Master's Degree Thesis

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Requirements for a Logistics Information System in the oil and gas industry – A case study for Statoil

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Foreword and Acknowledgements

This master thesis completes a three year experience based master's degree in logistics. The years at Molde University College has been very interesting but also demanding in the context of finding the right balance between a full time job in Statoil, the family life in Stavanger and the remote studies in Molde. Through the work with the master thesis I have had the pleasure to be able to immerse into an exciting area of genuine interest to me. The paramount nature of effective supply chain planning and execution as a premise provider for high operational productivity and sustainability has for many years been a guidance to my professional direction. During the work with the paper I have gained a deeper academic insight as well as valuable transfer of operational, tactical and strategic competence from professionals within supply chain and other areas. The work has also given me a unique opportunity during a short period of time to view the Statoil supply chain management on the Norwegian Continental Shelf (NCS) from a more holistic perspective. I would like to use this opportunity to thank my all parties having contributed to this final stage of the educational program. My family has waited patiently for three years, and I really look forward to spending more time with you again. I would also like to thank Statoil for all support in relation to the master program and also to all employees inside and outside Statoil who has helped me to provide information to the paper. At last I would like to thank the staff at Molde University College. For a remote student from Stavanger it has always been a pleasure to be in contact with the extremely helpful staff. I would like to express my gratitude to my supervisor for all help during this period. Thank you for all advice on structure and content!

Abstract

The goal for this thesis has been to recommend to Statoil high level functional requirements for a Logistics Information System. The underlying contextual frame is the recent dramatic fall in oil prices where the industry has to cut costs and regain a balance with sustainable profit margins. The majority of the Statoil total expenditures stem from supplier activities, and all parties have to contribute to bring down the costs in the industry. Increased information sharing is repeatedly prescribed by academia as a remedy to elevate the performance in supply chains. The Exploration & Production Information Management Association (EPIM) owned by operators on the Norwegian Continental Shelf (NCS) is running a joint industrial initiative in the Norwegian oil and gas sector with the intention to increase the visibility and performance in the supply chain on the NCS. The association has estimated that the solution has the potential to increase the efficiency up to 25 per cent.

I have analyzed if the current extended supply chain of Statoil on the NCS offers real-time visibility for goods. The conclusion is that there is no real-time visibility among actors in the extended supply chain since the Statoil supply chain systems have no automated electronic B2B interface with non-Statoil supply chain systems. Some limited visibility of goods based on manually entered status information in enterprise systems at each actor exists. The suppliers have equally limited visibility of their equipment in the Statoil internal supplier chain. The actors in the extended supply chain regularly compensate for lack of real-time information through the use of manual resources and higher inventory levels. The study has also revealed that several actors in the oil and gas industry are working on solutions to increase the visibility for the extended supply chain.

A recommendation of the study is to increase the visibility in the extended supply chain by making use of the momentum available through the ongoing Statoil internal Event Management project and EPIM LogisticsHub project (ELH). The aim of these projects is to improve the planning and execution and thus the performance related to the supply of goods to offshore installations. The thesis proposes high level functional requirements to an internal planning and execution Logistics Information System. A model for information sharing in the extended supply chain is proposed along with information elements, documents and events. A business case should reveal the business potential and if justified, further iterations on requirements are recommended to reach a sufficient detailed level.

Table of Contents

List of figures

List of tables

1. Introduction

The oil and gas business has a cyclic nature and high revenues have characterized the industry for the past years. The Wall Street Journal (2015) reported recently that Statoil now shares a current problem in the oil and gas industry; how to handle the recent and dramatic fall in oil prices to a level around $50 a barrel. The drop in profitability following the fall in oil prices is the revised framework for the industry to adapt to a new challenging business context. Higher operational efficiency and reduced costs are paramount to a successful adaption process.

From a supply chain management perspective it is a target to have high performing supply chain activities with high service levels, high throughput and low variability. Increased complexity in the supply chain necessitates premeditated supply strategies and corresponding Logistics Information Systems supporting the strategies. The offshore drilling and production of oil and gas on the NCS operate on a 24/7-schedule, and the supply chain scenario facing Statoil has a high complexity. A large volume of cargo is moving to and from the offshore installations from 7 different supply bases along the Norwegian coast; often in harsh weather conditions. This is coordinated with a large number of suppliers supporting a wide range of products. Changes in operational logistic plans occur regularly due to unpredictability on progress in drilling and well operations causing a demand for flexibility in the supply chain.

Well planned and timely deliveries are important due to limited storage on the offshore installations, but also due to a high cost supply scenario involving transportation of cargo both on land and sea. Late deliveries can be critical for the operations and can lead to severe cost implications. In such a complex supply scenario some vital prerequisites for cost efficient supply chains are precise supply chain management with the availability of updated information in the chain. The availability of good quality and real-time information which is shared among the actors in the supply chain is important for a well-functioning supply chain. For the operational planning and execution of the logistical activities companies are dependent on a Logistics Information System, and the ability to specify the right requirements for such a system is mandatory to reap the potential benefits of the system.

An *Information System* is defined as:

A system which assembles, stores, processes and delivers information relevant to an organisation (or to society), in such a way that the information is accessible and useful to those who wish to use it, including managers, staff, clients and citizens. An information system is a human activity (social) system which may or may not involve the use of computer systems (Buckingham et al. 1987, quoted in Avison and Fitzgerald 2006, 23).

