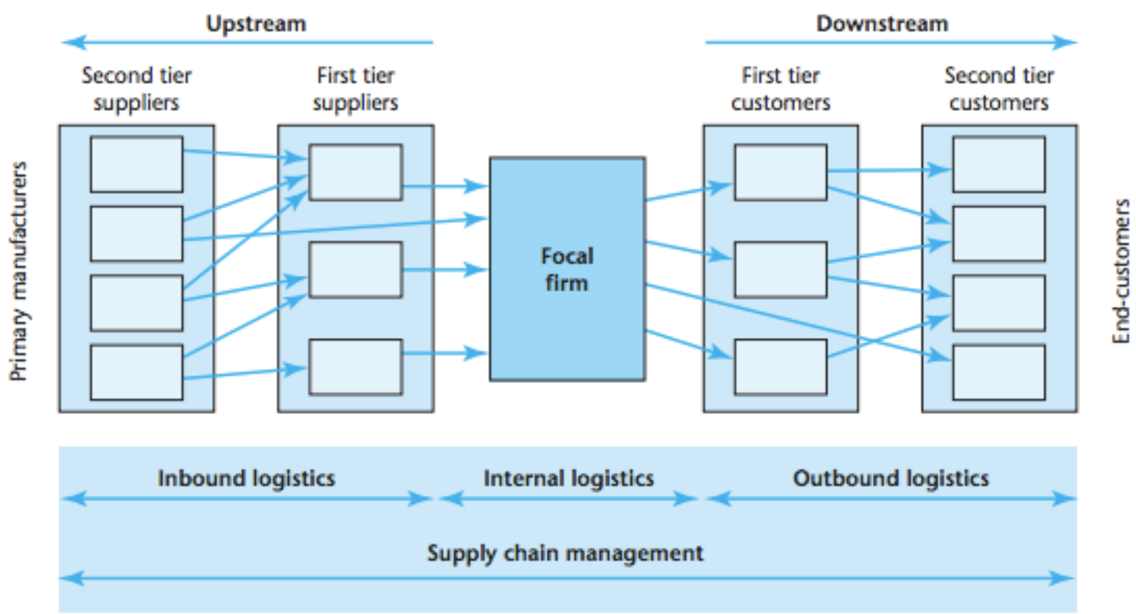


Figure 4-1 Upstream supply chain (Harrison & Van Hoek 2005)

The downstream SC is the activities connected to the operations from the oil are produced on Norne and until the oil is processed, transported and delivered to the end customer. The first tier customer for Norne will be the oil and gas refineries that processes the oil and gas into the end products as gasoline, diesel. The second tier customer will then be the retailer that sells these products to the end customers. The logistical activities connected to the downstream supply chain are called outbound logistics.

The upstream SC is the activities connected to exploration and production of oil and gas, this includes all maintenance that is required in these processes. That means from a need occurs offshore and until this need is fulfilled, and are all activities from sourcing, planning, transportation and the end activity. In the figure the suppliers are divided into first and second tier suppliers. The first tier suppliers are the direct suppliers for the focal firm, and for Norne that would be, e.g. Aker Solutions, Linjebygg Offshore and Siemens. The second tier suppliers are the key suppliers of the first tiers suppliers, without supplying the focal firm directly. Bring is responsible for the transportation between Statoil's suppliers and the supply bases, in this case HB. The supply base in Sandnessjøen is the storage location for Norne, and it is here all materials is transported and stored before it is shipped out to Norne. The scope of this research will be focusing on the upstream supply chain where Norne will be defined as an end customer, since the downstream supply chain is not within the scope of this research.

4.3 Planning structure

Statoil's planning structure is divided into:

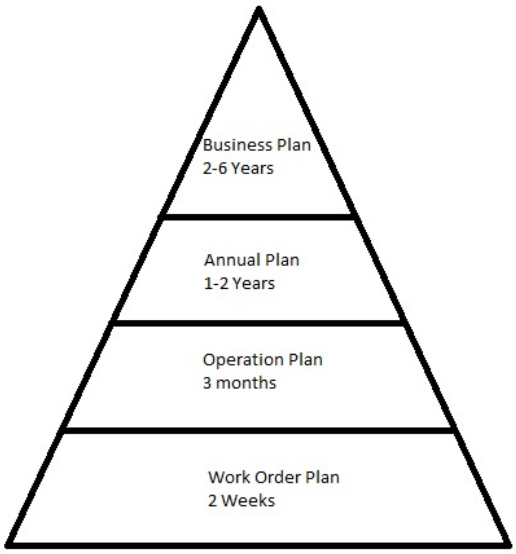


Figure 4-2 Planning structure

Work Order Plan

The scope of this research will be focusing on the 2 week work order plan, as this will be the area affected by the HOLD solution. All work that is planned for the next 14 days on Norne is planned and structured through the work order plan at Norne OPS.

4.4 Norne supply chain

Here it will be given an illustration and brief description of how Statoil's supply chain for Figure 4-3 illustrates Statoils supply chain.

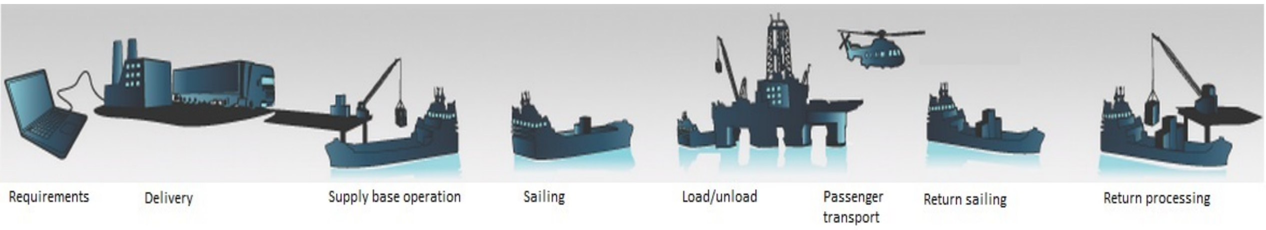


Figure 4-3 Statoil supply chain

4.4.1 Need Occurs

A continuous high level of offshore activity generates an increasing onshore demand for material and bulk goods. Both D&W, operations and maintenance (O&M) and ongoing projects demands huge amounts of supplies. The demand varies depending on the installations size and activities. Some of the material is stored at the supply bases and some needs to be requisitioned from external suppliers.
The logistical operations connected to an offshore installation are huge and complicated. There is lot of operations in process at all times and often simultaneously in order to maintain continuously operations offshore. This makes the planning of the logistics a highly demanding task.

Material/equipment that is going offshore has to be delivered at the latest 16.00 the day before the departure for the vessel at HB. This is so that the base personnel have time to check and pack the material/equipment and plan the placement of the load carriers onboard the vessel so that everything is ready before the departure. It is however possible to bypass this deadline and that is when unforeseen situations occurs and there are immediate needs offshore. These rush orders are called B-priorities and they are a specification on why this order is qualified for this shipment. In some cases the supply vessel
needs to be hold back in order to wait for the b-priority to arrive/prepared for the transportation. (Logistikkportalen 2014a)

Approximately 75% of the tonnage that is sent offshore is also shipped back onshore in form of return/backload shipment. This is a significant part of the total transport volume, and it has to be taken under consideration when the sailing plan is created to ensure that there is sufficient capacity onboard the vessel when it is going back onshore. For shipments going onshore, has to be registered latest by 10.00 the day the supply vessel leaves the supply base.

The material coordinator offshore is responsible for register the return shipment, and it is done through a notification in SAP. It is very important that this notification is done correctly so that the exact volume, weight, and numbers are registered so that the base can plan the capacity and vessel need.

4.4.2 Delivery

When a need arises offshore, it needs to be defined and approved with a notification as mentioned earlier. After the need is defined, a requisition is made based on the notification. The notification is the documentation that describes what materials is needed for the different operations on a WO. All supply need is initiated by a requisition which is created in SAP. The requisition and WO form the basis for the procurement, and the components are procured according to the WO.

When the supplier has received the order from Statoil, the shipment needs to be prepared for it is shipped off. This includes proper packing and securing the materials according to Statoil's guidelines, also they need to make sure that the proper documentation; product information, certificates and approved data sheet follows the shipment. There should also be a waybill and a packing list, and every line of the order has to be labeled.
The shipment is then transported to the supply base, and it is Bring that is responsible for Statoil's transportation between suppliers and the supply bases.
It is usually trucks that are used as transportation mode to the bases, but also sea and air transport is used. This will depend on rush orders, weather conditions etc.
Statoil have set some deadlines on delivery times from supplier to supply bases, and these can vary depending on where the supplier and the supply base are located. In some cases however it might be needed to get the shipment to the base faster than it usually does depending on how fast it is needed. (Logistikkportalen 2014b)

4.4.3 Base Activities

Base activities include all activities that are linked to the outgoing material flow in the supply chain. All loading and unloading of load carriers that arrive at one of Statoil's supply bases have to be done according to European and international regulations as well as Statoil's own internal regulations.

When the shipment arrives at the supply base it is checked and given a quality inspection. There are different procedures for receiving goods depending on the kind of material that is received, and it is important that the shipment is checked according to the procedures made for the specific material. It is also important that the documentation from the supplier matches the information in the order.

It is important to check that all necessary documentation that is supposed to follow the shipment is actually there. After the shipment is received and approved, it is ready for further transportation offshore. Also here it is regulation of how the load carriers should be properly packed. The load carrier should be suited for the cargo it is transporting, e.g. some cargo requires special carriers and some require open carriers. Every load carrier should be regularly checked and controlled. Cargo going offshore has to be properly packed with the receivers' safety mind, and it have to be placed and secured correctly in the load carrier. The load carriers also need to be correctly sealed and marked.

It is the supply bases responsibility to make the sailing plan for the supply vessels, which contains what is shipped and to which installations the vessel is going with both in and out going shipments. The plan is made in accordance with the installation, supply vessel and other parts that may be relevant. After the vessel leaves the supply base it is Statoil Marin that follow ups the sailing plan and the vessel, and are responsible for changes that may be necessary. This could be changes in weather conditions.
To ensure best possible information flow and sharing, there are daily coordination meetings between all supply bases, Statoil Marin and marine operation.
The sailing plan has to be completed by 12.00 the same day of departure of the vessel. The completed version of the plan will form the basis for the loading plan. Changes made on the plan after this deadline lead to increased costs for the customer that requests the B-priority.

When the sailing plan is finished and approved it will be handed over to the supply vessel Before the supply vessel is loaded there is a meeting between the captain on the vessel and the person responsible on the base where the loading plan is made, but it is the captain that is the responsible for this plan. When everything is loaded according to this plan and secured a manifesto is signed and delivered from the vessel and to the supply base, which is then registered it in SAP.

The benefit with correct and good placement of goods on the vessel, besides safety, is that the vessel can reduce the loading time at the installation, and reduce number of lifting operations. (Logistikkportalen 2014c)

4.4.4 Sailing

Statoil Marin and the vessels captain have a continuous communication and consultation to decide whether if it is safe to start sailing or not. Things like sea and weather conditions have to be taken under consideration before the vessel sails. However, it is the captain that got the overall responsibility for all vessel operations and has the final word.
If the weather conditions are bad and the captain thinks that either the sailing or the lifting operations are too risky to perform, then this will be postponed.

When the supply vessel is at sea it always has continuous communication with Statoil Marin and the offshore installations. All offshore installations have a 500 m safety zone around the installation, this means that the vessel needs permission from the installation before entering the zone and cannot enter before this is approved. Statoil also got different guidelines and procedures in case of the vessel comes on collision course with the installation.
When the vessel is approved for entering the zone and approach the installation the preparation for the lifting operations can begin. Also here is it a continuous communication between the bridge, crew and the crane operator on the installation. When the vessel is done and ready to leave the installation, it also need to rapport to Statoil Marin with the departure time so that the sailing plan can be updated and be as correct as possible. Unplanned changes to this plan can only be executed by Statoil Marin.
HB has 3 weekly departures from the base, which is Monday, Wednesday and Friday. When the vessel is fully loaded, Statoil Marine takes over the responsibility for the sailing plan. (Logistikkportalen 2014d)

4.4.5 Receiving and return

When the installation is notified about a call from a supply vessel, a set of procedures is initiated to be ready for the vessel to arrive. All goods that is going back onshore is registered in SAP of the materials owner and material coordinator offshore, and they make sure that the correct documentation for the shipment is available before it is properly packed and secured. This will be most important information for the captain and the supply vessel, especially with dangerous goods.
Since the lift operations are the mist critical activity he communication between vessel, installation and crew is very important in every lift operation, and the radio communication has to be tested before the operation starts.

When the supply vessel arrives at the installation, the lifting operations start. Load carriers from the vessel are lifted onboard the installation and any load carriers going in return onshore, is lifted from the installation to the vessel. Since the lift operations between the installation and the supply vessel are the most critical activity in the supply chain, it requires very good preparations and communication. The communication between vessel, installation and crew is essential in every lift operation, and the radio communication has to be tested before the operation starts. Good preparation also reduces time and risk connected to this operation.

If the operational conditions that were based on the risk assessment when the plan was made is changed when a lift operation is performed the operation stops. It will then be made a new risk assessment and corrective safety measures are executed if necessary, and this will in the end be the captains' decision. (Logistikkportalen 2014e)

4.4.6 Return sailing

When the vessel leaves that installation and the 500m zone, it sends a report to Statoil Marin containing: Backload, remaining cargo, what the vessel has unloaded and received, free cargo capacity, arrival and departure times, and if there were any delays.
When the vessel is approaching the base again it is important that the base have received the correct information about the cargo coming in return and the vessels need for service. The vessel have been designated its own place at the dock, and the necessary cranes, cargo receivers, and crew has to be mobilized to receive the vessel. It will also be made a activity plan for unloading the vessel at dock. (Logistikkportalen 2014f)

4.4.7 Return processing

When the vessel is docked at the supply base, the base personnel and the crew from the vessel has a meeting where the unloading of the vessel is planned. After the vessel has been unloaded, the bulk tanks needs to be controlled and cleaned. Some bulk products require a tank that is cleaner than the washing system onboard the vessel can perform. This will then be washed manually by a hired specialist from a supplier.
The cargo that has been lifted onshore from the vessel will be sent for repair, stored at the base, returned to external supplier, or scrapped/disposed.

Either way, the cargo has to be registered on designated return codes.
Hazardous waste should be sent to an approved waste disposal as fast as possible. Before it is sent from the base it needs to be stored at temporary storage that is clearly marked. (Logistikkportalen 2014g)

4.4.8 Air transport

It is not just shipments of material/equipment that has to be planned for Statoil's operations offshore. Equally important is the logistics of people working offshore. Most of the offshore workers have a fixed shift arrangement where they work 2 weeks offshore and have 4 weeks off, and gets automatically booked after this schedule. If there is single bookings or extra trips planned it is each installations responsibility that this is done by 12.00 two days before the departure of the helicopter.
Statoil uses helicopters as the only mode to transport personnel to and from more than 50 offshore installations, and they transport around 190 000 passengers per year on the Norwegian Continental shelf. There are 6 helipads along the Norwegian coast, from Stavanger in south to Hammerfest in the north. The helicopters are mainly used for personnel transport, but they also transport mail and luggage.
The personnel going offshore have to meet at least 60 minutes before the departure with the necessary documentation and certificates to go offshore. There will also be a briefing in the usage of the survival suit and safety routines.
The pilots have to perform technical and operational checklists before the flight to ensure the safety of the flight, and of course also here the weather conditions play a significant role. Today it is the companies CHC and Bristow that performs the transportation flights for Statoil.

When the helicopter arrives at the installation the arriving personnel will be designated a cabin and be introduced to the safety routines for the installation.
The transportation of personnel has to be carefully planned with regard to numbers of seats in the helicopters, and numbers of flights with the helicopter. In addition there are a certain number of cabins onboard the offshore installation. An already complex operation is further complicated when factors like wind and weather is taken under consideration, so to make this work requires a lot of attention and detailed planning.
(Logistikkportalen 2014 h)

5.0 Description of SAP

SAP ERP is the enterprise resource planning software system that Statoil uses, and the purpose with the system is that it incorporates key functions of an organization. It is a common centralized database for all the applications that are within the organization. The idea is that one system can handle the entire functional departments in an organization. It can be used to collect, store, manage and interpret data from different activities as: Planning, cost and development, inventory management, and shipping and payment. All technical actions that are connected to activities for the supply chain of Norne, from creating notifications to ending work orders, is done through SAP.

5.1 Tag

In SAP, a tag is an object that describes the function and location of installed equipment on an onshore or offshore installation and it contains different attributes depending on the tag category. Every functional component subject to certification, inspection or maintenance during operations has to be allocated a unique plant tag number.

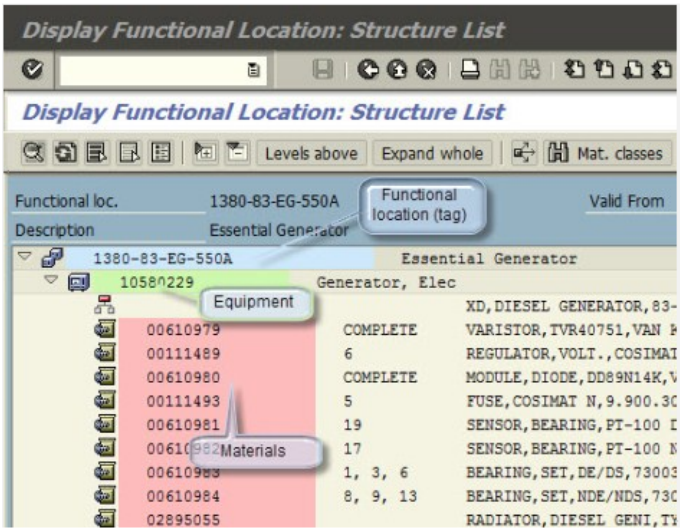


Figure 5-1 TAG

In figure 5-1 there is an example of how the tag system works in SAP and as we see in the description this is an essential generator, and it got a unique functional location (tag) 1380-83EG-550A. This is then the unique tag number that every functional component that Statoil uses on their installations should have. The line below the tag line is the equipment line (10580229) and it indicates all equipment that is sub-categorized to the specific tag.

The last category is materials also known as bill of material (BOM). BOM is the list of all components that the specific equipment consists of, included quantity and unit of measure. Each equipment line has its own BOM. All relevant technical documents that are connected to the tag and BOM, are also transferred in SAP.

5.2 Material master

Material master is the register of material numbers in SAP. A material number describes a specific product, and is used in warehouse management, BOM, material planning, purchasing and agreements.

5.3 Notification

The first step when need for material/services occurs offshore is to define and verify the need. When personnel identify a failure or that non-malfunction work is required, a notification has to be created. This is done in SAP, and the notification that has to contain sufficient and correct information on why it is created. After the notification is created it will be reviewed and discussed in cooperation with the onshore personnel.

Every morning at OPS Norne there is a 24h-meeting through a videoconference. This meeting consists of offshore personnel at Norne and onshore personnel at OPS Harstad, and includes supply chain coordinator, field managers and planners. The purpose of the meeting is to check all new notifications that have been made since the last 24h-meeting and decided whether the notifications are approved, declined or returned offshore in order to be modified so that it will fulfill the requirements. They also have to agree on the priority of the approved notifications depending on the criticality of the notification.
To secure correct required end date the notification should not be released, or the work order should not be established, before the required end time and risk assessment has been evaluated and agreed upon.

5.4 M5 updates

For technical updates in SAP an M5 notification is required. This is an technical information update request handled directly in the operation system, SAP.

It is an notification of change to initiate, allocate and follow up work in order to update technical information and will include all types of updating request, including:

- Updating of drawings or other technical documentation
- Changing of spare part list (BOM – Bill of material) and inventory information
- Updating the maintenance program and inspection program.
- Updating of classification e.g. criticality, containment, chosen safety critical equipment.
- Updating of masterdata/inventory information in SAP, e.g. equipment information, work center, planner group, WBS and measuring points.

5.5 Work order (WO)

A WO is made on the basis of approved notifications in the 24h-meetings. There are 5 kinds of WO: Corrective maintenance orders, preventive maintenance orders, modification orders, cost orders and project orders.

Corrective maintenance orders are used for all corrective maintenance, meaning all maintenance that are executed with the goal of restore the equipment technical condition so that it can perform its intended function.

Preventive maintenance orders are used for all preventive maintenance, and these WO are generated from a predefined maintenance program in SAP. The different activities types for preventive maintenance are: Periodic maintenance, condition monitoring, inspection and surface maintenance.

Modification orders are used for improvement measures or smaller modifications where it is not necessary with network planning to execute the job. Modification orders can also be created without a notification.

Cost orders are used in cases where it is not appropriate to create a separate WO for a job. This can be operating activities that are not necessary to order on material/equipment or smaller maintenance activities. Examples of this can be bulk cargo, consumable materials (chemicals, diesel, filters, gaskets, tools etc)

Project orders are only used in connection with projects and modifications that relates to physical work like welding, piping, assembly and installation. These orders are always made directly and never through a notification.

Statoil's priorities and deadlines is based on how critical the order is and how it affect the operations on the installation and. The different deadlines are divided into 4 priorities, and it indicates how many days until the WO has to be rectified:

- High: 5 days
- Medium: 45 days
- Low: 180 days
- Non-priority: 365 days

For Statoil it is crucial that these deadlines are met. If not, it could cause severe consequences in terms of health, safety and environment. It is also an economic aspect of this in terms of huge economic loss if the installation has to shut down the production due to delays. When the notification has passed the requirements, a WO will be made on the basis of the notification. Then a requisition has to be made for the needed material/equipment. A requisition is the basis document for the procurement function that describes what is needed.

Figure 5-2 illustrates how a WO is set up in SAP. On the top of the page we can see the WO number followed by a description of the content and the activities performed that is connected to the WO. In the row under the description there are different tabs that contain different information. The tabs used for this topic was HeaderData, Operations and Components.

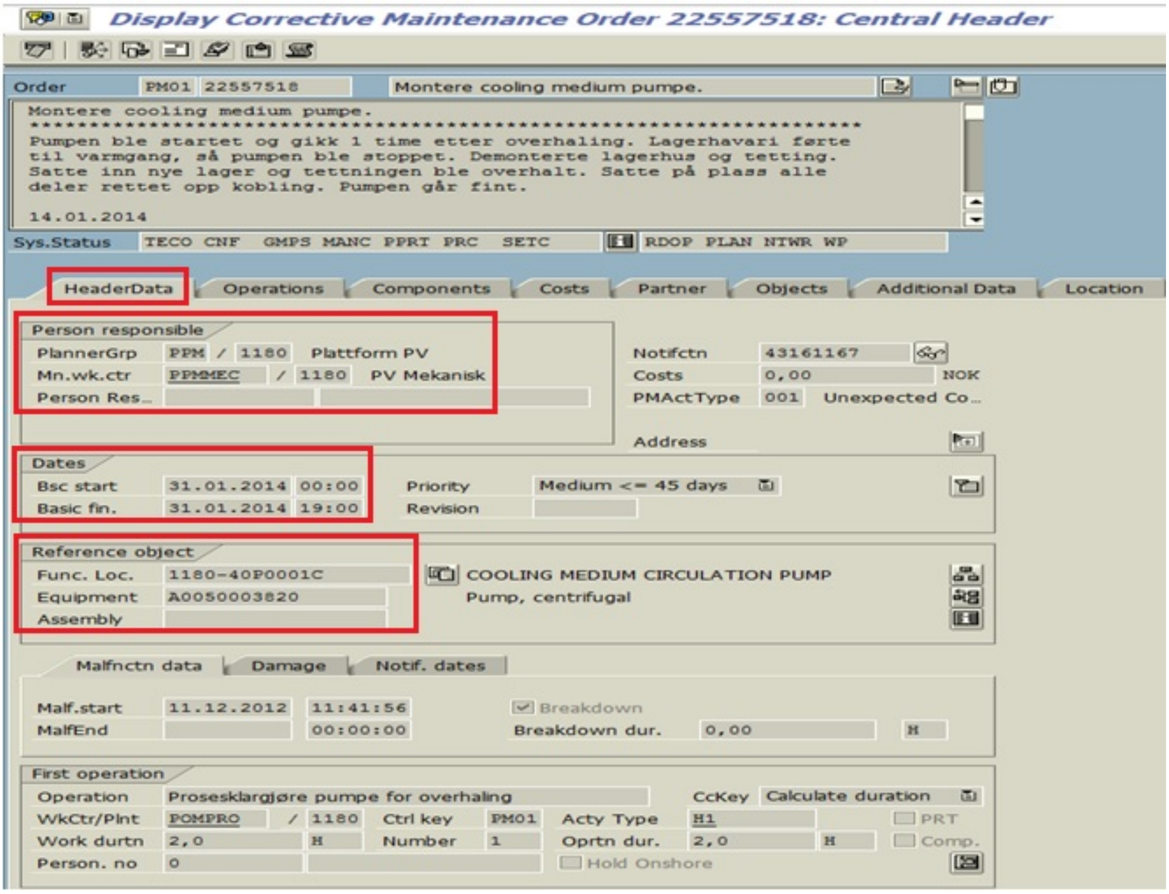


Figure 5-2: WO 1

The HeaderData tab provides with some general information about the WO as who is responsible for the WO, priority levels, planned start and ending date for the WO, and functional location (Tag). The functional location number is the reference that is used to connect operations on a WO to HOLD and is located under the “reference object”, and will be further explained later later.

Every WO that is valid for the 2-week plan-period, have to be registered with a PLAN code, which can be seen under Sys.Status in the figure. The plan code have to be registered on the WO in order for the hold indicator to be activated, if not it will not be picked up by the automatic hold/release function. The Main Work Center indicates who is responsible for each specific WO; in this case PPMMEC. This means that when all equipment is required and the operations are planned, the WO gets a plan code that makes it ready to be placed on the 2-week plan-period.

The next figure 5-3, is the operations window and it displays all operations that are connected to a WO.

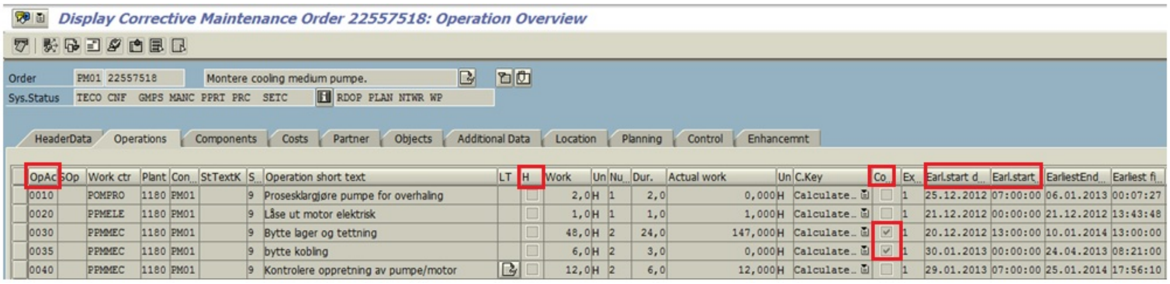
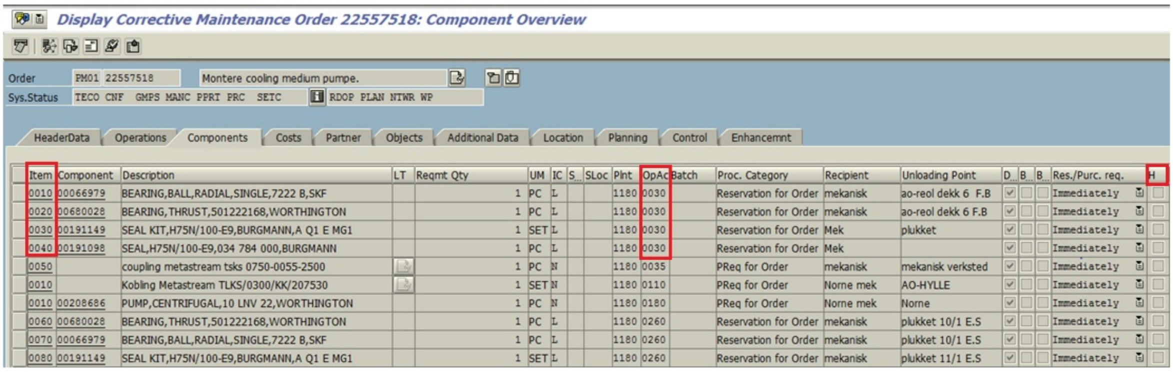


Figure 5-3: WO 2

An operation is a work activity that is a part of a WO. These operations can be preparing components for overhauling, changing components, and test new components. A WO can consist of many different operations and they are displayed in the first column OpAc where they are identified by numbers 0010, 0020, 0030 etc.

Under the column “Co” it is possible to see which operations that it is ordered components for, in this example we can see that there is ordered components for operation 30 and 35. Further down this list there is also ordered components for operations 110, 180 and 260. The dates for the operations are also displayed here under the columns “Earl.start.d” and “Earl.end”. Since all these lines belong to the same operation they have the same dates, but in cases where there are different operations there can be different start and ending dates for the different operations. It is also these dates that the HOLD indicator relates to when they release the materials for the operations, and they are released 10 days before the start date.

In figure 5-4 the component window is displayed, this shows which components that are ordered for the specific operations on the WO.



Item	Component	Description	LT	Reqmt Qty	UM	IC	S...	SLoc	Plnt	OpAc	Batch	Proc. Category	Recipient	Unloading Point	D...	B...	B...	Res./Purc. req.	H
0010	00066979	BEARING,BALL,RADIAL,SINGLE,7222 B,SKF		1	PC	L			1180	0030		Reservation for Order	mekanisk	ao-reol dekk 6 F.B				Immediately	
0020	00680028	BEARING,THRUST,501222168,WORTHINGTON		1	PC	L			1180	0030		Reservation for Order	mekanisk	ao-reol dekk 6 F.B				Immediately	
0030	00191149	SEAL KIT,H75N/100-E9,BURGMANN,A Q1 E MG1		1	SET	L			1180	0030		Reservation for Order	Mek	plukket				Immediately	
0040	00191098	SEAL,H75N/100-E9,034 784 000,BURGMANN		1	PC	L			1180	0030		Reservation for Order	Mek					Immediately	
0050		coupling metastream tsks 0750-0055-2500		1	PC	N			1180	0035		PReq for Order	mekanisk	mekanisk verksted				Immediately	
0010		Kobling Metastream TLKS/0300/KK/207530		1	SET	N			1180	0110		PReq for Order	Norne mek	AO-HYLLE				Immediately	
0010	00208686	PUMP,CENTRIFUGAL,10 LNV 22,WORTHINGTON		1	PC	N			1180	0180		PReq for Order	Norne mek	Norne				Immediately	
0060	00680028	BEARING,THRUST,501222168,WORTHINGTON		1	PC	L			1180	0260		Reservation for Order	mekanisk	plukket 10/1 E.S				Immediately	
0070	00066979	BEARING,BALL,RADIAL,SINGLE,7222 B,SKF		1	PC	L			1180	0260		Reservation for Order	mekanisk	plukket 10/1 E.S				Immediately	
0080	00191149	SEAL KIT,H75N/100-E9,BURGMANN,A Q1 E MG1		1	SET	L			1180	0260		Reservation for Order	mekanisk	plukket 11/1 E.S				Immediately	

Figure 5-4: WO 3

Under the column OpAc it is given which operation each of the lines is connected to, e.g. the first 4 lines, 0010-0040, belongs to operation 30 that means that the 4 components ordered all belongs to the same operation. It is also a column that shows which components that are connected to HOLD and not, this is the last column "H" in the figure. If the operation were registered with HOLD, then all components connected to this operation would have been connected to the HOLD indicator.

Usually the hold indicator releases all items that are connected to the same operation at the same time. However, if needed there is possible to manually shift the requirement date for one specific item of an operation either before or after the rest of the items. This makes the solution very flexible for handling all WO, depending on the situation

5.6 TECO

Technical completion of the production/process order – TECO, means ending an order from a logistical point of view. This is a function that is mainly used when the execution of an order has to be stopped before it was intended, or of some reason could not be executed as it first was intended, e.g. wrong components shipped or missing parts.
The end point for the measure is when an operation is set to finally confirmed (CNF) or the order is set to TECCO.

6.0 Supply Chain Improvement Project (SCIP)

SCIP – Supply chain Improvement Project was established in 2011, and is a project where DPN and TPD – Technology, Projects and Drilling cooperates to make the operations in the supply chain more efficient through focus on closing identified gaps and finding lasting solutions that improves the supply chain. It is essential for Statoil to have an effective supply chain in order to secure safe and reliable operations and maintenances. This means to coordinate activities and operations that are being performed by several organizations on different operations. The key to get a successful result is to cooperate and coordinate across organizations and activities. The goal of SCIP is that when it is phased out, it has build sustainable solutions through development of competence in the organization, so that uncertainty is eliminated and efficiency increased. Then the line organization will be prepared to face the remaining and future challenges that occur in the supply chain.

By creating SCIP, Statoil is also aiming for eliminating the knowledge related barriers across the organization. This means that e.g. the procurement department is dependent on having efficient processes that ensures precise deliveries to operations that are according to demand and guidelines. Operations on the other hand, have detailed knowledge about their needs and demands, but have limited knowledge about the conditions of contracts and prices. To be able to be efficient and cost conscious it is a necessity to understand both businesses and the terms and conditions of the processes. Another place it is important to eliminate barriers is between the onshore and offshore personnel.

The project had an original timeframe that was set to mid-2013, but based on a detailed summary of status and further potential improvement the project was decided to prolong for at least 2 years, and a maximum of 13 years.

6.1 Why SCIP?

There has been a challenge for Statoil to keep high efficiency in their supply chain because of the limited focus that has been on optimizing the supply chains. The upstream supply chain are working in a high pace environment, and they are complex with a lot of different actors.

Illustration 6-1 gives a picture of the complexity and the challenges that Statoil faces in terms of efficiency in the supply chain, and this is what the SCIP project is based on. The illustration summarizes the different challenges that Statoils supply chains are facing.
In the next part there will be a more detailed description of the content in this illustration.

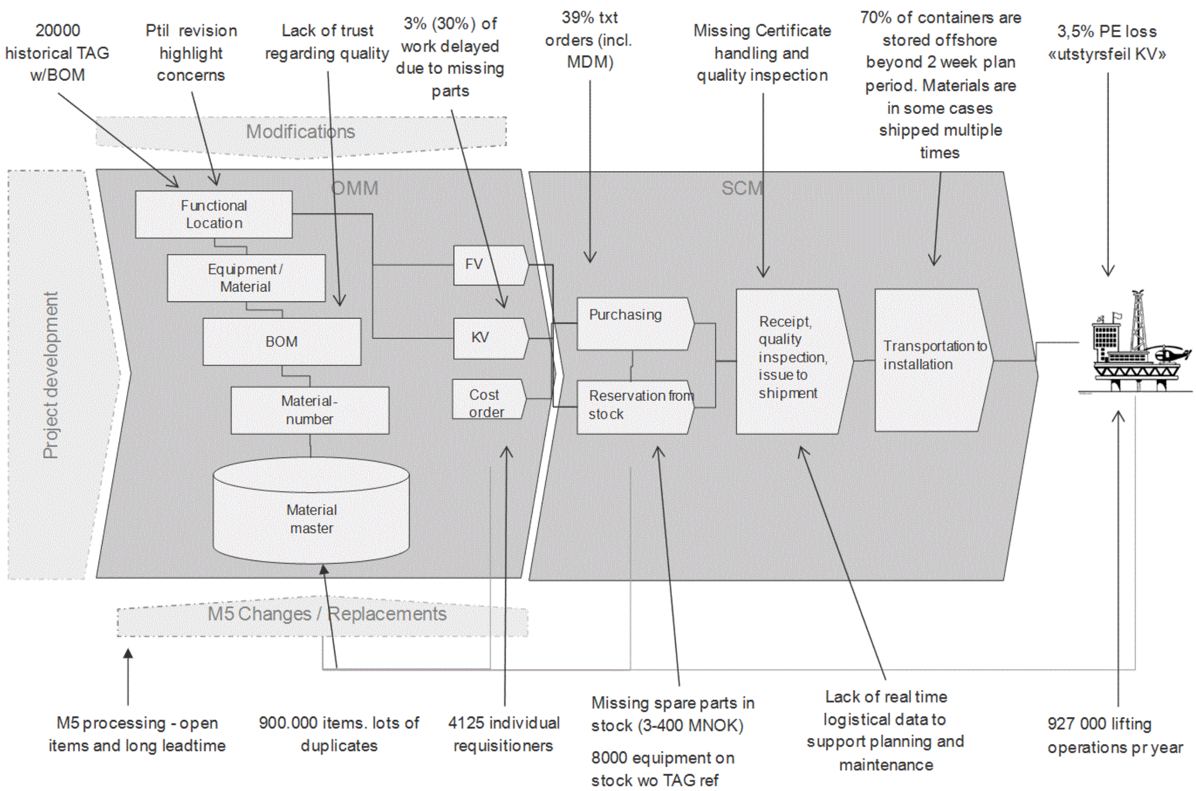


Figure 6-1: SCIP challenges

6.1.1 Historical tags

As time has gone by Statoil's offshore installations has undergone modifications where equipment and components (TAG) has been replaced or modified to other replacements. This lead to a situation where the spare parts and material (BOM) linked to these outdated, or historical, TAGs became redundant. The problem was that these BOMs were not cleared from the offshore stocks or onshore warehouses. An analysis from 2011 revealed that there were more than 4,000 items linked to historical TAGs. This link between historical tags and the BOMs was highlighted as a concern from the Norwegian Petroleum Safety Authority (PSA). If a component at some point is being replaced for another similar component with some modifications, or removed, it is crucial that the belonging tags also are being changed in the system.

This is because if there are spare parts in storage for the first origin component and the tags are not changed according to the new one, spare parts for the origin component will be shipped out when the component needs maintenance or repairs.

It is estimated that around 3 % of work is delayed due to missing parts. This was reflected in situations where an order appeared to contain the correct part when it was ordered, but it turned out to be wrong part when the part was received and inspected before it was supposed to be installed offshore. The consequence was then that the job had to be postponed and removed from the current plan, and the item had to be shipped in return and a new part had to be ordered.