Logistics Management can be defined as:

Logistics Management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements (Council of Supply Chain Management Professionals 2015).

Following these two definitions I define *Logistics Information System* as a system that has the ability to handle issues related to the flow of goods, services and the associated information between the point of origin and the point of consumption in order to meet customers' requirements.

A Logistics Information System differs from typical Enterprise Resource Planning (ERP)-systems. Typical issues handled in a Logistics Information System are status information on expected/departing goods, arrivals, departures, loading, unloading, inspection, certifications, alerts when something is not according to plan, and means to execute corrective actions.

There exists some literature for Logistics Information Systems requirements. Although the literature provides some general guidelines, establishing requirements for such a system at Statoil is still a challenge for researchers and practitioners.
The major reasons are:
- A Logistics Information System affects many business units within Statoil.
- A Logistics Information System affects many external partners interacting with Statoil.
- Each unit and partners have their own goals which could be conflicting, e.g. a logistics service provider wants to maximize its logistical services to maximize profit, while Statoil wants to provide lean logistical services and thus minimise these costs.

- A Logistics Information System must be aligned and integrated with existing systems e.g. ERP-system.
- Sharing of information is required, but partners normally hesitate due to confidentiality issues.
- The consequences of wrong or missing requirements are severe in relation to cost and time.
- It is not possible to foresee all consequences of new information stemming from information systems.
- More than 80% of Statoils total expenditures stems from activities purchased from suppliers. With the recent drop in oil price the current goal in the oil and gas business is to cut costs to adapt to the new business scenario. A natural consequence is that the external actors must be involved to reach a competitive level.
- The cost structure of Statoil has been moving towards an increasing CAPEX (Capital Expenditure).

In this thesis I aim to explore the challenges mentioned to develop requirements for a Logistics Information System. The main research problem for the study is:

What are the requirements for a Logistic Information System at Statoil?

A Statoil internal assertion among supply chain professionals is that there is lack of real-time information in relation to planning and execution of supply chain operations on the Norwegian Continental Shelf (NCS). In order to compensate for lack of real-time information for material under transportation, Statoil uses manual resources to follow up transportation ordered from third party logistical providers. It has further been argued that the internal information systems in Statoil do not communicate with other actors in the supply chain. Not knowing details of goods whereabouts and condition makes the operations less flexible. There are especially challenges related to the time perspective with regards to the planning of logistical activities and the handling of unexpected events. The second research problem is:

To what extent do the current Statoil internal and the extended supply chain offer real-time visibility on the NCS?

A successful capture of requirements for a Logistics Information System is a complex task. Information systems have been used by the businesses through several decades, but even today businesses stumble on this matter resulting in higher costs than necessary as requirements are misunderstood, are incorrect, have changed, etc. The understanding of what peers in the oil and gas industry do in relation to Logistics Information Systems will help Statoil reduce some uncertainty and give guidance on the current best practice within Logistics Information Systems.

The third research problem is:

What is the current trend among peers in the oil and gas sector in relation to Logistics Information Systems?

Students and researchers have done various studies which have been related to the oil and gas business on the NCS. I have identified several studies suggesting improvements for the supply chain (Shyshou et al. 2012, Aas 2008, Aas, Halskau Sr, and Wallace 2009). A pre-study regarding logistics to the Heidrun installation was performed for Statoil in 2010 (X2X Maritime 2010). The study recommends Statoil to implement a real-time event management solution for the logistics activities.

2. Research title, design, methodology and research methods

2.1. Title for the research problem

My thesis will outline a first iteration of recommendations to high level functional requirements for an operational logistics planning and execution information system to be used in the oil and gas industry on the NCS by Statoil.

The title for the study is:

REQUIREMENTS FOR A LOGISTICS INFORMATION SYSTEM IN THE OIL AND GAS INDUSTRY: A CASE STUDY FOR STATOIL

Both the Drilling & Well (D&W) and Operations & Maintenance (O&M) part of the organization operates a planning and execution Logistics Information System which has limited possibilities to add information about transports from suppliers to the Statoil supply bases. The interface with other internal and external systems is partly fragmented and for the extended supply chain partly non-existing. There appears to be a potential for improvement. Statoil will identify if one operational planning and execution Logistics Information System can cover the requirements for both O&M and D&W where the system is going to track and trace all goods being shipped to and from the offshore facilities. The objective is to increase the performance in the supply chain from a supplier to the Statoil operation and back to the supplier again through the availability of real-time information and thus increased visibility of goods. Potential benefits include increased planning horizon along the supply chain, reduced so-called bullwhip effect if any is present, less inventory through higher turn-around of tools and equipment required for the operations, and more efficient handling of unexpected events.

2.2. Research questions

In context of the research problem and the scenario described above I have formulated the following research questions for the study:

Research Question 1:

To what extent do the current Statoil internal and the extended supply chain offer real-time visibility on the NCS?

Research Question 2:

What is the current trend among peers in the oil and gas sector in relation to Logistics Information Systems?

Research Question 3:

What are the requirements for a Logistic Information System at Statoil?

The term *real-time visibility* is an important part of research question 1, and I find it relevant to explain the term through one definition of *real-time* and another one for *visibility*. *Real-time* can be defined as: "Relating to a system in which input data is processed within milliseconds so that it is available virtually immediately as feedback to the process from which it is coming…" (Oxford Dictionaries 2015). *Visibility* can be seen as: "the extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations and which they consider will be of mutual benefit" (Barratt and Oke 2007).

2.2.1. Delimitations

The study will be limited to only comprise the upstream O&M and D&W organizations in Statoil and the supply value chains related to the NCS. Other parts of the Statoil business areas e.g. onshore plants refining oil products and sales will not be subject for any considerations. The study will be limited to the first iteration of a set of high level functional requirements for an operational planning and execution Logistics Information System. I have decided to only focus functional requirements, and non-functional requirements will correspondingly not be covered. The supply chain will not be an end-to-end supply chain in the meaning that goods are going to be traced from the raw material manufacturer and all the way to the offshore oil and gas installations. Figure 2.2.1.1 illustrates the relevant supply chain scenario.

Figure 2.2.1.1 Supply chain in a typical offshore related transportation scenario

| Demand | Delivery | Supply base activities | Sailing | Receipt and return offshore | Return sailing | Receipt of returns at base |
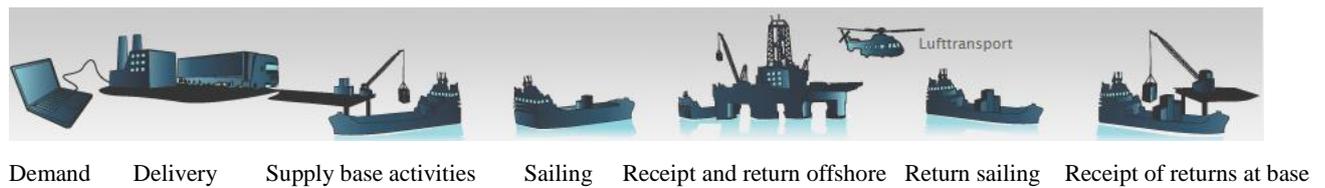
Source: Statoil internal

A delimitation is that the supply chain starts with purchase orders from Statoil to its suppliers of goods and services for the offshore oil and gas installations, but it also encompass potential returns from the offshore installations back to the suppliers. The majority of goods heading for the offshore installations are primarily being transported by supply boats, and the use of helicopters for this purpose is very limited. I will for this reason not focus on helicopters as a means of transportation of goods/equipment. Transportation of persons to and from the offshore installations is not taken into account. This paper will not include any kind of cost benefit analysis or development of a business case.

2.3.   Method of analysis/model

Working with a case study Yin (2003) postulates that interview is a vital source for information. During the work to collect information I have used interviews both internally and externally. I have approached key stakeholders and performed interviews where the context has been open-ended. The internal interviewees have been questioned about facts and I have asked them to explain the current business processes. They have given their opinions and perceptions about the processes where they especially have been asked to outline the well-functioning processes as well as challenging processes with a potential for improvements. Some of the interviewees have received follow-up questions to broaden my view and to gain a deeper understanding of some of the topics. I have been pro-active to seek key persons with a competence specifically valuable for the subject of the thesis, and the interviewees also suggested other persons to interview. This is in line with (Yin 2003) who accentuates the selection of key informants to be paramount in a successful process towards a finalized thesis. Yin (2003) also emphasizes that case studies should be documented through more than one source. An advantage with the use of multiple sources is the possibility to converge fragments of information into facts (Figure 2.3.1).

Figure 2.3.1 Convergence of evidence
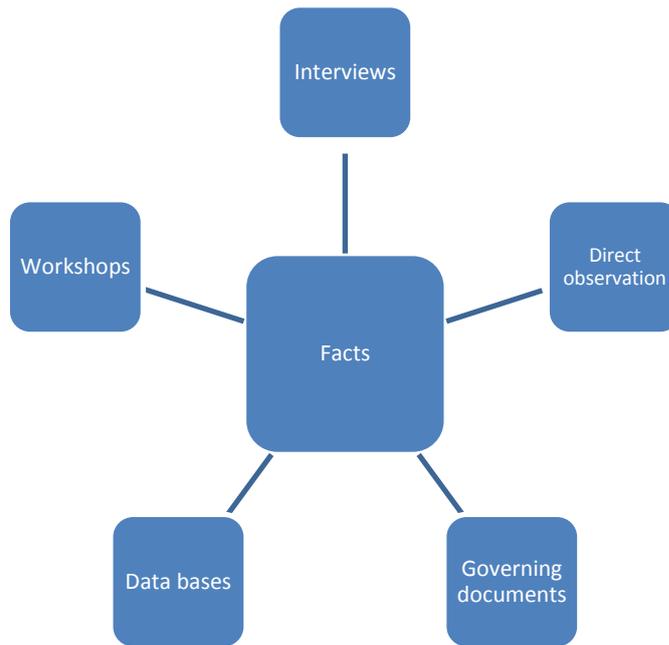
Source: (Yin 2003)

Figure 2.3.2 illustrates the sources of data used in the thesis. I have collected data from sources within Statoil and sources outside Statoil, and I have selected to classify this into the two categories internal and external sources. The primary data is collected through interviews and conversations with key persons inside and outside the Statoil organization. Examples of key persons are specialists and managers in logistics and IT as well as persons having their daily work in the supply chain loop at Statoil. Existing information collected and used in relation to the work have been classified as secondary data.