6.1.2 Requisition

There has also been a challenge in Statoil that there were too many requisitioners.
They first found 9000 people that had access to make requisitions in DPN. Of these, over 3000 made 50 or less requisitions per year, and over 600 made only 1 requisition per year. The less requisitions made per person, the higher the use of free text with poor quality was used as a result of not knowing the correct procedures of creating requisitions. This led to a situation where a lot of the requisitions being made was not done according to the correct procedures and the risk for making mistakes increased drastically. This gave a negative impact on the quality, processing costs and deliveries.

The danger is that when people that do not have sufficient knowledge about the requirement process makes requisitions, it is much more likely that mistakes are made. If e.g. requirement date is not correct, or the start/end date for the different operations is not correct, this will lead to a situation where the material does not arrive at the correct dates. It could also occur situations where the PLAN code was not correct registered or registered at all. Without the PLAN code, the material will not be working as it should, and the automatic release function will never be activated. So by professionalizing this role the quality of the requisitions should be improved and the hold function will have better possibilities to deliver results to its intended goal.

The role of a requisitioner is to secure dualism in the procurement process. This means that a minimum of two persons are involved in the procurement process, one person with the requirement and one who actually executes the procurement. The goal is to protect Statoil's reputation and ensure that the process is done according to laws and regulation. A good requisition forms the basis for the procurement of the appropriate goods and services.

6.1.3 Duplicates

There has also been an issue that there are 900 000 items registered in the material master that are already existing items. This means that there are a lot of items in the system that are registered on different tags e.g. different oilrigs can have different tags on the exact same component. This will in turn lead to situations where components that are needed are purchased even though they can be located somewhere within the Statoil system, but they are registered with a different tag number. Some of the components are more critical than others so by not getting a hold on the components will have different consequences depending on the operation. Some components are very expensive and it is not desirable to have a lot of expensive components on stock, especially if it is components that have a long shelf time. This could end with a situation where the same component is stored on multiple locations, when in reality it is a lot more than actually needed.

Another situation where duplicates have an impact is where items that have very long lead times and can be difficult to obtain, are needed. The installation that needs the component starts the process of ordering a new component, while the same component is stored at another Statoil location. If the installation that needs the component doesn't get it in time they might have to stop or postpone the operation, or in worst-case scenario they will have too shut down the production. If the duplicates did not exist, it would been much higher reliability to the ordering process and the risk of making wrong orders would be reduced.

6.1.4 Free text

In SAP it is possible to use a free text area, as mentioned earlier, to require and procure spare parts and equipment. The usage of the free text area on requisitions instead of using material number or catalogue numbers varies from 12-33% on the different installations. The problem with using free text is that there are significant costs and higher risk of making wrong orders associated with the use of free text area compared to using material number or a catalogue.

When issuing a requisition for components for one of the plants, there are clear requirements to the process and the content. The goal is to obtain right part for the right quality, as cheap and efficient as possible. To be able to achieve high efficiency in this work, it is crucial that the correct procedures are followed and the quality of the work done by the requisitioner is high. This requires that the requisitioners are using the relevant procedures and material or catalogue number when creating the requisition and not the free text area. This should secure that the risk of wrong deliveries go down, and that the relevant frame agreements being used goes up.

The reason for why free text is used to such extent even though it's less reliable and less efficient, is diverse. As mentioned earlier, the historical tags led to a lack of trust regarding quality in the material master. It made uncertainty to whether the item that was procured was the right one or not. The quality of the master data in the material master was in general low, where a lot of duplicates existed or BOM were missing. The consequences of having a high number of historical tags and duplicates are that there is a high risk of getting orders with wrong components when ordering. The challenge here has been that the processing time for making changes has been too long, not fully understood and too complicated and thus too resource demanding.

When those who worked with the procurement process did not find the correct items by searching the tag number, or the items connected to the tag was wrong, they used the free text area. This was done to faster find the item they were looking for, instead of jeopardizing by using the tag numbers. The problem is that using free text is much more time consuming and it is higher risk for ordering wrong component when using free text. It is necessary with a lot of information on the product to be absolutely sure that the right one is ordered.

The lack of trust in the system and the extensive use of free text are have a negative impact on the process of getting materials on the right WO shipped out at the right time. This factor has a significant impact on what the HOLD solution tries to prevent. So an improvement in this area would also help on the situation HOLD focuses on improving.

This combined with inferior plant data, material numbers that are rarely searched for or updated and a SAP search engine that is not as user friendly as it could be, gives a very complex picture of the situation and something that will require more than just a quick fix.

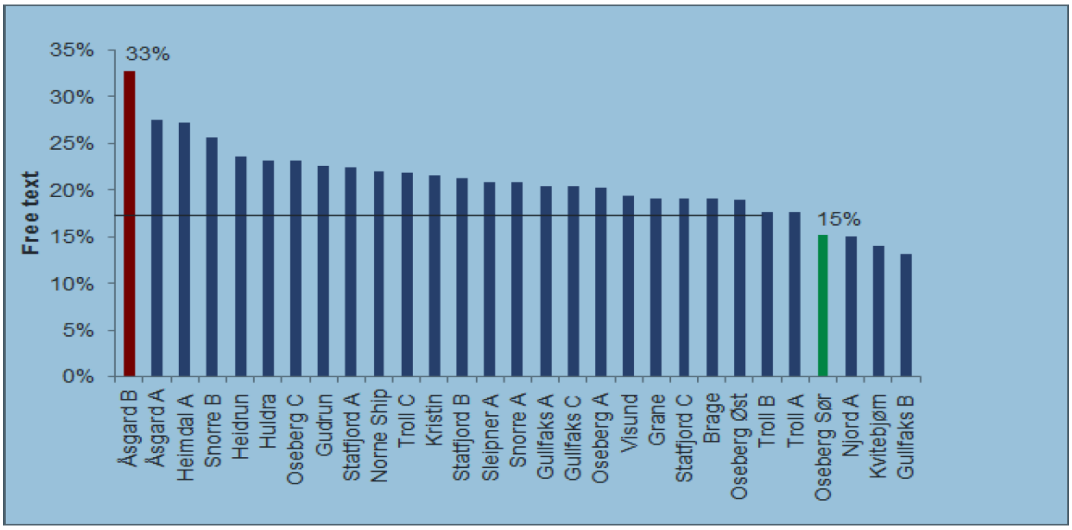


Figure 6-2: Free text

There has also been a problem connected to stock, where the items were picked from storage offshore, which was not signed off on. This causes that there is no data on stock levels that was decreasing, and it was estimated that there was items picked for around 3-400 MNOK that was not signed off on.

There also exists 8000 equipment on stock that does not have a TAG reference.
When an item is purchased, it is required that necessary certificates and documentation of quality inspection follows the item from the supplier. And there have been cases where this necessary documentation has been insufficient or missing. This will in combination with the earlier mention challenges within SAP cause problems to execute the planned operations.

6.1.5 Transportation to installation

Before the implementation of the HOLD solution materials and equipment was shipped consecutively to the installations as they arrived at the base, even though they belonged to the same operation on the WO. As an effect of this, the decks on the installation were filled up with load carriers and stored until every component of the WO had arrived and was available offshore. In average a load carrier was stored approximately 60 days, and moved 6-9 times on deck. This made it difficult to maintain a good overview of the cargo and it complicated the boat transportation unnecessary and the work execution of the planned operations.

70% of the load carriers that was stored offshore beyond a 2 week plan period. This caused a lot of movement of both the content of the containers and the containers itself on the installation. Materials have also in some cases been shipped multiple times between HB and Norne, and since there was limited control over the materials being shipped offshore, it complicated things even further if something had to be sent onshore again.

This resulted in increased numbers of lift operations offshore. In average there was 927 000 lifting operations and a significant number of these was caused by materials that was shipped several times. According to the Senior Supply Chain Coordinator (SSCC) almost 300 000 of these were unnecessary operation caused by activities that could have been avoided, and this creates a lot of extra costs and reduces the efficiency. This means that almost 1/3 of the lifting operations done on Statoil installations could have been avoided if all operations had been done according to the plan and there were no delays in any links.

In addition to the increases costs and reduced efficiency, there is HSE aspect of the lifting operations as well. There is a lot of risk connected to the lifting operations offshore; in fact this is seen upon as the most critical activities in the supply chain. There has also been production loss up to 3,5% connected to wrong components located at the rig when operations were to be executed, or the components had been used in other operations and was not available for the job it was intended for.

With strict regulations and procedures that have to be followed before anything can be shipped offshore, means that there are both resources and time spent on preparing shipments extra shipments that in reality was not necessary. This is why it is important that the materials and components going offshore is correct when it is getting shipped offshore.

6.1.6 Certificates

When materials and equipment are purchased, it is required different necessary certificates and documentations of quality inspections and the quality of the materials/equipment itself. The challenge here have been that the necessary documentation needed have been insufficient of missing. However, this factor will not be within the scope of the research and will thus not be further discussed.

6.2 HOLD solution

HOLD solution allows items connected to operations on a WO to be hold back at the supply base until all items on the order has arrived at the base, and it will continue to be stored at HOLD until the release date is due. The automatic release function in the system has to be set to a specific number of days that it will release the items connected to a specific operation and WO. The number of days that the release date is set to is 10 days. This is a default setting for all installations, but can be individually set for each installation depending on what fits the different installations best. The reason of releasing the materials, in this case 10 days, before the requirement date is that it takes time to pack the material stored at the base and the type of material can vary a lot in these shipments. It is also important to perform a quality check and securing that the correct documentation is prepared before shipping offshore. It will also require some time to secure the shipment offshore, and place the material at its correct location offshore.

All materials connected to HOLD are located at own holding areas at the supply base. This makes it easier for the base personnel to collect and prepare the items for the shipment. This creates the need for increased storage capacity at HB, since materials and equipment now is supposed to be sent out when it is needed, and not just because it has arrived from the suppliers. This will release valuable storage capacity at Norne that can be used to store materials for operations that needs the deliveries.

Figure 6-3 describes an operation on a WO before the implementation of HOLD and is used as in illustration on the challenge of different materials stored in different load carriers with different shipment dates.

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	Parker 12-12FE 6MO	3,000	PC				GFC Aut	B6 Grovverksted WEF 1403	377271	AMD294
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	ADAPTER,TUBE TO PIPE,12MM	12,000	PC				GFC Aut	B6 Grovverksted WEF 1403	371637	AMB1583
	ADAPTER,TUBE TOPIPE,12MM :	12,000	PC				GFC Aut	B6 Grovverksted WEF 1403	371637	AMB1583
	ELBOW,TUBE,12MM,6MO,90 DE	6,000	PC				GFC Aut	B6 Grovverksted WEF 1403	371637	AMB1583
	ADAPTER,TUBE TO PIPE,12MM	12,000	PC				GFC Aut	GFC Lager M12	376308	AMD2467
	ADAPTER,TUBE TO PIPE,12MM	12,000	PC				GFC Aut	GFC Lager M12	377764	AMN060

Figure 6-3: Lod carriers example

The figure describes one operation on a WO that has materials stored in 6 different load carriers that arrived and were shipped with 7 months difference between the first and last load carrier. The figure illustrates the location of the different load carriers containing materials for this operation, which is described by the colored arrows.

In best-case scenario this material is placed on temporary storage at the base, which takes up loading capacity at the base. In worst case scenario this material is stored in load carriers offshore, meaning that in order for the workers to start with the work, 6 load carriers have to be lifted and moved to be able to get the parts needed and lifted back to its origin place when the parts have been picked. This means that there are performed 12 lifts to get parts for one single operation, which in turn creates a lot of extra waiting time for the workers that are supposed to perform the job, and also increases the risk connected to each lift being performed offshore.

If the materials for this operation is had been packed together in one load carrier at the base before it was shipped, the number of lift operations could have been reduced by 10 lifts and the waiting time would have been significantly reduced along with the risk if lifting. If the parts had been properly prepared before the work on the operation, the personnel offshore would not have to wait for the parts and the work could start immediately after the load carrier is received offshore.

Through HOLD solution Statoil was aiming to create a more effective supply chain. Statoil was in a situation where it was limited cooperation of improvement initiatives, which lead to sub optimized solutions, and HOLD-solution is one measure that was intended to make a more effective supply chain.

The overall objectives of the implementation of the HOLD solution are:

- Make calls safer by reduce manual labor work in the system (fewer error due to less human interaction)
- Securing shipments offshore, according to the actual demand
- Ensures that the focus can be directed towards packing and shipments, instead of searching for the location of the materials at the base, if it even was there.
- On Time In Full (OTIF) deliveries.
  On Time: Materials delivered on time, based on actual delivery compared to purchase order (PO) delivery date.
  In Full: Materials delivered in ordered quantity, based on delivery quantity compared to ordered quantity. (ta med som en av faktorene som ikke er malt?)

Every item linked to an operation that is set to HOLD, will also automatically be tagged with the HOLD indicator. When an operation on a WO is completely registered and connected to HOLD, SAP will copy the requirement date over too every material that is linked to this operation. This is done because it will secure that partial deliveries are hold back at the supply base until every component on the operation has arrived at the base. This means that all materials connected to one operation with HOLD, have to be both required an arrived/registered at the supply base before the system can remove the HOLD indicator.

When the operation is complete, the HOLD indicator will automatically be removed by the system 10 days before the requirement date offshore and the order will be shipped collectively to the installation.

This is to avoid too early or too late deliveries to the offshore plant. It is still possible to manage item deliveries on manual if needed. This could be necessary in cases where one item on a WO was needed at some other time then the rest of the WO e.g. certain components as pumps or aggregates often needs to be tested offshore before the rest of the materials on the operation is shipped. This is in special cases, and in general the solution is set up to release the entire operation at the same time. It is also the most preferable solution since they only need to handle items to one operation in one activity.

The HOLD solution ensures a more even workflow for the planners, HB, the supply vessel, and the offshore personnel that are executing the operations. It is also important to mention that the HOLD solution are for planned operations, and will not be able to handle any unforeseen events that requires rush orders or other unplanned actions.

6.2.1 HOLD process for outbound logistics

In the figure 6-4 for outbound logistics we can see the processes and the different roles for the outbound logistics connected to the Hold solution.

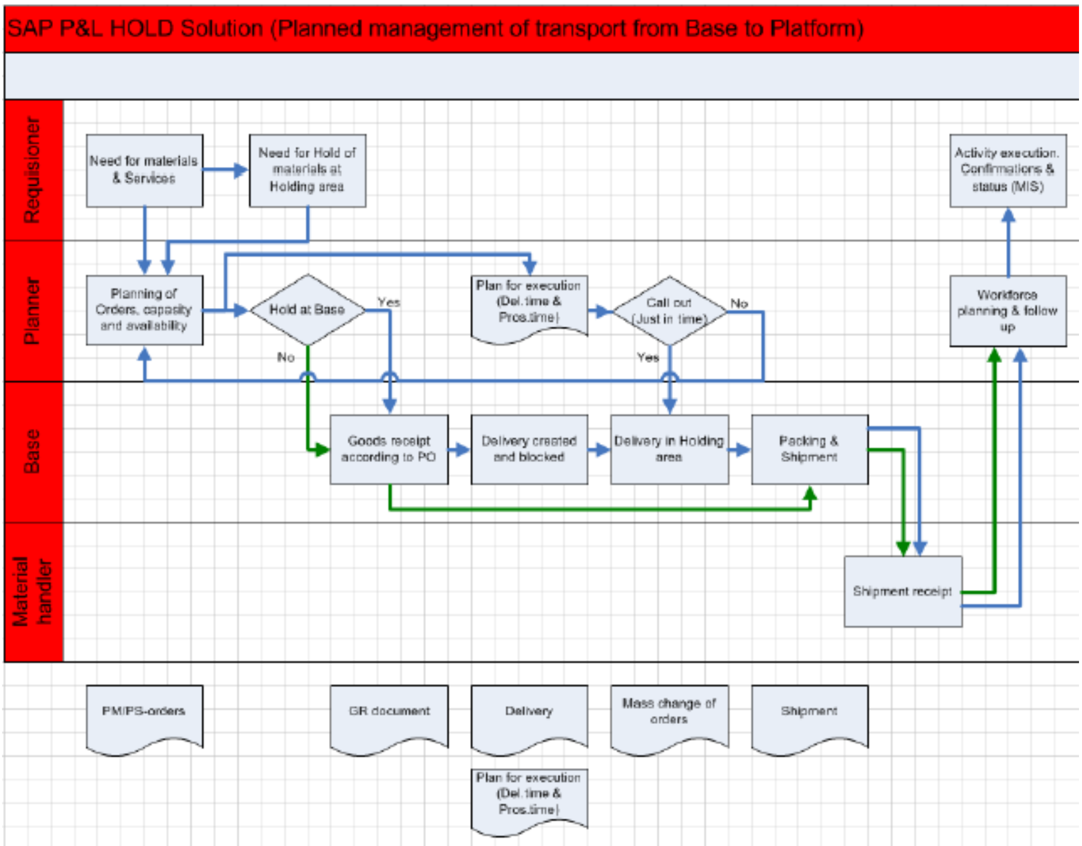


Figure 6-4: HOLD process for outbound logistics

Requisitioner

The role of the requisitioner is to define the need for materials and services that occurs from the offshore installation into a requisition. This stage is also the beginning of deciding whether there is a need for holding material at holding area at the base, in other words if the order needs to be connected to a HOLD indicator. The requisitioner is also the responsible for following up the activity execution, confirmation and statuses on the order in MIS all the way through the process from start to end.

Planner

When the need is clearly defined and requisitioned, the planner takes over the process. The planner sets up the planning of orders according to capacity, availability and the criticality of the jobs that needs to be performed. (base, supply vessel, correct type of personnel etc)

The planner also needs to take under consideration the plan of execution, and factors like delivery and processes times on the materials that is requisitioned.
When the planner has set up the plan the materials connected to the WO should arrive at the base at the time when it is needed. WORKFORCE planning & follow up.

Base
The base receive the materials at the base and checks the goods receipt according to the PO, which should match each other. If there is a HOLD indicator on the WO, SAP will automatically block the delivery when the materials are registered at arrival. The materials will then be placed on designated holding area at the base pending on the call-out. When the system removes the HOLD indicator automatically, the base personnel will pack and ship the materials offshore. Materials that doe not have a HOLD indicator when it arrives at the base will also be sent directly to packing and shipment.

Material handler
When the materials is received offshore the material handler checks the materials and registries the shipment. This needs to be done so that the WO can be closed in a proper way when everything is received according to the plan.

6.2.2 HOLD process for inbound logistics

In the figure 6-5 for outbound logistics we can see the processes and the different roles for the outbound logistics connected to the Hold solution.