Figure 2.3.2 Sources of data used in the master thesis

Data sources	Internal	External
Primary data	Direct observations, interviews, work shops	Interviews
Secondary data	Statoil governing documents, the Statoil intranet (Entry), different databases in SAP, 20-F report for 2014, minutes of meetings	The internet, scientific articles, textbooks, master theses, doctoral thesis, white papers

The intention with the case study has been to give a recommendation to high level functional requirements for an operational planning and execution Logistics Information System to be used by O&M and D&W in the context of the ongoing ELH project and the Statoil internal event management project.

During the work I have observed, increased my understanding, collected information, described, analysed, explained, interpreted, compared and recommended. Relevant information has been collected from different sources which has been the core elements of an analysis. The outcome of the analysis along with information from the workshops has been the essence in the recommendations to Statoil. Figure 2.3.3 below is a simple model illustrating the method.

Figure 2.3.3 Model
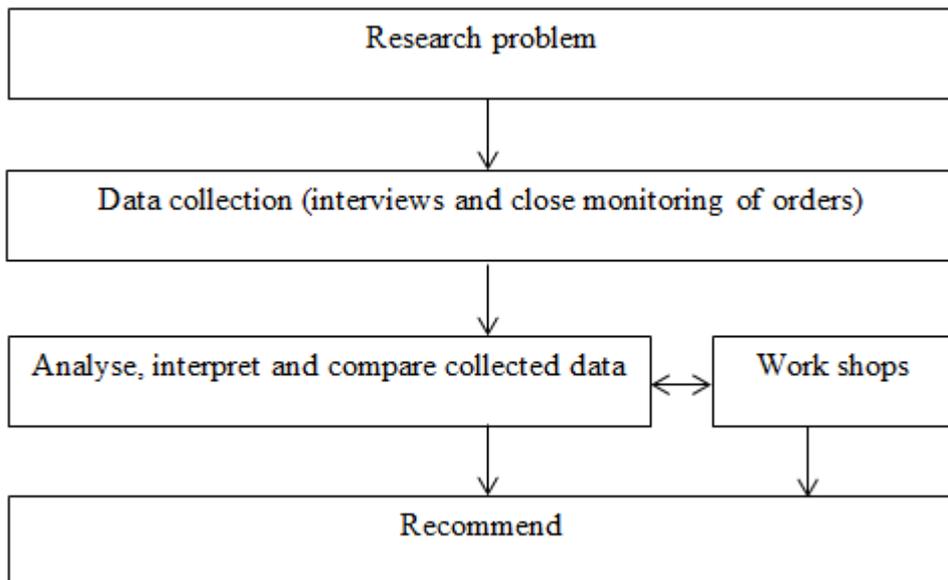
The results from the study will primarily be useful for Statoil in the further work towards the potential implementing an information system for O&M and D&W. The results can also be useful for other actors in the supply chain as they should experience increased value creation as a result of a potential future implementation of the Statoil operational planning and execution Logistics Information System. Statoil is a corporation which over the last years has grown internationally and there is a potential that the international organisation can benefit from the results going forward. The results can also be of value for other larger organizations facing similar challenges.

Figure 2.3.4 Reference overview for research questions

Research question	Reference to case/ analyse	Reference to theory
Q1: To what extent do the current Statoil internal and the extended supply chain offer real-time visibility on the NCS?	Chapters 1, 2, 3, 6, 7, 9, 10.	Chapter 4.1, 4.2, 4.3, 4.6.
Q2: What is the current trend among peers in the oil and gas sector in relation to Logistics Information Systems?	Chapter 1, 2, 5, 9.	N/A
Q3: What are the requirements for a Logistic Information System at Statoil?	Chapters 1, 2, 3, 7, 8, 9, 10.	Chapters 4.1, 4.2, 4.3, 4.4, 4.5, 4.6.

2.4.   Research design

The intention with research design is to plan how to conduct the empirical research in order to collect evidence (see Figure 2.3.1) for answering the research questions. Thus, research design can be considered as a connection between the conceptual and the empirical level. The research questions are related to the philosophy of science and the research design lead the way to the research practice / research method. During the work with the study I have made use of induction by collecting empirical evidence that lead to general conclusions. The research methods used to collect empirical evidence are the sources of data listed in Figure 2.3.2.

2.5.   Plans and activities

2.5.1. Plan for data collection and data collection method

Once the delimitations in Section 2.2.1 were established, I developed the plan for data collection. The plan has been the guideline for how this work has proceeded although adjustments have occurred as the study has progressed. The idea has been to have a clear correlation between the research questions, the data collected and the how the data should be analysed. The plan for the interviews contained information on who to interview, how and with time windows for the interviews. A specified list of anticipated primary and secondary data was also included in the plan.

For research question 1 I have made use of two methods and compared the results. The first method was that I internally in Statoil made use of semi-structured interviews where questions primarily were constructed in advance. I also added some questions to gain a deeper understanding of the subject when deemed necessary. It was important to decide which groups of persons to be interviewed in order to understand the limitations on the current operational planning and execution Logistics Information System. The interviews were also used to collect information on expected functionality for a future operational planning and execution Logistics Information System. The second method was to make observations while following an order through the order management cycle (OMC) as described in the classical Harvard Business Review article "Staple Yourself to an Order" (Shapiro, Rangan, and Sviokla 1992). I collected data and information for the sourcing of some equipment through the supply chain from a supplier to an offshore installation. I also stapled myself to an order the opposite way from the offshore installation back to the supplier. Information regarding the theoretical approach for this method is described in chapter 4.6. The information collected from both the interviews and the walk-throughs of the OMC were compared and analysed. This forms the basis for the understanding of the current situation regarding real-time visibility. For research question 2 regarding best practices by peers in the oil and gas sector, I contacted candidates with adequate information and performed interviews. In relation to research question 3 where the high level requirements were developed, I have received information from internal experts and relevant Statoil supply chain managers. Workshops were used in an iterative process with these Statoil practitioners to gain a deeper insight and increased knowledge in the group to be able to recommend a set of high level requirements for an operational planning and execution Logistics Information System for Statoil.

2.5.2. Sources of information

A systematic approach to ensure a thorough and robust collection of data was to develop a stakeholder analysis for the different research questions. Through the stakeholder analysis I detected the relevant sources for information subject to interviews. Examples of stakeholder groups were:

Statoil: user groups like customers and distribution actors in D&W and O&M, relevant supply chain managers, different experts, decision makers, the event management project in Statoil, stakeholders in relevant projects like ELH.

Non-Statoil: suppliers, transporters, experts at Molde University College, fellow students, peers like ConocoPhillips, BP and Talisman.

2.6. Research integrity

As the requirements for the master's degree thesis at the "Erfaringsbasert master i logistikk" states that the thesis primarily should be related to a project or a problem associated with the student's work place, many of the stakeholders to collect information from will naturally be employees in own company. The potential bias during the collection of data in own company is present, and I have selected some mitigating actions to reduce the associated risk. I used several sources of information and the results were compared. I have performed interviews with stakeholders from different levels in the Statoil organization e.g. drilling supply responsible persons, SCM coordinators, purchasers, supply chain managers, and material coordinators. All employees have been able to read through the text to ensure that the descriptions have been depicted correctly. I have made observations during the work, and I have "stapled myself to orders" through the supply chain. After having followed the orders I have compared the results and made the analysis and given my recommendations.

I have made research on high level functional requirements, and this study does not contain a recommendation for a complete set of functional and non-functional requirements with a high granularity. Statoil has been at an early stage in the process without the necessary process matureness where it is natural to recommend requirements on a detailed level. Further work needs to be conducted in the organization with several iterations to reach a deeper level of matureness on this matter.

3. Statoil and the organization

3.1.   The current business environment

The expenses in the oil and gas industry the last decade has reached record levels and the Statoil return on capital employed has diminished with a third during the same period even though the oil price has been high. The recent drop in the oil price has forced the oil companies to address the high cost level and adapt to lower revenues. Statoil has lately had an annual growth in investments by more than 75%, and for the coming years the investments will remain on a high level. The cost level has to be addressed to ensure profitable production in the future (Statoil 2014). The cost-cutting in Statoil shall be escalated according to the company's director for development and production in Norway Mr Arne Sigve Nylund. He states: "We've seen a higher cost level and reduced profitability. The way I see it, we will see a more margin-focused business, with much more focus on costs" (The Wall Street Journal 2015). The company started the cost reductions in February 2014 following some years of rapidly rising costs in the oil and gas sector. With a continued high level of CAPEX, it is utmost important that the operational expenditures are used cost effective to achieve a high performance on the operations. For this reason Statoil has several improvement programs ongoing e.g. the Statoil Technical Efficiency Program (STEP) and Organizational Efficiency (OE). A large part of the total Statoil expenditures comes from its suppliers, and cooperation with the suppliers is necessary to address the current business scenario. One can say that Statoil's success on this matter actually is dependent on the suppliers. Hence, close cooperation with suppliers is also necessary for the extended supply chain to achieve a high performing supply chain.

3.2.   The organization

Statoil is an international energy corporation with operations in more than 30 countries and territories (Figure 3.2.1), and the corporation has per 2014 approximately 22 500 employees globally. Statoil has gained experience from oil and gas production on the Norwegian continental shelf (NCS) for about 40 years, and the largest activities are still on the NCS. Statoil is also the largest operator on the NCS and holds the majority of the oil and gas licences.

Figure 3.2.1 The Statoil global presence per 2014

Source: Statoil (2015)

Statoil has a growing international presence. For 2014 39% of the total production was achieved from the global activities not being part of the NCS. In the continued international business development Statoil will use the core knowledge from the NCS within deep waters, heavy oil, harsh environments and gas value chains to explore upcoming business opportunities. Besides processing and refining activities the corporation is a large supplier of natural gas to Europe and is also among the largest sellers of crude oil in a global scale. Table 3.2.1 illustrates the Statoil equity production for the years 2012 – 2014. Statoil has also projects in other energy forms like carbon capture and storage and offshore wind.