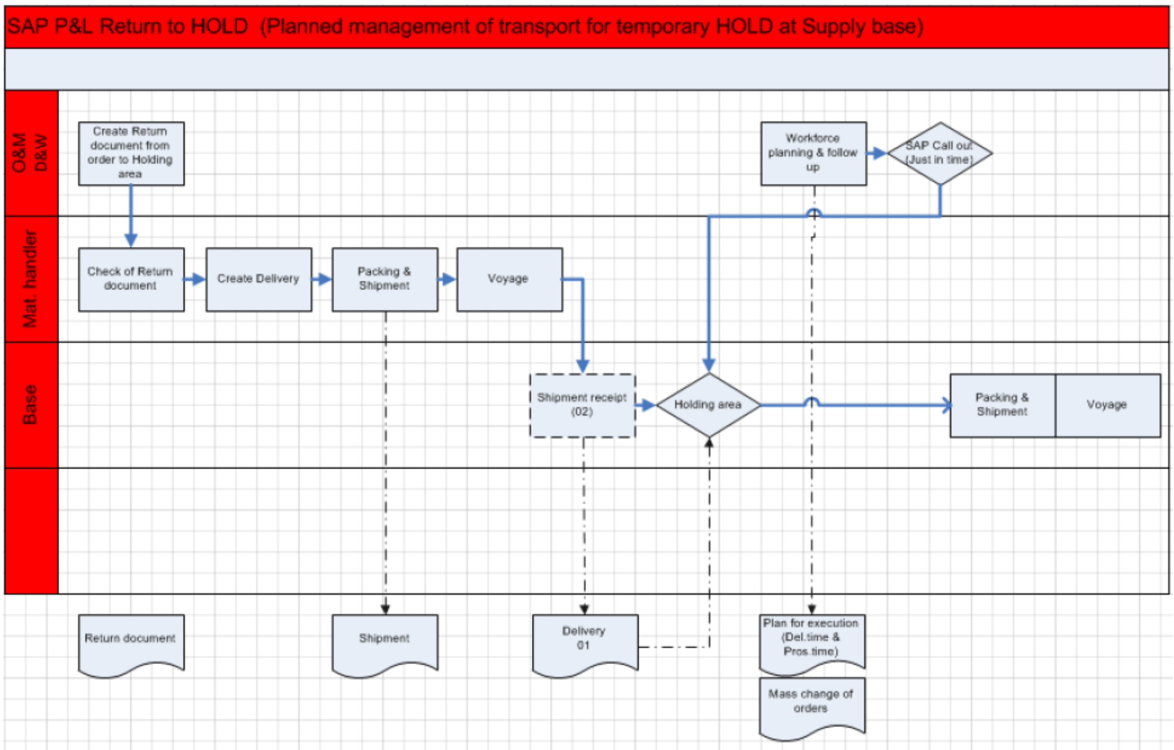


Figure 6-5: HOLD process for inbound logistics

Sometimes, of different reasons, materials needs to be shipped onshore again for temporary storage at the supply base. This figure describes the return to HOLD process, and the roles that is participating in the process.

O&M/ D&W

When the need for return shipment occurs, O&M or D&W will create a return document based on the order and to Holding are at base. They also have to follow up this shipment, and communicate with onshore personnel for further planning of when it is needed offshore again.

Material Handler

The material handler offshore will then check the return document to see that it is made accordingly to the correct procedures, before creating a delivery on the shipment. The materials are then packed properly and lifted onboard the vessel before it is sent onshore.

Base

The base receive the shipment at the base checks the order and the return document. The material is then sent to temporary storage at the given Holding area at the base. When the times come, and the materials is needed offshore again the system will, if everything is done correctly, remove the HOLD indicator again and the base personnel will pack the materials and send it offshore again.

6.2.3 New report

With the implementation of HOLD there was also created a new follow-up report called ZMM_HOLD in SAP. This report follows up the automatically call-out function on what is going for call-out and when. This report is created as a tool for both O&M and M&M and the base personnel. The goal is that it can more easily share the flow of information and documentations/statuses concerning HOLD materials in an efficient way.
ZMM_HOLD is in other words a report customized for the HOLD indicator and all its activities and interactions, and created to be a common user-friendly tool for the personnel

The report is made with a focus on making an efficient and simplified layout to make it easier for the personnel using it. It automatically follows and updates call-outs, WO, operations and items. It also monitors the planning plant/base and the holding areas located on the base, so that it can keep track of which material is stored and not. It is set up to follow the general 2 week plan period for the WO, and it is the same standardization for every Statoil plant. The report also follows up on the delivery and shipment of the order, from the supply base and until it is registered received offshore by the material handler or returned onshore, if necessary. It is also set up so that it is easy to locate the items through default searches in SAP, if a specific item in the shipments needs to be located.
The benefit with these automatically updates are that the human interaction is significantly reduced, and thus the danger for errors has also been reduced. There is also an own function that is made to secure OTIF where orders are packed and shipped together offshore according to the requirement date.

The layout of the report is made so that the most relevant search criteria are displayed first and these are planning plant, holding area, work order, call-out date, and delivered base plant.

The report has detailed information all the way down to item level. This allows the personnel to register the exact physical location of the items, and this is useful if materials are moved within the base area and relocated to new areas.
There is also a new function that allows relevant deliveries to be direct packed in the desired shipments.

Every night at 0001 there is an automatically call out of orders that have been released from HOLD from the SAP. Released material will then the day after be prepared and packed and, and it will then be put on the first possible supply vessel. The base personnel is responsible for performing daily checks of which orders getting released and shipped offshore.

ZMM_HOLD makes it possible to collect and sort the most relevant data for materials going between HB and Norne. This makes it easier to track where the materials are located, where it is headed, and that that it is shipped according to the scheduled plan and dates.

7.0 Theoretical Framework

This chapter will provide with the theoretical framework used in this thesis.

7.1 Lean thinking

Lean thinking is more of a generic philosophy or framework, than a set of tools and techniques. This gives lean thinking the potential to be applied to any system or process to identify critical areas of improvements and to make improvements to these. The philosophy seeks for a continuous approach for process improvement and helps on targeting tools and methods to for improvements.
The principles behind lean thinking focuses on eliminating waste and unnecessary actions and linking all steps that creates value and ensuring value flows, which reflects the idea of information management. Criteria for a successful implementation of lean are to identify value and understanding the flow and characteristics of waste.

Womack & Jones (1996) defined and described five key principles in lean thinking:

1. Specify value:

   Clearly define value from the customers' perspective in terms of specific product with specific capabilities offered at a specific time.

2. Identify value streams:

   Value stream is a set of the specific actions that is necessary to bring a specific product (a good, service, or a combination of the two) through the three different management task of any business:

   Problem-solving task concerns the activities from concept through detailed design and engineering to the launch of the product.

   Information management task concerns the process from order taking, through scheduling to delivery.

   Physical transformation task runs from raw materials to a finished product delivered to the customer.

   Identifying the entire value stream for each product, shows all actions that occurs along the stream. And enables the company to identify the actions that creates waste.

   Creating lean enterprise requires new ways of thinking about firm-to-firm relations, some actions that helps regulating the behavior, and transparency in all steps along the value chain. So that the members of the chain can compare and align with each other.

3. <u>Make value flow</u>

   Make the remaining value-creating steps flow.

   This requires challenging the perception of what is efficient today. The goal is that the value flow happens in a continuous flow to avoid bottlenecks and waiting time, which will be waste.

4. <u>Let the customer pull value</u>

   This principle allows the customer to pull the value instead of that the organization push the value through the process. This means that when the customer pulls the value, the product or service is available when the customer needs it. The demand will be more stable when the customers know they can get what they want right away. The aim of this principle is to make a process that is structured in a way that gives just in time results.

5. Pursue perfection
   The fifth and final principle of lean thinking is the pursue of perfection, and this principle focuses on actions to eliminate waste and achieve a perfect process, or as close to perfect as possible. When the four other principles interact with each other, and the value flow runs faster it will expose hidden activities that create waste. The faster the flow runs, the more revealed the obstacle becomes so they can be removed. Pursue perfection shows that lean is a continuous process..

For this research the steps: make value flow, let the customer pull value, and pursue perfection is most relevant. The make value flow step will here aim to make the materials flow in a continuous flow from the supplier and all the way out to Norne. This requires bottlenecks and other activities that create waste for the supply chain is removed. The waiting time caused by materials shipped and stored at different time and locations are activities that do not create any value for any of the links in the supply chain and therefore it can be defined as waste. The goal here will then be to eliminate the activities creating this waste.

The step regard letting the customer pull value allows Norne to order exactly what they want, when they want it. In this way they don’t have to fill up the storage capacity at HB or Norne with expensive components and spare parts. In theory it wouldn’t be necessary with storage in a just in time principle, but in reality this is not possible. The challenge for Statoil is that certain components and spare parts have very long lead times, or can be difficult to obtain, and some parts are of such criticality that they are needed to be stored either at Norne or HB.

The step regarding pursue perfection is the step that seeks to improve the flow even further. There could be activities creating waste that are not visible before the efficiency is increased and the materials flow faster. This is a continuous process where the idea is that you can always be better and seek improvements. If the HOLD solution leads to improvements in the supply chain, it is necessary to see what exactly are these improvements and what are they affecting and not. Here it could be room for further improvement in the future, to create an even more seamless supply chain.

Figure 7-1: Lean (Womack and Jones 1996)

7.2 Theory of Constraints – TOC

TOC are focusing on the management of existing processes, and there is always at least one constraint reducing the outcome of a company. A constraint is defined by Goldratt and Cox (1992) as a factor that limits the system from performing optimal, or what the goal it was designed to achieve. It is the owner of a system that establishes the system goal and for most businesses that is to make money.

In this case Statoil is the system owner, and the system is defined as the upstream supply chain for Norne. The system goal can either be defined as making money, or more specific in this case reduce the cost that is connected to the logistical activities in the chain, mainly between HB and Norne. Even in big complex systems there are only a few constraints that could have significant, immediate, impact on the whole system. Goldratt & Cox (1992) identified 5 focusing steps that should help on reducing or hopefully eliminating the constraint(s).

1. Identifying the systems constraint that prevents the achievement of the goal.

   The output of every system is decided by the bottleneck. Through SCIP it is clear that the bottleneck is the storage capacity onboard Norne, but as described earlier there was different other factors that also had an impact on this situation.

Materials for operations were not ready or present to be used when the job was supposed to be done, either because parts were missing, wrong parts was shipped due to wrong information in the material master, or just parts of the shipment was stored offshore. The rest had either been shipped onshore again due to long storage time at Norne, or the parts had simply not arrived along with the other parts connected to the specific operation that was supposed to be performed.

2. Decide how to exploit the systems constraint in order to avoid unnecessary idle time.

   This requires that non-value adding work and interruptions or obstacles are removed. It is also important to carefully prioritize the bottleneck's work so that they work on the most important work. Information sharing is very important, and that the team working against the constraints gets sufficient information.

   For Norne non-value adding work is created when materials is transported offshore in different load carriers at different times. This created a lot of unnecessary lift operations and the danger of losing track of the materials increased the longer the materials were stored offshore. This also applies for materials that are first shipped offshore just to be sent onshore for temporary storage again. It creates a lot of non-value adding work. Because of the resources needed to transport materials to/from Norne it is very important that the correct materials are actually present and available when needed. Materials that are not available, or wrong materials, is also causing a lot of non-value adding work in form of mobilizing of personnel and shut down of other operations to be able to perform the job.

3. Subordinate the rest of the system to decisions made above to align the whole system to support the bottleneck connected to the operations.

   This means that all resources that are not bottlenecks must have some slack, and this slack can be used to support the bottleneck. That could be to letting the non-bottlenecks help the bottleneck, or the rest of the system is adapted to the pace of the bottleneck to avoid overloading the bottleneck. The non-bottlenecks are also ensuring that only high quality work is handed to the bottleneck.

The critical point for Norne is the storage capacity offshore. The mentioned slack that helps support the bottleneck will then be storage capacity at HB, where materials are kept longer at HB instead of just shipping it out offshore as soon as the materials is received at the base. This releases valuable cargo capacity offshore and enables a more lean approach for Norne. This would also help on adapting the rest of the system to the pace of the constraint, assumed that the HOLD indicator is made correctly in the WO. Due to the challenge connected to store materials at Norne, it is naturally that the most important jobs are prioritized to be performed first.

4. Elevate the constraint, meaning making changes to change the constraints capacity.

   This is a step that is taken only when all "free" improvements have been performed. The constraint can be elevated by adding more people or machines, improve training or switch to a different technology, in this case HOLD is a technical improvement that has required investments of both money and resources. Thus, it can be seen as an elevation of the constraint and that was implemented on the basis of the identification step.

5. When one improvement is implemented and gives positive effect, it is time to go back and start over again on step 1.

   When the biggest problem is taken care of the focus can then be aimed for the next bottleneck. When repeating these focusing steps, they become integrated in the company and they will be a naturally part of the company. When HOLD is implemented and perfected so that the resources that are connected to the constraint are utilized, it is time to go back to step 1. The purpose is to identify the constraint that now is inhibiting the supply chain the most, and then go over the following steps again.

A chain is only as strong as it weakest link and to make it stronger, the weakest link needs to be strengthen. A supply chain can only deliver results that are set by the constraint, no matter how efficient and fast other parts of the supply chain is. The bottleneck will decide the end result of the entire chain.

7.3 Supply Chain Management Process

According to Lambert (2008) The International Center for Competitive Excellence have defined supply chain management as:

"Supply chain management is the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers".

The structure of activities within and between companies in the chain is an essential cornerstone to create unique and superior performance in a supply chain. Lambert (2008) presents 8 different supply chain management processes:

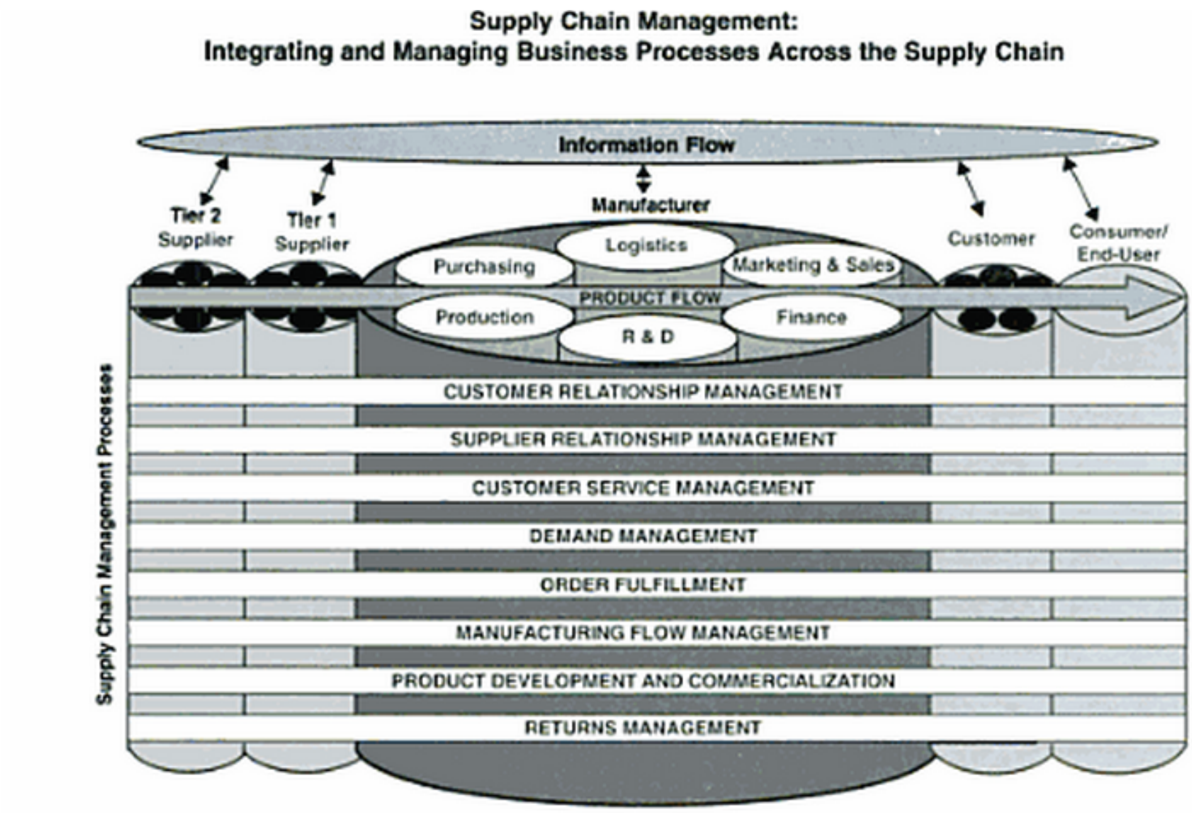


Figure 7-2: Supply Chain Management processes (Lambert 2008)

Each of these processes has both strategic and operational sub-processes. The strategic sub-processes describe how the processes will be implemented and is a necessary step in integrating different members in the chain. The operational sub-processes describe the detailed steps for implementation and it is here the day-to-day activities take place.

Customer Service Management

This is the process that deals with the structure of relationship with the suppliers, so that they will be developed and maintained. In the same way a company needs to develop relationships with its customers it also need to create close relationships with its suppliers. This is a proactive process meaning that it should be developed triggers that can detect possible problems in the supply chain. To be able to develop these triggers, it is essential that critical links in the supply chain is monitored. The goal of this process is to solve problems before they affect the customers negatively, in this case Norne. A reliable way of monitoring the links in the supply chain is to use and share the information that exists in the supply chain, assuming that the information used is correct.

For Norne and other offshore installations it is important to have efficient and reliable information and it is critical that the information shared, and used, is correct. This is factors that are essential to be able to keep a high degree of efficiency and to reduce the risk for errors.

Demand Management

This process concerns the balance between customers' requirements and the capabilities of the supply chain. If this is done correctly management can match the supply with the demand proactively and execute the plan without disruptions. This doesn't mean that this process is limited to forecasting, but also includes synchronizing supply and demand by reducing variability and increasing flexibility.

For Statoil and Norne, this would apply for the challenge of dimensioning and allocating resources in the supply chain, this would be the transportation between suppliers and supply base, base capacity, number of supply vessels used and numbers of departures of supply vessels and capacity onboard Norne. When these relationships are in balance the planned operations can be executed without disruptions.

Order fulfillment

The order fulfillment process is not just concerning filling orders, it also includes all necessary activities that is connected to the design of a network and enables a company to meet the customer requests while minimizing the total delivery cost. This process is concerning the challenge of delivering the right order on time. It is mainly a logistical function, but it needs to be implemented at a cross-functional level with coordination of key suppliers and customers. The process goal is to create a seamless process throughout the supply chain. A strategic process is to define the plan for order fulfillment, deciding how orders from customers will be filled. Key inputs in the order fulfillment are lead-times and customer service requirements.

This is an essential factor for Statoil and their offshore installations and Statoil have as a goal to achieve delivering the right order at the right time, for every order they produce. If there could be delivered perfect orders every time offshore at Norne, there could be substantial costs to reduce for Statoil. For orders that fulfill the customer requirements and have satisfying low lead-times there would not be disruptions or delays to the performance of the orders.

7.4 Collaborative supply chain

A collaborative supply chain can be defined as two or more independent companies cooperate to plan and execute supply chain operations with the goal to achieve better compared with acting isolated. This requires that the companies are prepared to both the risks and the rewards that cooperation produces (Lambert et al 1999). But even though the collaboration is a project with mutual objectives, it is still a self-interested process where cooperation is initiated if their own survival or situation is improved compared to before. (Simatupang and Sridharan 2002)

Collaborative supply chains can be divided into three different structures: Vertical, horizontal and lateral.