Table 3.2.1 The Statoil equity production in million barrels oil equivalents (mboe) per day

Year	2014	2013	2012
Equity production (mboe per day)	1 927	1 940	2 004

Source: Statoil (2015)

To keep the competitive abilities Statoil will continue the managerial focus to achieve a higher efficiency and a trimming of costs per unit. The ambition is still to maintain a stable growth in the oil and gas reserves and production through the use of technological innovation (Statoil 2015).

The corporation's global operations are per 2015 managed by the Chief Executive Officer, staffs and support divisions and the following 7 business areas (Appendix A Statoil organization chart): 1) Development and Production Norway (DPN) 2) Development and Production International (DPI) 3) Development and Production North America (DPNA) 4) Marketing Processing and Renewable energy (MPR) 5) Technology, Projects and Drilling (TPD 6) Exploration (EXP), and 7) Global Strategy and Business Development (GSB). The business areas affected by this paper, DPN, TPD and EXP are described below.

Development and Production Norway (DPN)

DPN has the responsibility for all upstream activities on the NCS. The current activities are illustrated in Figure 3.2.2.

Figure 3.2.2 Overview Statoil offshore installations and onshore sites of the NCS
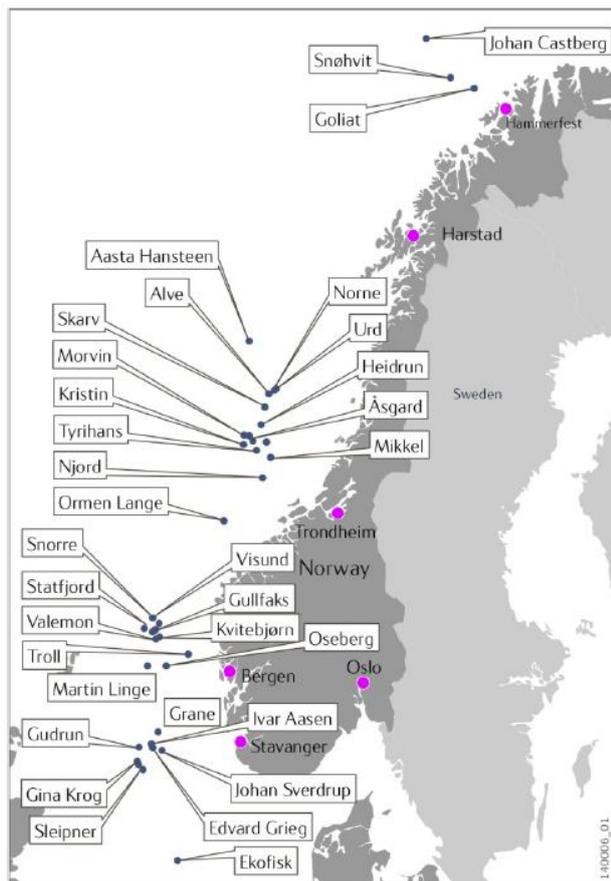
Source: Statoil (2015)

A main objective for DPN is to maximize the value creation on the NCS. The business unit aims to excel the operational performance and cost. Through a strong Health, Safety and Environment (HSE)

culture DPN endeavours to strengthen the position Statoil has as one of the leading operators of offshore oil and gas production in the world. The business unit pursues an ambition for improved oil recovery rates, further exploration prospects and also to open new areas on the NCS. The focus for field developments is the use of standardized and proven solutions.

The O&M is a part of the DPN business area. Other DPN organizational elements supporting logistics on the NCS is Joint Operations – Logistics and Emergency preparedness (JO LE) which is responsible for marine operations to and from installations, the supply bases, air transportation of personnel and the helicopter terminals.

Technology, Projects and Drilling (TPD)

The responsibility for TPD is to develop the corporation technologically, deliver projects and wells in safe, efficient and global cost competitive manner. The procurement activities in Statoil are organized as a part of the TPD business area. D&W and the procurement related activities performed for D&W is organized as a part of the TPD business unit.

Exploration (EXP)

The responsibility of EXP on the NCS is to perform exploration activities for the North Sea, Norwegian Sea and the Barents Sea in accordance with corporate priorities. In a global perspective EXP has the ambition to access new areas in prioritized growth and frontier basins. EXP also has a target to place Statoil as a leading international exploration company (Statoil 2015).

4. Theoretical framework

4.1.   Introduction

The general theoretical concepts for the study are within supply chain management (SCM) and information sharing. The overall intention with the SCM philosophy is to manage the total flow of information and materials in a distribution channel from vendors to manufacturing, distribution and finally to the end customer (Cooper, Lambert, and Pagh 1997, Houlihan 1987, Simchi-Levi, Kaminsky, and Simchi-Levi 2000, Tarn, Yen, and Beaumont 2002). Typical goals in SCM are to increase the total performance of the system rather than optimizing individual echelons in the supply chain. Endeavours should be done to optimize the business processes related to material handling and information processing as well as financial control (Stevens 1989).