Vertical: Two or more companies share their responsibility, resources and performance information to serve similar end costumers. Examples of this structure is vendor managed inventory (VMI), efficient customer response (ECR), and collaborative planning, forecasting and replenishment (CPFR)

Horizontal: Two or more unrelated or competing companies cooperate and shares their private information/resources, as joint distribution centers.
Lateral: Gives flexibility by combining both vertical and horizontal aspects, where lean and transport dynamics are examples of a lateral structure. (Simatupang and Sridharan 2002) The supply chain for Norne can be defined as a lateral supply chain with a focus on lean. Statoil have to use concepts from the vertical supply chain as collaborative planning for operations and WO-plans with their suppliers in order to execute jobs in time. They also use the concept of sharing private information /resources, from the horizontal supply chain, with their suppliers. This combination forms the lateral structure that Statoil uses.

A good collaborative supply chain should have a structured and detailed planning which is robust to disturbances as demand fluctuations and rush orders. And, the supply chain members perform daily operations to meet the long and short-term goals that are set. According to (Simatupang and Sridharan 2002) a key concept of collaboration is interdependence where one company is dependent on another, because it relies on the other companies' resources and services. And to manage dependence is a critical process in collaboration, since members in the chain wants to ensure their own survival and protect their own interest. Dependency can be in form of tasks and tasks, tasks and resources, and resources and resources that occurs along the supply chain. Tasks can be activities as planning, forecasting, ordering, distributing and serving. Resources can be inventory, funds, capacity and capabilities. So e.g demand interdependence can be managed when supplier and retailer cooperate in joint demand planning.
Coordinated and collaborative supply chains increases the responsiveness and gives reduction of uncertainty, and this can be achieved by sharing information between the supply chain members and increasing the information visibility in the chain. This can produce benefits in form of utilize resources better, improve the inventory management and improve planning and forecasts. (Zhenxin et al 2001)

7.5 KPI

Key Performance Indicators (KPI) is a tool made for helping an organization reach its goals through defining and measuring progress. The idea behind KPI is that it is possible to take technical data, as big complex spreadsheets and applications, and present it using business-relevant language.

KPI are quantifiable measures that reflect critical success factors of an organization. These factors needs to be agreed on and defined clearly before they are implemented. It is also important that the definition of the KPI stays the same from year to year, so that the basis for the measurement is the same when comparing over time.
When defining KPIs it is also important to set targets for each indicator that is clear and that everyone will understand. This will form the basis to be able to take specific action to reach the target goals. (Peterson 2006)

8.0 Analysis

In this section the analysis for this thesis will be conducted. First the data collection will be presented, and the following analysis of them. In the first part there will be given a description of the KPIs used. These are Statoil's own KPIs, and they measure the plan achievement and plan productivity. Then there will be a more thorough analysis of the KPIs and other data collections and analysis conducted in this research.

8.1 Definition of KPI – WO plan

This section provides a description of the definition of the KPIs that are used in the analysis for this research. This is Statoil's own KPIs that they use to measure plan achievement and plan productivity.

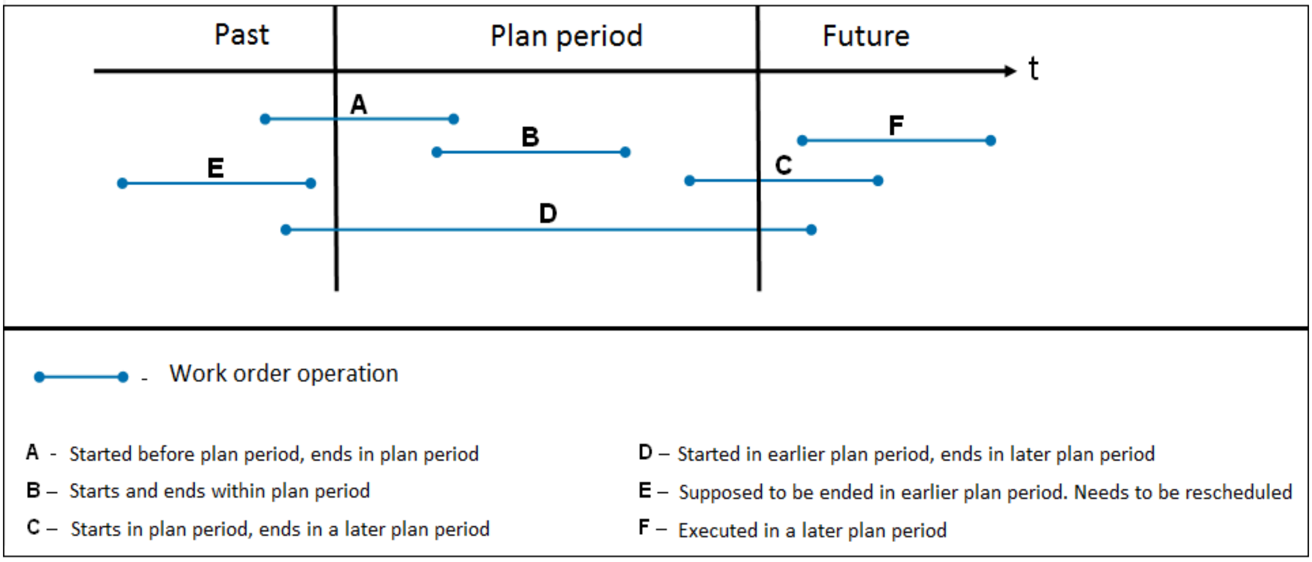


Figure 8-1: Definition of KPI

Plan achievement:

Number of completed operations in the plan period / Number of planned operations in the plan period.

The result tells to which degree the job are finished according to the plan.
100% = All planned operations completed.
Under 100% = Not all planned operations completed.
The KPI Plan achievement measures 1 day after the WO is completed, this requires that operations are registered continuously to get as correct and accurate results as possible.

Planning degree:

Number of hours recorded on planned operations in the plan period / Total number of hours booked against operations in the plan period.

The result tells how much of the work performed is on planned vs unplanned operations.
100% = All work that was performed was according to planned operations.
Less than 100% = Degree of unplanned operations performed.
It is possible to adjust the time spent 30 days after the plan period ends.
Here it is important to have an overview of remaining hours available at all time, so that it is possible to keep track of the time consumed on the different operations. It is also important to take advantage of the information available at the end of each period and make a better plan for the next WO-plan period.

8.2 KPI

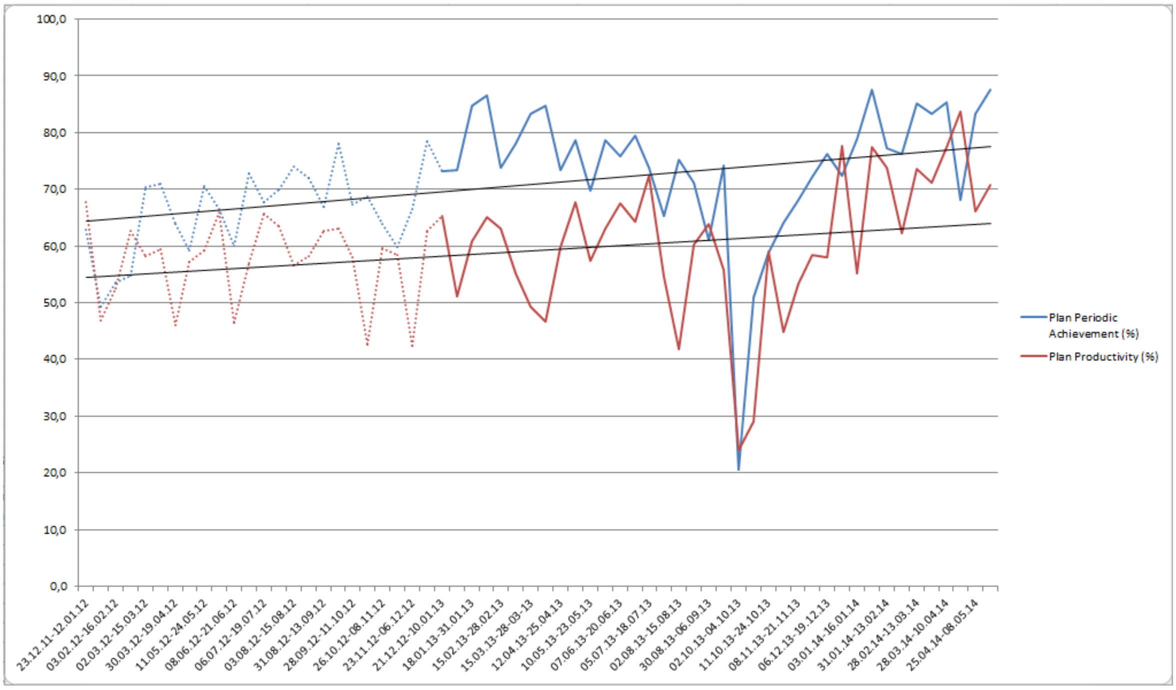


Figure 8-2: KPI: plan periodic achievement & plan productivity

The blue line indicates the plan periodic achievement, and the red line illustrates the plan productivity. The stapled part of the two lines is displaying the measures from the end of December 2011 – the end of December 2012. There is no WO and WO plans analyzed in this time period, but it is just used as a description of the situation and development of the results over time.

8.2.1 Plan periodic achievement

The plan periodic achievement is as mentioned telling to which degree the planned jobs are finished according to the plan. The graph above shows an increasing trend from the beginning of 2012 and all the way up to today. The HOLD indicator was not implemented for Norne before November 2013, so what caused the increase before the implementation? From the interviews with the supply chain coordinator and the SSCC it was notified that the increasing results in the KPI before the implementation was caused by an increased focus on achieving better planning results.

It was allocated more resources and people specific for this purpose. The focus was on achieving better plan results, and that required a more thorough job in planning and coordinating operations, personnel and suppliers for Norne. This was the beginning of the improving results we see today, and was adopted through the entire organization.

When an operation with that is supposed to be performed at a specific date and the needed materials has not arrived at the requirement date, means that the operation cannot be finished according to the plan and will affect the plan periodic achievement degree negatively. This is the kind of situations that the HOLD solution aims to eliminate.
If the HOLD solution has worked according to the goals set, correct materials should be arriving at Norne at correct requirement dates in a bigger degree after the implementation compared with before, which will lead to a positive effect on the plan periodic achievement.

Although there is a significant increase in the plan productivity achievement and plan productivity, it indicates that the condition before 2012 was an area given very little focus, and it is confirmed through the interviews. In such cases it is naturally that you come far with little, meaning that these improvements demanded a relatively small effort of resources to make significant improvements.

As with any improvements each measure can only do so much. To be able to continue to improve the results, other measures often have to be implemented to reach further progress. It gets harder to improve the better one become and it demands more resources and the margins of success gets smaller. In this case, the HOLD solution is such link in the further search for improvement and it shows in the graph that all though it is still early in the process, it indicates that there has been continuous improvement.

Other factors explaining the increasing positive trend is improved focus on achieving better plans and coordination are a continuous process that also helps on the improved results. There have also been focused on reducing waste in these processes, meaning that Statoil have become more strict about which operations that are necessary to execute and which operations that can be postponed. This gives a more accurate plan, instead of just putting an WO on the plan and deal with those who don't get finished when the plan period is over.

As we can see in the graph there is a sudden drop in the plan periodic achievement and the plan productivity in the beginning of October 2013. This drop was caused by a turnaround that was being performed at this time. A turnaround is a planned production stop at an installation that it is necessary in order to perform certain maintenance jobs that is not possible to do when the production is running. It is important that a turnaround is thoroughly planned and that the maintenance is executed as fast as possible to get the production up and running again. When there is a turnaround on an offshore installation, it is not the operation group that is responsible for the plan period as long as the turnaround is being ongoing, it is own turnaround groups that is responsible for all activities being performed in this time period. So this outlier on the graph is not valid for the this research.

8.2.2 Plan Productivity

The plan productivity describes the relationship between planned vs unplanned operations that is performed in the plan period. It will of course be difficult for an offshore installation to obtain a 100% achievement. There are many operations going on simultaneously and many of them affect each other, and in many cases there are difficult and technical operations that can be both time and resource demanding. This makes it easier for errors to happen than in many other industries.

If a need occurs offshore that demands immediate action and has high priority, and this operation is not included in the plan period, this goes as an unplanned operation. There could also be situations where the materials sent offshore is wrong, or if it has not arrived offshore at the requirement date, weather conditions that prevent shipments or personnel to get offshore. If this happens and it is not possible to execute the planned operations, other jobs will then be performed as a substitute. This can be smaller maintenance jobs onboard Norne that does not have any big impact on the daily operations of the production. These jobs are defined as unplanned operations.

However, as with the plan periodic achievement there has been a positive trend also for the plan productivity achievement, which it to some degree should be.

The plan periodic achievement and plan productivity will to a certain degree follow each other, meaning that if there is a high degree of planned jobs finished according to the plan, the number of planned operations have to be higher than the number of unplanned operations as well.

However, the plan productivity has had more fluctuation results than the plan periodic achievement. This means that even though the overall result have been improving, it still have various results between the plan periods.

If a job has materials that hasnot arrived at requirement date for an operation and this operation cannot be performed as planned and e.g. smaller unplanned maintenance operations is being performed instead, this would lead to a lower result in the plan productivity KPI. If the planned operations were performed to a higher degree than before, there would be less unplanned operation performed, which in turn would lead to a higher result on the KPI.

8.3 Factors affecting KPI

In this section it will be given a more detailed explanation about some of the factors behind the KPIs. The data for this analyze is collected through analyzing the different WO plans between the time period between 01.11.13 - 22.05.14. The aim of this analyze is to map the reasons of why work have been delayed or postponed. The results have been categorized into two categories, "Delayed that could have been prevented by a correct HOLD function", and "Delayed due to other reasons". The purpose of this is to see how the HOLD solution has affected planned operations. There have also been made an analysis for M5 technical updates. This is a measure in the work with increasing the quality in the material master, and increasing the use of correct use of procedures when creating WO.

Delays that could have been prevented by HOLD solution

This group is defined as jobs that is not performed, and had to be postponed, due to materials or equipment that could not be used for its intended purpose. This is materials/equipment that is ordered and should be present and ready to use, but is not. Example of reasons to this is, wrong component received offshore, or shipped at wrong dates, or the materials/equipment was not shipped from the supply base at all, or the shipment had to be returned to the supply base. It can also be that the material is stored at Norne but was used in other jobs, or no one knows the exact location of items.
In other words these are jobs that could have been prevented by the help of a correct HOLD solution.

<u>Delayed due to other reasons</u>

This is jobs that is delayed due to time constraints, capacity or that the job had to be rescheduled of some reason. It can be operations addressed in the part about plan productivity, where unforeseen events occurs that demand full focus and have a high criticality level that leads to postponement of the planned operations.

Which delays that could have been prevented by a correct use of HOLD solution, is defined through discussions with the SCC and these are the one that is presented in figure 8-3. The rest of the number of delayed jobs are collected and presented in the figure 8-4. These delays could not been prevented by HOLD directly. These are situations where e.g. jobs are delayed due to capacity problems, so if the HOLD solution worked correctly and there was less load carriers onboard Norne, there could have been capacity to receive other load carriers connected to other WO. These could indirectly been improved by a correct HOLD solution.

Unlike the KPIs which displays data from 2012, the data for these factors has been collected from the beginning of 2013 and to the end of May 2014, due to time constraints on the thesis and amount of work connected to the analyze of the WO an plans. Analyzing WO for the entire 2013 should be sufficient to present a realistic picture of the situation before the implementation of HOLD in November 2013.

8.3.1 Delays that could have been prevented by HOLD solution

The data collected for this analyze is collected through analyze of the 2 week work order plans and the WO connected to these plans. This is jobs where it is reported on the WO that there was missing materials for a specific operation on a WO that was supposed to be performed and had to be rescheduled.

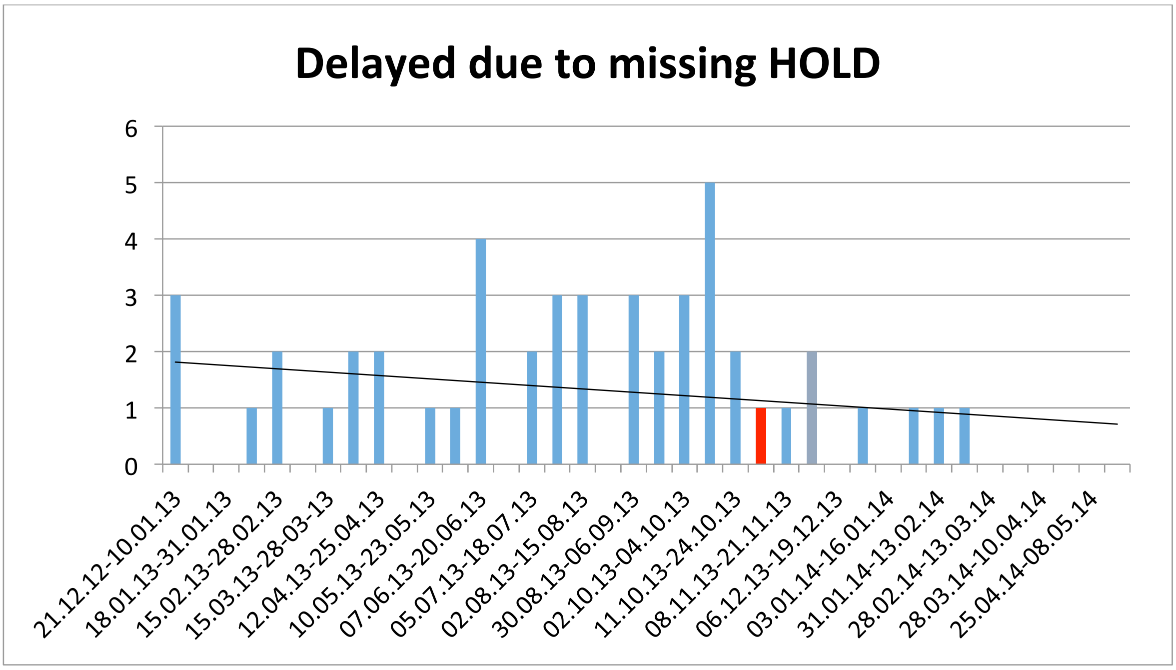


Figure 8-3: Delays that could have been prevented by HOLD solution

Figure 8-3 illustrates jobs that would have been prevented with a correct HOLD solution. If the HOLD solution has had positive effect there should be a reduction of these delays. The number of these delays have ranged from 0 to 5 on a single WO plan before the implementation, and the data shows that the time before the implementation have had a higher number of delays pr WO and more frequent than after the implementation.

After the implementation, marked with red in the figure, it seems to be a reduction of these types of delays. There is one WO plan that has 2 jobs delayed, and that was the second WO plan after the implementation. In the beginning of implementation of new systems, it is common with a period where the system is being adapted and fitted properly for its environment. The rest of the plans have either 1 or 0 jobs delayed, and after WO plan 14.02.14-27.02.14 there has actually not been any such delays.