4.2.   Management of logistics - information sharing and collaboration

Many companies face the challenge of having several information systems not communicating internally in the company. The challenge grows if one adds the lack of information sharing between companies in a business relation. This has the potential to create a blurry overview preventing transparency and efficiency in the supply chain (Simchi-Levi, Simchi-Levi, and Kaminsky 2008). According to Pereira (2009) the management of information is a core element in a SCM context and missing, delayed, distorted or wrong information is normally a considerable challenge and a source for inefficiencies in a supply chain. Lee, Padmanabhan, and Whang (1997) state that the bullwhip-effect causing inefficiencies in supply chains can be counteracted through increased sharing of accurate information in the supply chain. Bodendorf and Zimmermann (2005) argue that the importance of information management is growing in dynamic environments, and this can be considered as another layer of complexity in dynamic supply chains scenarios. Simchi-Levi, Simchi-Levi, and Kaminsky (2008) argue that the ability to track goods in supply chains is an asset which should be utilized. Challenges linked to the lack of visibility for goods in a supply chain are typically addressed by an enhanced readiness capability including more staff and increased inventories. A better solution can however be to establish a good cooperation with the transport companies and suppliers within the area of information sharing. Good cooperation with information systems communicating across the supply chain can offer real-time information and has the potential to provide mutual benefits for the involved parties removing inefficiencies. The facilitation of enhanced information sharing is also reported by

Pereira (2009) to be a measure to excel transparency, communication and a contributor to remove inefficiencies. A white paper from IBM postulates:

> A good supply chain visibility solution can help you resolve supply chain exceptions before they escalate into major problems and can improve the performance of your suppliers and carriers, reducing the number of delays and order errors that occur in the first place. All of this adds up to a sizeable return on investment together with operational improvements across the supply chain (IBM 2011).

This is also supported through the concept of the 3V's of supply chain: visibility, velocity (throughput) and variability[1]. Art Mesher claims that increased visibility in the supply chain will lead to increased velocity/throughput and reduced variability. The result is likely to be increased value creation in the supply chain (SupplyChainDigest 2005).

The persistent and rapid development in information technology can be a gate opener for more efficient supply chain strategies, and has e.g. created a shift in interaction between business partners. In many industries companies have entered into strategic partnership where benefits from information sharing are a key. The analysis of data made available through the partnership creates opportunities for savings. This change in behaviour has also encouraged researchers to look into the area of information sharing (Simchi-Levi and Zhao 2003). Simchi-Levi and Zhao (2003) report about potential benefits from sharing demand information. Through a computational study they have demonstrated that the manufacturer can reduce inventory costs and maintain the same level of service to retailers. They also refer to several other studies documenting the benefits of information sharing. Stein and Sweat (quoted in Simchi-Levi and Zhao 2003) report that the sharing of demand information vertically among supply chain echelons has provided huge benefits. The sharing of inventory level, forecasting data, and sales trends, has reduced cycle times, fulfilling orders more quickly. The customer service has improved and the companies have removed excess inventory for millions of dollars. Another study by Aviv and Federgruen (quoted in Simchi-Levi and Zhao 2003) looks into a single supplier multiple retailer system with a random demand for the retailers. They share inventories and sales data with the supplier. They examine the effectiveness of a Vendor Managed Inventory (VMI) program and observed that the VMI reduced cost relative to information sharing was an average of 4.7%. They report that the sharing of information has a potential to save cost also for the supplier. An analysis by

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[1] B. Jæger: LOG904 Seminars in Logistics, Seminar 120: RFID. Lecture at Molde University College, Faculty of Logistics, Molde, 6 October 2014.

Gavirneni, Kapuscinski, and Tayur (quoted in Simchi-Levi and Zhao 2003) for a simple two-stage supply chain with a single capacitated supplier and a single retailer reveals increased production capacity in the range from 1% to 35%.

4.3.   Business-To-Business (B2B) Supply Chain Systems

According to Cecere (2014) supply chains have become networked instead of point-to-point. The supply networks are complex networks with many trading partners encompassing mutual dependencies with outsourced contract manufacturing companies, third-party logistics providers (3PLs), freight forwarders, and transportation providers. These relationships are outsourced, becoming external, but the information systems have not been updated accordingly, i.e. they are still mainly internally focused. Firms have automated the internal information systems; but the extended supply value chain still has an unreleased potential. Even though the data flows are dynamic, most networks still have to operate with static ad hoc manual processes, e-mails and Electronic Data Interchange (EDI) in spite of the development of B2B connectivity the last decade. It is for this reason challenging for the extended trading partners to keep information synchronized as changes occur in the network. Even if some information is integrated, it is not synchronized across several actors. Cecere (2014) argues that there is no network system of record as the information flows are point-to-point and there is an immense latency on data. Data received is correspondingly often out-of-sync and out-of-date.

There is a need for increased enterprise visibility. Cecere (2014) claims that supply chain leaders have huge gaps between the required level of visibility and the present levels (Figure 4.3.1).