However, it is not given that HOLD solution is the sole reason to these reductions, as this could have other explanation factors or just be a coincidence. There will be more analysis of other factors that might give an indication on these results. Although it is still early in the process after the implementation this result indicates that there have been an improvement compared to the situation before the implementation that are according to the goal of the project.

It can also be mentioned that reductions of these kind of delays is directly impacting the production loss of 3,5% connected to wrong components at wrong locations that was displayed in figure 6-1, and described in chapter 6.1.5. These kinds of delays should be possible to eliminate entirely, because these from the beginning created due to human interaction and these errors should be possible to prevent.

8.3.2 Delayed due to other reasons

The figure 8-4 below, illustrates the situation before and after the implementation. There are no big changes in the number of these kinds of delays. As we can see the number of jobs delayed can vary a lot from one WO plan to another. After the implementation there has been one WO plan with more than 4 jobs delayed, and one with 4 jobs delayed. The rest of the WO plans have had between 0-2 jobs delayed per plan. So there is an indication of less fluctuation in number of delayed jobs. This means that the work on improving the planning of WO plans seems to have had an positive affect and there have been a slight improvement alongside with the implementation of the HOLD solution.

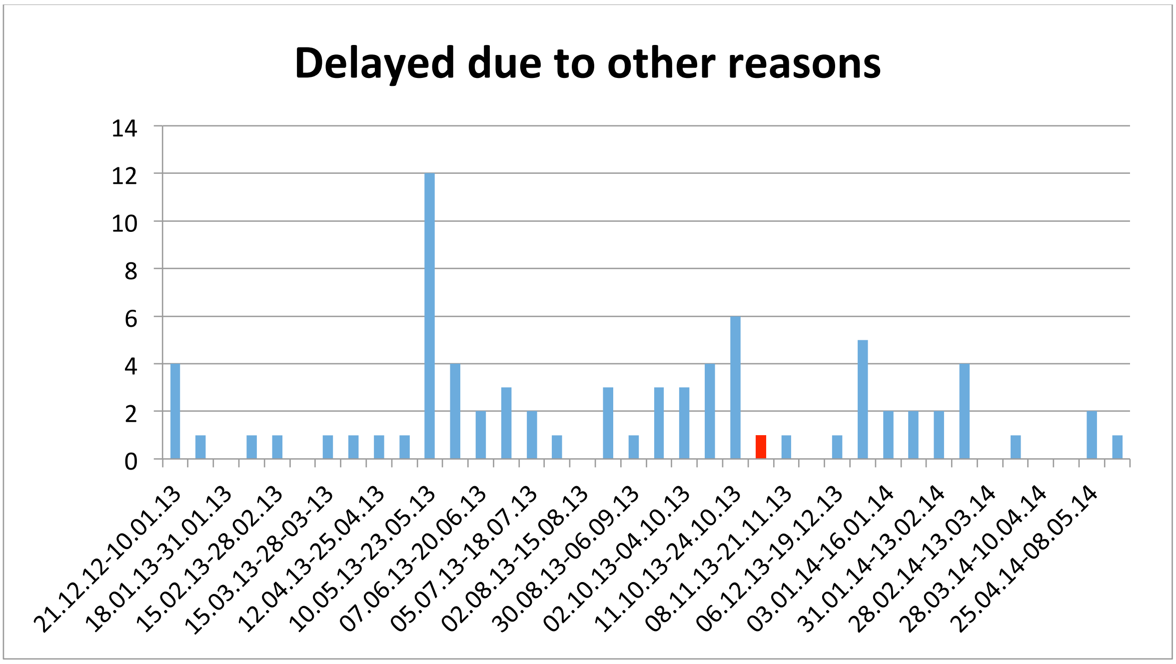


Figure 8-4: Delayed due to other reasons

The kind of delays that this graph describes will in practice never be totally eliminated. In cases where an unforeseen event occurs and there is an immediate need for changes or modification offshore, these kinds of orders will have first priority.

It has been mentioned that some jobs have very high criticality, and the consequences that may occur if these are not taken care of in time. When such event demand attention, other planned jobs on the WO plan which goes under the category planned maintenance which does not have the same priority, will then be rescheduled to the next plan period or later. This will also be the case for operations that is delayed due to weather conditions, a factor that is not possible to affect or predict. Thus some types of delays will always be present and not possible to eliminate. But, as we can see there is less fluctuation in number of delays, so with improved planning and overview of the operations it indicates that there is possible to limit the delays compared to the before situation.

8.3.3 M5 Updates

M5 is an update request to report errors, lacks or discrepancies, and is used when historical tags and duplicates are removed. The problem Statoil faced was that there were a lot of historical tags and duplicates in the system that caused poor quality on the information in the material master. This lead to a lack of trust in the system that further caused an increased use of free text area that increased the risk of creating WO with errors.

Through the SCIP project there has been focused on reducing these kinds of errors that was created earlier in the material master. The M5 does not have a direct impact on the transportation of materials, but it does help on improving the quality of the material master, which ensures that the correct procedures are followed when making requistions and WO. This means that the quality of the information is improved and the need for using the free text area is reduced. With a material master with higher and improved information quality, it is easier to use the system as it was intended and it should help reducing the lack of trust to the system that exists.

There are no data specific for Norne on M5 modifications, how many duplicates etc. they had, but through the analyze of the WO and WO plans, we can see in figure 7-5 that this is a ongoing process and there is regular updates and modifications on materials and equipment that is not linked to the correct tag. This helps on the quality of the material master, and creates better trust to the system so that WO can be created according to the correct procedures that are a necessity for the HOLD indicator to function correctly.

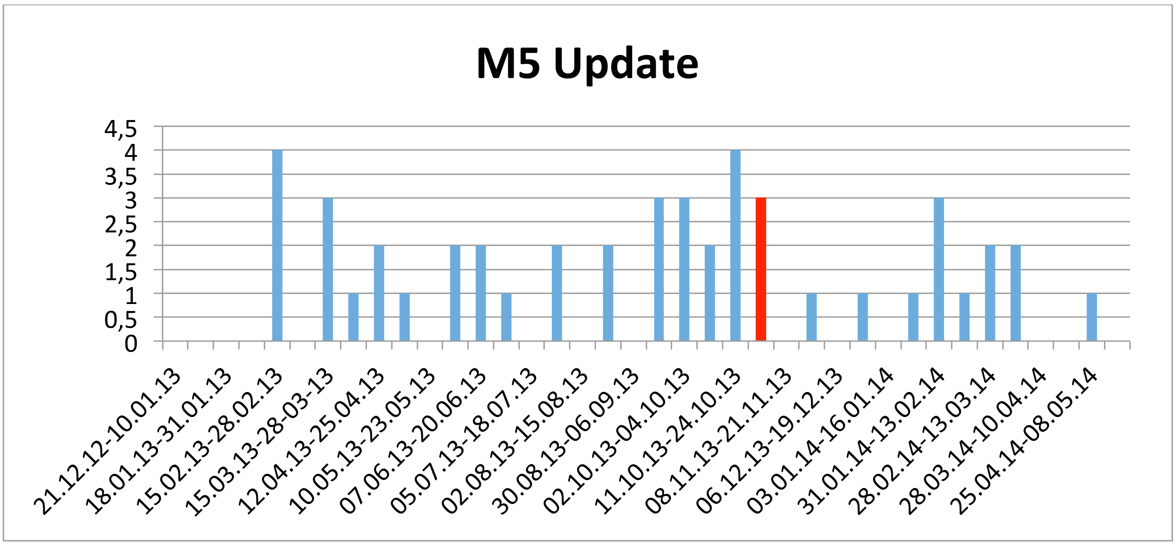


Figure 8-5: M5 update

With a continuous focus on this area in the future the material master will be more and more up to date, which in turn will lead to a higher quality of the data in the material master. This will increase the trust in the system for the users, and will encourage creating WO after the correct set of procedures, and not using the free text area when making requisitions. This will help on improving the quality in the material master, and prevent these kinds of these delays in the future.

8.4 Operations connected to HOLD

The data collected for this analysis contains information about orders with components that is connected to HOLD, and is collected from the ZMM_HOLD report from SAP that was described in chapter 5.2.1.

From the report I have chosen two orders to describe the situation, one before and one after the implementation of HOLD. These are two big orders used as an illustration, and they provide with a general picture of how the situation have been in the past, and how it should be for the future.

Following there is an explanation of the columns in the figures used to describe the WO.

Call date

Call date indicates when the WO is supposed to be called out to Norne.

Planning plant

As mentioned earlier in the paper each offshore installation got a unique planning plant number, and for Norne this is 1180.

Order

Operation is simply the work order that is made for the planned job.

Operation

The operation column is a sub-category of the WO that describes which rows on the WO that belongs to the same operation.

Requirement date

The specific date of when the items on the operations is required offshore.

Item

The item column is a sub-category of the operations that describes which items that belongs to which operation.

Handling unit

Handling unit shows which container the item(s) is shipped in.

Shipment

The shipment column describes which shipment the handling unit is sent with

Purchasing document

This column gives the information of which purchase order the units are ordered on.

8.4.1 Before HOLD implementation

One of the big challenges before the implementation of HOLD was that over 70% of the load carriers was stored offshore beyond the 2 week plan period. This was caused due to litle or no control over what was shipped, and when it was shipped. This led to a situation where materials were sent in different load carriers and even sent multiple times back and forward between the supply base and the Norne ship.

The figure 8-6 below describes how a WO was created before the implementation of HOLD.

Call Date	Planning Plant	Order	Main work center	Operatior	Req. Date	Handling unit	Shipment	Shipment date	Item	Short text	Purchasing. Doc
02.08.2013	1180	22586844	IMOMECRO	150	12.08.2013	C-10-319	425750	01.08.2013	10	Trekrybber	4502816282
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	DUMMY MOTTAK.	428070	18.08.2013	30	BOLT,EYE,RS-M8,RUD,WLL0.2T,GR.80	4502714966
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	DUMMY MOTTAK.	428070	18.08.2013	40	BOLT,EYE,RS-M10,RUD,WLL0.25T,GR.80	4502714966
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	DUMMY MOTTAK.	428070	18.08.2013	50	BOLT,EYE,RS-M12,RUD,WLL0.4T,GR.80	4502714966
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	DUMMY MOTTAK.	428070	18.08.2013	60	BOLT,EYE,RS-M14,RUD,WLL0.75T,GR.80	4502714966
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	DUMMY MOTTAK.	428070	18.08.2013	70	BOLT,EYE,RS-M16,RUD,WLL1.0T,GR.80	4502714966
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-319	425750	01.08.2013	110	7200,LOCTITE,HENKEL NORDEN,400ml	4502714688
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-319	425750	01.08.2013	120	LOCTITE 7063 AEROSOL,HENKEL,1x150ml	4502714688
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-319	425750	01.08.2013	130	PRO-LONG UNIVERSAL+SPRAY,PRO-LONG,450r	4502714688
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-354	427823	14.08.2013	620	GASKET,RING-JOINT,OCTAGONAL,R 57,SS 316	4502847808
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	MDA-077	427466	12.08.2013	630	Bolt,stud,2 nuts,L7-B7,HDG,1 5/8x320	4502847863
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-611	427823	14.08.2013	640	CORD,O-RING,4.00mm,NBR,70 SH.A	4502850082
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	MDF-147	429166	23.08.2013	650	PRO-LONG UNIVERSAL+SPRAY,PRO-LONG,450r	4502852193
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	MDF-139	430531	03.09.2013	660	PRUSSIAN BLUE NR. 35,TUBE,AXFLOW,5x20ml	4502854216
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-305	427466	12.08.2013	670	GASKET,RING-JOINT,OCT.,R 13,SOFT IRON(d)	4502853063
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-305	427466	12.08.2013	680	GASKET,RING-JOINT,OCT.,R 18,SOFT IRON(d)	4502853063
20.04.2013	1180	22586844	IMOMECRO	290	30.04.2013	C-10-305	427466	12.08.2013	690	GASKET,RING-JOINT,OCT.,R 14,SOFT IRON(d)	4502853063

Figure 8-6: Operations before the implementation

This can be seen upon as one work activity, this means that all items ordered for an operation is the items needed to perform the objective of the specific operation. This would require that all items for an operation have to be located at Norne at the requirement date before the job can be performed.

This is a good example of the mentioned challenges connected the handling of materials connected to operations on WO. The figure shows just a small part of an entire WO 225586844 and it in total it consists of 9 different operations. The figure shows a part of operation 150 and 290 and it illustrates and is used as an example on how the materials connected to operations on a WO was handled before the implementation. As we can see all of these lines, except the first, belong to the same operation 290 on WO 22588844.

Even though all lines belonging to operation 290 have the same requirement date, we can see that they have different shipment dates, shipment numbers and handling units. The problem is that the operations on work orders have set requirement dates; in this case it was 30.04.13, which at first sight seems correct. However, through further analyzes it was revealed that operation 290 was not created according to the correct procedures and this

date is not applicable for all items on this operation. The dates where use.
It is not possible to find these dates either, because it was registered wrong from the beginning, but it was possible to find the actual shipment dates for the different items and the items are shipped out at very different times. In fact there is a difference in shipment dates on 33 days between the first and last shipment within the same operation, where shipment 425750 was shipped 01.08.13 and shipment 430531 was shipped 03.09.13. Differences like these were a typical reason for operations that was delayed, and items stored longer at Norne than first intended.

Statoil have as a goal to ship items belonging to the same operation together and preferably within the same load carrier according to the OTIF concept. Since this is not practical possible in many cases because some materials/equipment need specialized load carriers and the physical size of the items would require several load carriers for the entire operation, Statoil aims to at least manage the operation in one shipment. There is however some exceptions, as mention earlier some items are called out before others on the same operation, e.g. like motors that need to be tested before it is installed. Then they can be shipped out before the rest of the items are called out. The case with operation 290 is that there are a lot of items on a lot of different load carriers and shipments, at totally different shipment days with the biggest difference of 33 days. That means that it is over 1 month between the first and last shipment of items belonging to the same operation. This is a lot in a high pace environment as an offshore installation with limited cargo capacity. It is then very easy that items located in different load carriers the being relocated several times goes missing.

In total there were 9 different shipments for the work order 22586844, where 7 of them are just for operation 290. The items connected to this WO are divided on 16 load carriers, or handling units, where 13 of them belong to operation 290. The items for this WO were purchased through 30 different PO, where 21 of them are connected to operation 290.
The entire WO consists of 90 individual items, and 66 of these are items connected to operation 290.

The problem with so many different load carriers was that it was very easy to lose track of where the different items were located on Norne or HB. If the items also were shipped to Norne with several weeks apart, it made it even harder to keep track of the location of the different items. When shipments were sent offshore long before they were actually needed and there was no real system to store the load carriers and its content, the personnel offshore could lose track of where the item was located. This also caused situations where items that was intended for a specific job, could be used for another job because there was available parts offshore but there was not any specification of what these parts was intended for.

The consequences of having items stored unnecessarily offshore and uses valuable storage is that it will lead to extra lift operations when other shipments is shipped offshore, and the load carriers had to be reorganized and moved to make space for the new ones. In some cases the new shipment coming out would simply have to be returned to HB before it was even lifted onboard Norne because of no available capacity, and the job would have to be postponed to a later time.
This would require that the shipment is first returned to HB and then shipped offshore again closer to the requirement date, or when it is rescheduled. This will again lead to a number of extra lifting operations. If the load carrier is lifted onboard Norne and it is discovered that these items is not going to be used before a couple of weeks or months and they decide to return it to HB, the load carrier have to be lifted onboard a supply vessel again and shipped back.
This illustrates a good example of another challenge before the SCIP project, the high number of lifting operations that was performed at the installations.

This is either way use of unnecessary resources on activities that does not create any value for anyone. In some cases it was a situation where no one really knew exactly what was in the load carriers or when they were going to be used offshore. Time and resources was spent on shipping load carriers offshore that could instead stayed onshore and saved both costs and time for Statoil.

8.4.2 After HOLD implementation

The HOLD indicator aim to keep materials from being shipped offshore before it was needed. By using holding area at the supply base the idea was to make it easier to get an overview of what materials is actually in place and not.

Also, by collecting the items connected to the WO on own areas, it should be easier to make sure that the shipment is sent offshore in one shipment and in the correct load carriers. This is a very simple, but effective system that allows the supply base to collect the specific items for the specific operation on a given location to ensure that the quality of the shipment is according to Statoil requirements. Figure 8-7 shows an example of how the WO is organized after the HOLD implementation.

Call Date	Planning Plant	Order	Main work center	Operation	Req. Date	Handling unit	Shipment	Item	Short text	Purchasing. Doc
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	20	4Way Dir. Contrtol Valve	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	30	Valve Unit for motor drive	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	40	Valve Unit for brake and pawl	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	50	Block Dwg. 191676.10100	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	60	Tube Cross Dwg	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	70	Connector Male	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	80	Connector Male	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	90	Connector Male	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	100	Connector Male	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	110	Connector Male	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	120	Connector Male	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	130	Adapter Male	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	140	Shoulder Nipple	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	150	Shoulder Nipple	4502683012
04.03.2014	1180	22490646	PPMMEC	10	14.03.2014	MD-603	420918	160	Nipple, Male	4502683012

Figure 8-7: Operations after the implementation

This figure shows a small part of the entire WO 22490646 and in total in consists of 4 different operations that had materials connected to them. The figure shows a part of operation 10, and it is used as an example of how the handling of shipments has changed from before the implementation.

Call and requirement dates are the same for all items, but the difference from the figure before the implementation is that these dates are correct and according to the actual date of when the job was executed. So to compare with the before situation, there is no “shipping date” column here because the call date in the after figure is correct.
In other words, this order is created based on the correct procedures and guidelines for work orders and it is planned and coordinated with the actual time and demand for the items. The material on this order was not shipped out before or after the actual requirement date, but they were sent out as one shipment with the purpose of arriving according to the requirement date, and according to the OTIF principle.

As mentioned this WO got 4 different operations, and in total there are 13 different items connected to this WO where 55 of them belongs to operation 10. The items were shipped in 4 different shipments, and they were also transported and loaded in just 4 different load carriers and there was used one load carrier for each of the operations on this WO. For example for operation 10, every item is loaded in load carrier MD-603, and shipped offshore with shipment 420918. This means that the items on the different operations are to a much bigger degree shipped together after the implementation than before.

It can also be notified that all of the items on this WO are also purchased through the same purchase order. This will secure fewer requisitions and PO that will reduce the costs and time connected to making them.

Even though WO 22490646 got items that is shipped in the same load carrier and purchased through the same PO, it does not mean that this is a requirement for the HOLD process as it would not be practical possible for every WO. It is however preferable if possible, as the more compact the shipment is, the more available capacity you have for other load carriers that in turn will reduce costs, but there are some factors to take under considerations here. Some materials and components will have to be shipped in specific containers, as mentioned before. There could be requirements for which container certain components are transported in, and some components are of such physical size that it will not be possible to ship all items connected to one operation in just one load carrier.

This gives a good indication on that the HOLD function is delivering results according to the project goal. This will automatically give a better overview and control over the location of the items for the different operations. When all items connected to the same operation arrives at the scheduled time and is ready to be used when the requirement date is due, the operation can be executed without any delays. The load carrier will arrive in time before the job starts, and when the job finishes the load carrier is ready to be returned to HB and release valuable cargo capacity onboard Norne.

8.5 Lifting operations and supply calls

One way to see whether the HOLD solution have had any positive effect on the daily operations on Norne, is to see if the number of lift operations onboard Norne have been reduced. Statoil have defined lift operations into 2 categories, inbound and outbound. The inbound lifts are connected to all operations that are going onshore from the installation.

This would be operations where a job is executed and finished, and the load carriers are sent back to the supply base. It also includes lifting operations connected to load carriers going in return for temporary storage, or other materials/equipment sent onshore for scrapping or repairs.

The outbound lifts are shipments that are sent to the offshore installation from the supply base, so everything arriving from the supply base can be defined as outbound lift. This would also include if the load carrier are lifted and relocated to another place onboard the installation. For this analyzes it will be the outbound lifts that is interesting because it is here that the effects of HOLD are assumed to be most visible.

From figure 6-1 it was stated that there was 927 000 lifting operations performed on Statoil offshore installations per year, where almost 300 000 of these were unnecessary operations that could have been avoided. In average each load carrier was lifted 6-9 times offshore, before it was shipped onshore again. The optimal solution would be if the load carrier was lifted onboard the installation directly from the supply vessel, and placed on a given location where it was located until the job was performed and the load carrier was ready for its return shipment and lifted onboard the supply vessel again.

The challenge of getting data for this measure was that Statoil have does not have such detailed way of measuring their inbound logistic processes. There are no direct measures of how many times each load carrier is lifted onboard Norne, so the data collected for this analyze is calculated through the total number of lifts performed and number of tonnage that is lifted onboard Norne. This analyze is calculated where the outbound tonnage are divided on outbound lifts that gives an average number of tons per lift. This number is calculated both before and after the implementation, and by comparing them the result will indicate whether the lift operations have been affected by the HOLD solution.

Data collected from Statoil databases on the outbound tonnage and number of outbound lifts onboard Norne are for time period 01.12.12 – 30.04.13 and 01.12.13 – 30.04.2014, so that a comparison before and after the implementation can be performed.

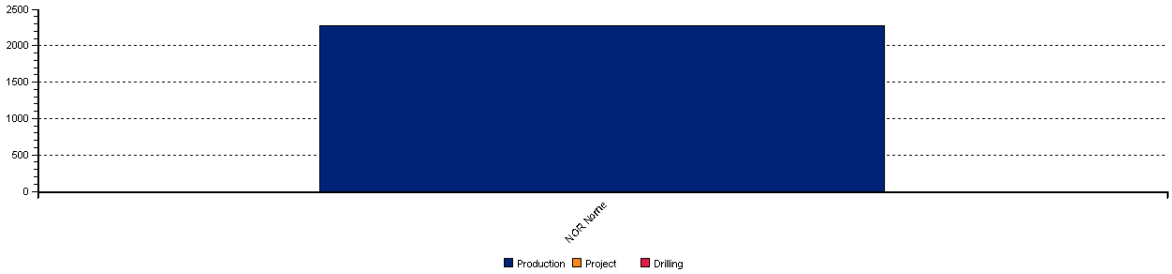
The goal was to see if the hold solution have had positive effect on the lifts performed onboard Norne, or at least it should give an indication of whether there have been any effect or not. If the average ton per lift is higher after the implementation than before, it is an indication that the number of lifts has been reduced.

This analysis is, as we can see in the figures, only focusing on production lifts, and not lifts that are connected to projects and drilling. This is because production lifts are the ones that are within the scope of this research.

01.12.12 – 30.04.13

Installation		Supply calls	Supply laytime	Extra calls	Extra laytime	Other calls (excl. supply & extra)	Other laytime (excl. supply & extra)	Storage days	WOP hrs	Inbound lifts	Outbound lifts	Outbound tonnage production	Outbound tonnage drilling	Outbound tonnage project	Inbound tonnage production	Inbound tonnage drilling	Inbound tonnage project	Outbound bulk	Inbound bulk
NOR	NOR Norne	59	185,9			18	835,2		27,8	637	637	2.269,3			1.741,2			8.891,0	

Outbound tonnage for Norne



Outbound lifts for Norne

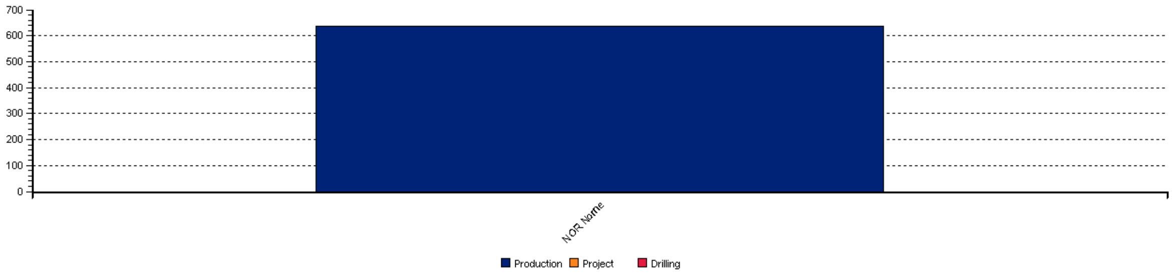


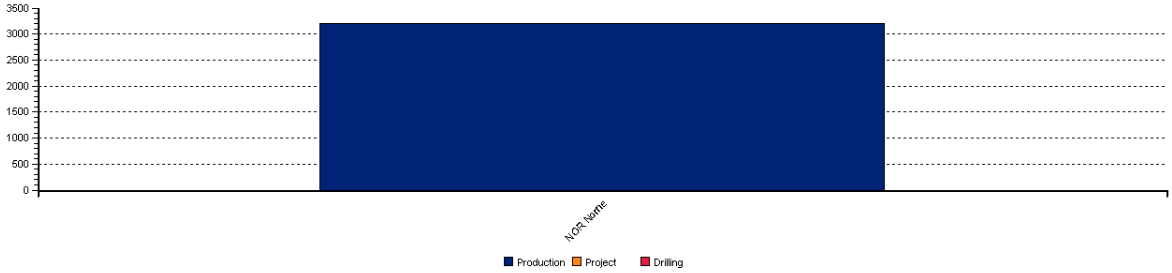
Figure 8-8: Outbound results before the implementation

From the table we can see that the in the time period before the implementation Norne had outbound tonnage production of 2 269.3 ton. This was divided on 637 outbound lifts for the period. The result when the tonnage is divided on the lifts gives the result of 2269.3 / 637 = 3, 56 ton per lift.

01.12.13-30.04.14

Installation		Supply calls	Supply laytime	Extra calls	Extra laytime	Other calls (excl. supply & extra)	Other laytime (excl. supply & extra)	Storage days	WOP hrs	Inbound lifts	Outbound lifts	Outbound tonnage production	Outbound tonnage drilling	Outbound tonnage project	Inbound tonnage production	Inbound tonnage drilling	Inbound tonnage project	Outbound bulk	Inbound bulk
NOR	NOR Norne	47	231,0			33	1.418,3		31,5	868	827	3.196,4			2.441,7			10.468,3	

Outbound tonnage for Norne



Outbound lifts for Norne

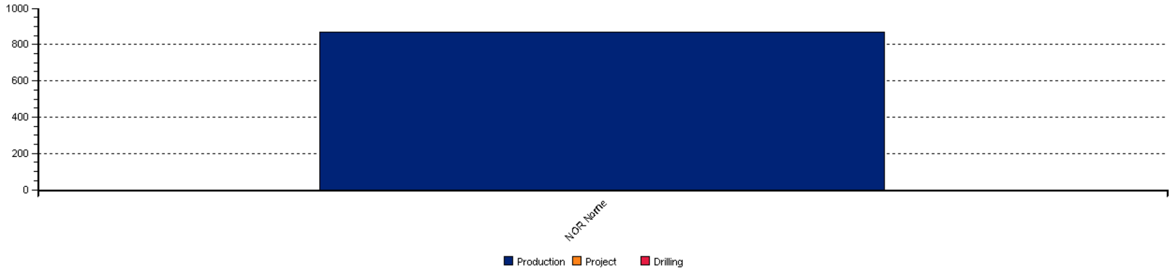


Figure 8-9: Outbound results after the implementation

From this table we can see that in the time period after the implementation Norne had outbound tonnage production of 3 196.4 ton. This was divided on 827 outbound lifts for the period. The result when the tonnage is divided on the number of lifts gives the result of 3 196.4 / 868 = 3, 68 ton per lift.

The figures show that there have actually been an increased in number of outbound lifts after the implementation, from 637 to 868 lifts that gives an increase of 231 lifts from last year's period. There is also a similar situation for the tonnage produced, last year it was produced 2269.3 tons and this year it was produced 3196.4 tons, which is an increase in tonnage produced of 927,1 tons. If we then compare the two years, we can see that this year it was 927, 1 tons more lifted, that was divided on 231 more lifts compared to last year. This means that there has been an increased activity level for this year period compare to last year. But, when we compare the lift-tonnage ratio we see that before the implementation there was 3, 56 vs 3, 68 after, which give an average difference of 120 kg increase per lift after the implementation. This is not a huge difference, but could be an indication of that the load carriers are slightly better coordinated than before.

It is important to take under consideration that the HOLD solution is valid only for Statoil own fields, and not their suppliers. This means that the suppliers' material and equipment is still being sent offshore without using the HOLD indicator, and these will not help improving the result for this analyze, in fact if anything they will have a negative impact on these results.

8.5.1 Supply calls

By comparing the tables before and after the implementations we can also see that the number of supply calls have been reduced after the implementation. Before HOLD there were registered 59 calls, and in the same period after the implementation there were registered 47 calls. That means that in a 5 month period there were 12 less supply calls for Norne at the same period as the number of lift increased with 190. The question of whether this is a result of the implementation of HOLD solution is difficult to answer to, as I do not have sufficient data or information to confirm this due to the time constraint and access of information. We could however say that this is an indication of a better utilization of the supply vessels, which again could be an indication of better planning, which in turn indicates that there are less "emergency" voyages with only a few containers.

8.6 B-priorities

When there are shipments that have to be rushed to the installation and the shipment would under normal circumstances miss the departure of the next supply vessel, the installation can benefit from a B-priority. This priority ensures that the supply vessel will be hold back until the shipment has arrived at the base and onboard the vessel.

B-priorities have to be issued by the installation or the operational unit, in this case the office in Harstad. When making a request for a B-priority it has to be specified what the consequences are by not getting the shipment, it can be stop in operations, production stop or economic loss of significant size. It is the installation that requested the priority that is responsible for all costs connected to a B-priority.
There are two different ways of using the B-priority, supply vessel and helicopter. The helicopter is faster, but is strictly regulated to the lifting capacity of the helicopter.

Below in table 8-10 the use of B-priorities is displayed for the same time period as the lifting operations. The priorities are divided into the two different main categories, vessel and helicopter. These again are divided into two categories of which unit the priority is connected to, operation and project. By operation, it means the daily operations and activities of Norne and the jobs that are connected to the ship. Project is operations that are connected to the subsea satellite field tied back to the Norne field's production vessel.

		Vessel priorities			Helicopter priorities			
	Installation	Operation	Project	Result	Operation	Project	Result	Over result
12.12 - 04.13	Norne	9	5	14	4	4	8	22
12.13 - 04.14	Norne	4	2	6	5	0	5	11

Figure 8-10: B-priorities

The table shows that before the implementation there was 14 priorities requested for Norne by supply vessels where 9 were requested for Operation and 5 for the projects. There was also 8 priorities requested by helicopter, where 4 were requested for Operation and 4 for the projects, which sums up to a total of 22 b-priorities for this period last year.
After the implementation Norne had only 6 priorities requested by supply vessels, where 4 were requested for Operation and 2 for the projects. There was also a decrease in helicopter priorities, where there was requested 5 helicopter priorities and 0 for the projects. This gives the result of a total of 11 b-priorities for this period after the implementation of HOLD.

This gives an exactly reduction of 50 % of b-priorities compared with the situation before the implementation. The biggest reduction is in vessel priorities where the number is reduced with 8, from 14 to 6. The helicopter priorities have in total been reduced by 3 priorities where the priority of operation actually has increased by 1, but there was 0 priorities requested for the projects. The improvements are clearly better for vessel priorities which is a naturally development because priorities that are shipped offshore with helicopter will be smaller items that do not request the same amount of time and resources to handle. Priorities connected to helicopter transport is also not affected to the same degree by the HOLD solution as the processes and activities connected to materials and equipment stored at HB that needs to be shipped with a supply vessel.

There is a question of whether the effects of HOLD cause these reductions of b-priorities, or if the decrease is caused by fewer unforeseen events than the year before. If the reduction was caused solely by unforeseen high priority events, it is not something that the HOLD solution could have affected. However, when taking this year higher activity level under consideration compared to last year, it suggests that the number of B-priorities should have increased. Higher activity level increases the risk of more activities that can be interrupted by unwanted incidents. From section 8.5 we saw that the outbound tonnage had been increased by 927.1 tons from the same period last year that produced 2269.3 tons, which is a big increase. That means that the decrease of 50% in B-priorities had to be caused by external factors that have affected the situation between the two periods. Through the analysis and the interviews there is not revealed other factors that could have caused such a significant reduction on such short time period.

This is another indication on that the HOLD solution have had positive effects on the reduction of unnecessary operations and activities. Better planning and control over items that are requisitioned have caused an improved execution of the WO. This would again mean that B-priorities for last year have not been just for unforeseen events. The reduction tells that a part of the B-priorities have been caused by factors that could have been prevented, which they have after the implementation. This also support the findings in chapter 8.5.1 as a factor that can help explain the number of supply calls have that been reduced.

8.7 Lay time load carriers

This part will be focusing on the lay time for the load carriers. The figure 8-11 describes the situation connected to load carriers and the lay time for these. The data collected for this analyze is from 13.09.2013 – 02.05.2014. It was not possible to collect data before 13.09.2013, because the data turned out to be damaged, and did not present a correct picture of the situation.

The data on load carriers have been divided into weekly intervals, and the analysis is presenting how many load carriers that have been located at Norne per week. It also shows how many containers that have been at Norne that is over and under 14 days. The goal is that the load carriers are stored less than the 2 week plan period.

There is also a column presenting the average lay time of a container each week. The last column shows how big part of the total number of load carriers that have lay time over 14 days.

	Number of load carriers	Under 14 days	over 14 days	Average laytime	Containers over 14 days
13.09.2013	39	25	14	21	35 %
20.09.2013	60	35	25	17	41,67 %
27.09.2013	34	15	19	23	55,90 %
04.10.2013	45	23	22	24	48,90 %
11.10.2013	53	29	24	20	45,30 %
18.10.2013	48	31	17	18	35,40 %
25.10.2013	40	32	8	13	20 %
01.11.2013	38	26	12	11	31,60 %
08.11.2013	40	23	17	14	42,50 %
15.11.2013	56	35	21	16	37,50 %
22.11.2013	46	27	19	16	41 %
29.11.2013	24	7	17	30	70,80 %
06.12.2013	34	12	22	27	64,70 %
20.12.2013	39	16	23	32	59 %
03.01.2014	48	23	25	26	52,10 %
10.01.2014	51	24	27	29	52,90 %
17.01.2014	25	7	18	31	72 %
24.01.2014	43	24	19	21	44,20 %
31.01.2014	41	25	16	22	39 %
07.02.2014	52	32	20	17	38,50 %
14.02.2014	40	20	20	21	50 %
21.02.2014	45	15	30	25	66,70 %
28.02.2014	36	14	22	30	61,10 %
07.03.2014	53	28	25	23	47,20 %
14.03.2014	39	15	24	34	61,55 %
21.03.2014	62	35	27	23	43,50 %
28.03.2014	42	25	17	28	40,50 %
04.04.2014	30	15	15	26	50 %
11.04.2014	48	34	14	16	29,20 %
25.04.2014	52	35	17	18	32,70 %
02.05.2014	59	34	25	19	42,40 %

Figure 8-11: Lay time for load carriers

The aim for this analysis is to see whether the hold indicator have had any impact on the reduction of the lay time of load carriers onboard Norne. Earlier in the paper there have been described situations where the load carriers where sent offshore with no or very limited knowledge of what the load carriers was containing. This led to a situation where the load carriers was stored offshore way beyond the 2 week plan period, because it contained materials from different operations and WO and there was no specific plan for when the load carrier could be emptied and returned onshore.

The implementation of HOLD, were supposed to hold back materials and secure that all materials were shipped offshore according to the requirement date on the operation and that the material were shipped together within the same shipment. This should make it easier to get an overview of the load carriers and the content of them and to empty them offshore. This means that if a load carrier is emptied faster, then it can be shipped onshore faster and that effect is what this analyzes is investigating.

From the figure we can see that there are no significant changes in the average lay time throughout this period. Also, there is no significant reduction of load carriers stored over 14 days onboard Norne. This could mean that the HOLD indicator have not had any significant impact on the lay time. Through the interview and conversation with the SCC it was pointed out that it was still early in the process to see big changes in any lay time reduction. Also, since HOLD solution only was implemented for Statoil’s own fields and not their suppliers, the potential improvements given by the HOLD might “get lost” when data for Statoil and their suppliers are presented together. Even if HOLD in fact managed to release cargo capacity offshore, it could be a challenge to actually specify and document this since the suppliers could then occupy the available cargo capacity.

The lay time for load carriers is a critical step for Norne, and the SC as a whole as this is the end customer in the upstream supply chain. Since the loading capacity is so limited makes it an even more critical step, and it requires sufficient information sharing and reliability in the information shared to succeed. It is essential that the information used is good enough and approved according to the procedures and steps to Statoil’s requirements. In this case the data collected was the total amount of load carriers stored offshore, and it was not possible to split into Statoil’s own fields and their suppliers. If Statoil could manage to create separate measures for the different load carriers owners, they would have an specific overview of which load carriers that is their own and which belongs to the different suppliers.

If the data for the load carriers could have been divided onto Statoil’s own fields and their suppliers, it could have helped to give a more accurate result of this analyze.

9.0 Findings in relation to theories

This chapter will describe the results of the data analysis in relation to the theoretical framework applied for this thesis. In chapter 8 analyze of the data collection for this research was presented with belonging results.

9.1 Supply chain management processes

Customer service management

To continue maintaining and developing relationships with the suppliers, the HOLD solution should be implemented for the suppliers. This would not only help Statoil in securing that all jobs were executed according to scheduled plans, but also securing more efficiency for their suppliers. This would in turn strengthen the relationship between Statoil and their suppliers.

Demand management

With better control over materials being shipped between Norne and HB, it will be easier to balance the requirements between the customer requirements and the capabilities of the supply chain. When the materials are shipped according to the plan and plan dates, and also the information in the material master is updated with correct information, it makes it easier to utilize the supply chain and making it more efficient.

Order fulfillment

When the orders are delivered in accordance to the plans and the shipments are more accurate than before due to a reduction in wrong shipments, it is easier to achieve the OTIF concept Statoil are striving to reach for every shipment. This secures both reliability to the shipments, which again reduces the transportation costs between HB and Norne.

9.2 Lean

With the HOLD solution, Statoil have challenged the perception of the efficiency of their logistics, in accordance with step 3 in lean thinking where the goal is to make value flow. The improvements secure more continuity in the supply chain and aims to avoid the bottleneck. Statoil is also in many cases pulling the value from the suppliers in the supply chain, instead of the suppliers pushing the value out. Statoil has more or less always used this specific concept because of the sudden demand that can occur offshore.

This is also a natural choice on terms of costs, since the prices of certain components would tie up a lot of money in storing these components that you never know when is going to be used.

The last step of the lean thinking principle is pursue perfection that shows that lean is an ongoing continues process, meaning in Norne and Statoils case the chase for improvements should not end with this project. It should be a process that goes on alongside with the daily operations and activities in the supply chain, and in this way become more proactive.

9.3 Theory of Constraints - TOC

The constraint occurs offshore at Norne. As an example, all materials and components for an operation that was planned executed at Norne could have some of the parts stored at HB and other could be stored offshore because it was no available storage capacity at Norne. It could also be situations where some parts were been shipped back and forth offshore several times while others could be stored at different locations, decks and shelves, at Norne. So even though all parts were received from suppliers they could still be spread around and stored at different locations, and sometimes it could lead to a situation where no one knew exactly where the parts were located. This means that it didn't matter that the materials and components were received, as long as they are not ready to be used when they are needed.

If parts are located at their designated spaces and shipped offshore according to the plans they were scheduled for this constraint would be removed. They still have a constraint what regards the loading capacity at Norne but it is a constraint that is not possible to eliminate, but it is a question of utilizing the cargo capacity in a best possible way.

1

The first step of TOC were to identify the constraint, this was done through the SCIP project where different challenges and problems was revealed.

2

The next step was to exploit the system constraint to avoid unnecessary idle time. Statoil began their exploiting of system constraints through focus on improving planning the operations, before implementing HOLD. This can be related to what was called a “free” improvement in the theory described earlier where all such improvements should be performed before elevating the bottleneck. This helped on improving the KPIs that were mentioned earlier, and also helped on getting a better overview of the different plans and operations so that it became easier to see which operations that could be performed at different times. With a better control over plans and location of materials, it is easier to prioritize the operations to keep the flow running. For the future it will be essential to keep this focus, so that they become even more efficient and creates better solution for their supply chain.

From chapter 8 it became clear that there had been an increasing positive trend in the results from the KPIs. There are different indications on that this is a result of a combination of both better focus on planning tasks and the implementation of HOLD. The focus on improving planning, before HOLD was implemented is what was described in TOC as “free” improvements. According to the theory all “free” improvements should be performed before elevating the bottleneck. The increased focus on improving the quality of planning through more accurate and precise documentation and information sharing is such “free” improvement described in the theory.

3.

The third step focused on subordinating the rest of the system to support the bottleneck. For Norne it is crucial to be supported by HB in terms of storage capacity. With HOLD solution it has been clear that the storage capacity at HB will be increased in order to organize all material and equipment that is going to be stored there. This will then be a measure in supporting the constraint of low loading capacity offshore.

In chapter 8.3.3 there was a description of the M5 updates being made in the database. It was described that this was something that was done continuous when such changes/updates were required. This does not have a direct impact on either HB or Norne, but ensures that when the orders are made, the material ordered is the correct one.

This will help reducing the risk of overloading the cargo capacity offshore and reducing number of lift operations through reducing shipments that have the wrong components. This will then be a supportive action to relieve some of the work to the constraint and to increase the efficiency in the supply chain between HB and Norne.

4.

The fourth step was to elevate the constraint and should be performed when all “free” measures are taken. HOLD solution is such measure with the goal of making further improvements. The results of the implementation were described earlier in chapter 8 where the results gave indications of that the results had improved on certain areas.

The results from the analysis indicated that HOLD solution have had an positive effect on the supply chain of Norne. There have been a reduction of jobs that could have been avoided by using HOLD. There is also some results that does not show any big changes after the implementation, but some factors have been presented that could help on understand why some analysis seems to be unaffected.

As we saw in chapter 8.4 the WO set-up extracted from the ZMM_HOLD report have improved compared to the situation before the implementation. The materials connected to the different operations are now shipped together to a higher degree then before and they are shipped according to the actual requirement date for the different operations, and not when they arrive at HB. This creates better control and secures a higher plan efficiency and plan productivity for Statoil.

After the implementation there had also been a reduction of required B-priorities, in fact the reduction was at 50%. This is a big change and it is another sign of the positive effect the implementation have had on the supply chain of Norne.

Other measures performed as the number of lift operations performed showed a increase in lift-tonnage ratio of 120 kg per lift. The increase is relatively small when knowing the average lift was over 3,5 tons, and knowing what exactly caused this change requires a much more detailed research of this topic.

The analyze of lay time of load carriers at Norne showed that there was no significant changes for the lay time for load carriers in general or load carriers stored over 14 days onboard Norne.

As mentioned earlier, the implementation of HOLD was only applied for Statoil´s own fields, and the data for the analyze regarding number of lifts and average lay time for load carriers are both for Statoil and their suppliers and it was not possible to divide these data. This means that even if there were improvements by the HOLD solution, it will not necessarily be visible in the analysis.

Another factor that is worth considering is the fact that there was a higher activity level of materials and shipments going offshore after the implementation than before, as described in the section 7.4. This factor actually confirms some of the improvements shown in other analysis, as the reduction of B-priorities and the reduced number of wrong shipments sent offshore. The activity level goes up but the number of B-priorities and the number of wrong shipments goes down, in other words the efficiency increases.

5

After the improvements are implemented and gives the wanted results, it is time to go back to step 1 and start over again. Through this research it is clear that there has been noticeable improvements on some areas after the implementation of HOLD, and the effects can be linked to the implementation. For the next process it is important to take the knowledge of this first process in the search for further improvements. The next natural step would be to take HOLD to the next level and involve the suppliers. This should help on further increase the positive results that are shown in this research, and also affect the analysis that was not affected in this research.

9.4 Collaborative supply chain

Cooperation between offshore personnel and the OPS group is working well with continuous meetings and communication to secure the correct execution of the operations. There is also a good communication line between Statoil and their suppliers, but as mentioned, if the suppliers implemented the HOLD indicator it could help on strengthening the collaboration even further in the SC with the goal of improving the efficiency and reducing the number of errors made. When all actors in the supply chain are working with the same tools and systems it makes the flow of both materials and communication stronger and more seamless.

Visibility is, as described in the theory part, an important factor to sustain an effective supply chain. The implementation of HOLD enables more visibility, because it requires more planning and detailed information about the materials being moved in the chain. And, with the new report Statoil has a better tool for analyzing what happens in the chain and the result is more detailed and accurate information. HOLD makes it easier to utilize the potential that exists in the supply chain.

The interaction between Statoil and their suppliers is not affected by HOLD solution, as it is today, where the implementation only applies for Statoil’s own fields.
Thus, implementation of HOLD for Statoil’s suppliers should be the next step in search for further improvements and efficiency in the supply chain.

If the implementation of HOLD for the suppliers also show a similar effect as it has for Statoil’s own fields, it should show significant improvements in the same analyzes that did not result in any changes in this research. That means that the average lay time for load carriers should go down and the lift-ton ratio should increase. The result will then be that all materials shipped offshore, either it is for Statoil’s own fields or the suppliers will be affected by HOLD solution, and the results shown in this research should be amplified compared to today. By including the suppliers the collaboration in the supply chain would be further improved and the cooperation that is necessary to make the material flow efficient would also be enhanced without having activities that creates waste.

It was also mentioned earlier from the interviews that better knowledge and skills in the IT system SAP could be another area of improvement for the personnel at HB. If the personnel don’t have sufficient skills to operate the systems, it could be a factor that prevents the supply chain to utilize its full potential.

10.0 Conclusion

From the research plan it was stated that this research was empirical and that this research is a real life case study. The goal of this research was to do an evaluation of the HOLD solution and to assess the results of the project, and to suggest potential improvements. During the work with this research it was a challenge to find relevant theories that supported this research area. Theories used in this research are lean, TOC and SCM that is interpreted to support the research objectives of this thesis. This chapter will try to answer the research problem and the hypothesis that was stated in the beginning of this thesis.

10.1 Research objectives

It was stated one research question in this thesis and three sub questions, alongside with a hypothesis. First the sub-questions will be answered, and then the research question and the hypothesis will be answered

1. *How are the present situation vs before the implementation*?

One of the biggest challenges Statoil faced was that there was that there was little or no control over what was stored offshore at Norne, which led to situations where planned jobs where delayed and postponed. This was caused by situations where wrong parts where shipped offshore where the result was that they had to return it and order a new part. It could also be that parts that where stored offshore was used in other operations, because they had been stored offshore for a long time, and due to lack of control of what these parts actually was supposed to be used for.

After the implementation of HOLD there was made some changes. Statoil focused on increasing the quality of their material master and ensuring that the procedures for requisitions, purchasing and planning was followed, which increased the reliability of the work done before the material was delivered. This combined with new reports have led to a more reliable tracking system of the materials and it is today possible to know which materials is located where to a significant higher degree than before the implementation of HOLD.

2. How are the effects of HOLD, if there are any, improving Nornes situation?

If HOLD solution is going to function as it was intended to it requires that the input is correct. In order for the input to be correct it is crucial that the procedures and set up for the solution is followed in every step of the supply chain. This means that it is necessary to understand how both the supply chain as a whole works, but also between the different actors in the chain. So there have been more focus on the supply chain and how to optimize it now than before, in order to get the HOLD solution to function according to the goal. The results after the implementation have shown that there are fewer jobs that are delayed and postponed, a more reliable material master, better control of materials and equipment that are going offshore where the HOLD indicators secures that materials are shipped offshore according to the requirement dates. The items connected to an operation are shipped together to a higher degree than before the implementation and there have also been a reduction of both B-priorities and supply calls.

For every delay that can be prevented means money and time saved and the resources can be better utilized. It is also another important preventive factor to include here, and that is when correct shipments arrives offshore according to the plan, the number of lift operations can be reduce and the HSE environment will be strengthen and the risk for accidents will decrease. The effects from HOLD are also improving the situation for HB and the personnel working there. With HOLD and the new report they have better control over which parts are located at the base, and to which operation it belongs and when the part is needed offshore.

3. *Are the effects according to the expectations of the implementation, and if not why so*?

Statoil was aiming to create a more efficient supply chain through the implementation of HOLD solution and was aiming to securing shipments offshore according to demand and requirement dates, also known as the OTIF principle. It was also a goal to make calls safer and reduce errors caused by human interaction.

The results from the analysis shows that the changes made after the implementation are according to the goals of HOLD solution, and there are indications and signs on that these changes can be linked to the implementation. Through the interviews it became clear that there was a general perception of that the HOLD solution have had an positive impact on different areas, all the way from the those who creates the requisition and WO, to the planning stage, and to the work done by the base personnel.

For the results that did not show any improvements, or not as much improvements that first expected, it is difficult to determine the cause. One explanation could be that HOLD solution is simply not able to deliver the results that that was assumed, but as explained earlier, the lack of opportunity to distinguish between Statoil and the suppliers in different measures could prevent the results from being visible in the analysis in this thesis. But, to find evidence for these allegations requires further research.

What are the effects of implementation of HOLD solution for the offshore installation Norne?

The effects of the implementation of HOLD solution have been thorough presented and analyzed in this thesis, and summed up in the sub-questions above. It is still early to draw a final conclusion on whether the HOLD solution is the reason of the improvements shown in this research, but it is possible to say that there are indications on that these improvements are caused by HOLD solution. Even though some of the results are relatively modest, it is still a step in the right direction, and if these results lasts in the future and if Statoil could further implement the suggestions made, there could be significant better effects than have been presented here.

Does this research answer the hypothesis?
Nornes upstream supply chain will increase its efficiency as a result of the implementation of HOLD

Based on the results from this research, it does seem to be some truth in the hypothesis. The effects might not be as strong to make a big impact yet but the results does show sign if improvements and there are indications on that the supply chain have been given a start of becoming more efficient and the different areas that was measured and analyzed are providing results according to the goal of the solution.

The effects measured can also show a more significant trend in future, since it still is still early in the process after the implementation and it is still not possible to determine whether the solution have been proper utilized yet.

10.2 Recommendations

The recommendations concluded with is related to how the supply chain of Norne could further improve the results that they already have achieved. To optimize the potential that exists in HOLD solution it is necessary that all participants in the supply chain are involved and have implemented the same system and have the same procedures. It is therefore essential that the suppliers also are introduced and implements the HOLD solution. This would utilize the potential that exists and it is assumed that it would optimize the results in the supply chain better than when HOLD is implemented just for Statoil. It will also, according to the theories, strengthen and increase the visibility between the participants in the chain.

Statoil could benefit by creating more detailed measures of their internal logistical processes, this includes the activities at HB. With better internal measures it is possible to get a more accurate picture of how the material flow is running and potential bottlenecks is easier to reveal. It could also be possible to measure more detailed and get access to valuable information that is not possible today. One example is with the load carriers where it could be possible to divide the measure on each supplier and Statoil.

It is also important that when new technological solutions are implemented that the users of the system and the solution is up to date on how to use the system best, so that the system and the new solution is utilized best possible.

10.3 Research weaknesses

Methodology

The research design used in this thesis is exploratory design due to little or no earlier research on this area. The consequence is that the information used in this thesis is based on interviews of key land based personnel in the upstream supply chain if Norne and own observation. If could have interviewed offshore personnel, this could probably have given confirmation on the information I got from the land-based personnel, which would given higher validity to the data collected.

The analyze of the lay time for load carriers also had incomplete historical data that only had registered data from 2 months before the implementation of HOLD. If I had data from one year before the implementation, as I had from the other data collections, it could have displayed a more significant trend than what was the case here.

Theory

The theories of lean thinking and SCM processes used in this thesis have been partially adopted to fit this research. For lean thinking there have been applied 3 of 5 key principles and for the SCM processes there have been applied 3 of 8 processes, and since there only have been applied parts of the suggested principles and processes it is a theoretical weakness in this thesis. The decision of not applying all principles and processes was made because of the nature of the research. Meaning that some were not relevant for the research, some were not possible to include due to the time frame of the thesis and some because I was lacking data to be able to apply these.

Recommendations

The recommendations proposed are based on the information and data collected from Statoil to improve their upstream supply chain. The results do show improvements on some areas, but there are some results that do not give as clear results as I was expecting. I could have gone deeper into these areas, but this would require a much more thorough analysis of the existing data collection and also new data had to be collected. The problem here is the time frame for the thesis, it was not possible to conduct more analysis or collect any more data in the time available and this soon became clear that it would have been a too comprehensive task for this thesis.

The idea of all actors in the supply chain implements HOLD solution, requires that all actors actually have the opportunity to do so, in terms of resources and time to both implement the system and to properly learn it.

10.4 Further Research

In such complex and high pace environment as an upstream supply chain in the oil and gas industry there are many possibilities for logistics research, both internal for Statoil and external in collaboration with suppliers, transporters and supply bases.

In the thesis it is suggested that HOLD solution should be implemented for Statoil's suppliers. The positive results from this evaluation give a good foundation for expanding the implementation to other actors. This could strengthen the results that are displayed in this thesis and help on increasing the overall efficiency and create a more dynamic supply chain, assuming that there is good collaboration between the actors in the supply chain.

It could also be interesting to do a research that focuses on Statoil's internal logistical measures, which also was suggested in this thesis. What was not suggested was how and which measures that could help Statoil map their internal logistical activities better. Such research could in turn provide with new measures that gives valuable information in the search for a more efficient supply chain.

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12.0 Appendix

Appendix A: Schedule plan for supply vessel Helgelandsbase

Classification: Internal   Status: Final   Expiry Date: 2014-12-31

MASTER-SCHEDULE FOR SANDNESSJØEN
Valid from 01.03.2010

				Weekday for departure	MONDAY				TUESDAY				WEDNESDAY				THURSDAY				FRIDAY				SATURDAY			
				Vessel	A		B		C		D		A		B		C		D		A		B		C		D	
				ETD Supply base	Mon	16:00	Mon	16:00	Tue	16:00	Tue	16:00	Wed	16:00	Wed	16:00	Thu	16:00	Thu	16:00	Fri	16:00	Fri	16:00	Sat	16:00	Sat	16:00
Installation	Night arr.?	No calls	ELT pr call	ELT pr week	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time	ETA Day	ETA Time
NORNE *	No	3	03:00	9:00	Tue	07:00							Thu	07:00							Sat	07:00						
AKER SPITSBERGEN	Yes	3	04:30	13:30	Tue	01:30							Thu	01:30							Sat	01:30						
DEEP SEA BERGEN	Yes	3	06:00	18:00	Tue	10:00							Thu	10:00							Sat	10:00						
ETA SUPPLY-BASE		9	09:00	40:30	Tue	07:00	Tue	07:00	Thu	07:00	Thu	07:00	Fri	07:00	Fri	07:00	Sat	07:00	Sat	07:00	Mon	07:00	Mon	07:00	Tue	07:00	Tue	07:00

Abbreviations:
ETD - Estimated Time of Departure
ELT - Estimated Lay Time pr Call
ETA - Estimated Time of Arrival
No calls - Number of planned calls pr week

Links:
VTMIS
APOS
Priority/Storage vessel
Weather Forecast

Contacts:
Supplybase day time: 75070330
Supplybase night time: 91143127
StatoilMarin 55143276

Notes:
This is a master-schedule, sailing-schedule for each day depends on volume, priorities and weather.
Respond whitin deadline to the proposition of "todays sailingorder" if divergence in ELT.
If change in opening-hours for vesselarrival, contact supply-base at least one month in advance.
* 3 calls per week when floating units on Norne field, otherwise 2 calls per week.

Appendix B: Deadlines logistic

Tidsfrister logistikk	
Base - Innmeldinger / Frister	
HOVEDREGEL	
Materiell levert base	Kl. 16:00 en virkedag før seilingsdag med unntak av søn- og helligdag
Innmelding av returlast	Kl. 10:00 avgangsdag fra base
UNNTAK	
Leieutstyr	Innmeldt innen kl 09:45 og levert base innen kl.10:00 seilingsdag
Proviant	Innmeldt innen kl 09:45 og levert base innen kl.12:00 seilingsdag
Midlertidig innleid utstyr (Z-015)	Innmeldt 3 dager før seilingsdag og levert kl 16:00 en virkedag før seilingsdag
Rekvirering av bulk	2 dager / 48 timer før fartøyavgang
Innmelding av OCTG (Needliste / Sjekkliste)	45 dager før behov på Innretning
Helikopter - Innmeldinger / Frister	
Bestilling av plass på helikopter	
Materiellforsendelse	Leveringsfrist på heliport er 2 timer før avgangLedetid til Heliport kommer i tillegg
Shuttling - HFIS/Log sender ruteoppsett til piloter	Normalt ca. 20 min før start
Shuttling - HFIS/Log låser ruten og setter opp mest effektive rute	1 time før avgang
Shuttling - innmelding av passasjer og last	1 time før oppstart

Appendix C: Key personnel interviewed

- Supply chain coodinator
- Senior supply chain coordinator
- Planner at Harstad
- Material coordinator at Helgelandsbase
- SCIP Analyst