Figure 4.3.1 Supply Chain Visibility in Business-To-Business Networks: Gap Analysis

Supply Chain Visibility: Importance vs. Performance
(Rated 5-7 on 7-point scale)

■ Importance   ■ Performance   □ Gap (Perf-Impt)

	Inter-enterprise order management to customers	First tier material suppliers	Transportation & logistics network	Third-party manufacturing	Third-party logistics	Transactions & supply chain decisions within company	Second & third tier suppliers	Manufacturing within company
Importance	79%	83%	96%	74%	87%	95%	50%	85%
Performance	29%	38%	53%	35%	47%	62%	18%	63%
Gap	-50%	-45%	-44%	-40%	-40%	-33%	-32%	-22%

Greatest Gaps

Source: Supply Chain Insights LLC, Supply Chain Visibility Study (Oct 2013- Jan 2014)

Source: Cecere (2014)

The greatest gaps are reported to be within the areas addressed by this thesis, namely the increased requirement for visibility across ERP-systems, and across multiple information systems to synchronize the company core production and procurement. On top of this there is an additional requirement for an inter-enterprise visibility or supply chain synchronization between the trading partners in the network. The requirement encompasses visibility across multiple tiers of suppliers, logistics providers as well as contracting manufacturers, and it can either be a one-to-many or a many-to-many (Cecere 2014).

The flows between the parties are complex, interweaved and signals flows through many trading partners several times during a day. A typical purchase order changes e.g. in average one to two times. During the 1990s a weekly flow of information was adequate for an efficient supply chain. The clock-speed of the supply chain information required daily updated information during the last decade. Now there is a need for real-time information continuously refreshed on hourly basis to synchronise the flow between the trading partners. Cecere (2014) claims the change in clock-speed is the biggest driver for B2B networks as ERP and EDI connectivity is not sufficient.

Figure 4.3.2 illustrates that the average company currently has greater visibility inside the enterprise than in the extended network. The gaps for the extended networks are considerable, and the there is an increasing business pain caused by these inefficiencies. This is presumed to be the case for the extended Statoil supply chain and thus a potential argument to increase the visibility in the chain. Cecere refers to Figure 4.3.2 and argues that the trust in ERP systems to create supply chain visibility

for the extended supply chain has diminished among supply chain leaders. The B2B business networks have reached a level of maturity where it is time to adopt B2B information systems.

Figure 4.3.2 Supply chain leaders' belief that supply chain visibility in the extended network will come from ERP providers
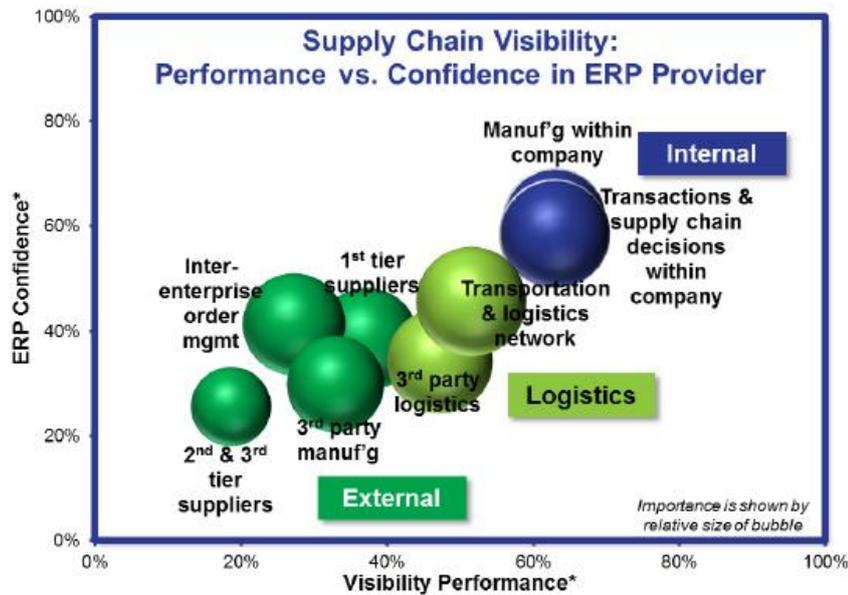
Source: Supply Chain Insights LLC, Supply Chain Visibility Study (Oct 2013- Jan 2014)
Base: Manufacturers, Retailers, Wholesalers / Distributors / Co-operatives and Third Party Logistics Providers – Have ERP System (n=70)

Source: Cecere (2014)

4.4. Operational planning and execution

To improve the performance in the supply chain and realize potential benefits from increased information sharing, a well-functioning supply chain planning is paramount. Simchi-Levi, Simchi-Levi, and Kaminsky (2008) postulate in their book: «Designing and managing the supply chain» the following to be vital prerequisites in a planning context:

1. The availability of relevant information
2. The transformation of relevant information to a viable plan
3. .. where the plan should be assessed in a cost-benefit perspective

The supply chain planning and execution are vital elements for a high operational productivity and sustainability in the business. In an information management context there is a potential for ubiquitous availability of data to share, collect and analyse. The key information pertinent for efficient planning and execution has to be identified and captured as a real world business case does not allow the

availability of unlimited planning resources. The collection and analysis of the information has to fit into a business setting of limited resources. The business context can in this perspective be a premise provider for the dimension of the available supply chain resources, but rational and effective supply chains can also create business opportunities and become a competitive advantage. Aas and Wallace (2010) claim that the coordination and planning of logistical activities gradually have become more complex, and this has led to the development of more standardized solutions and automated planning tools to reduce the uncertainties from intuitive decisions. An important feature of information systems is to be a tool for decision making, performance management and management of exceptions in case of unexpected events. This is embodied in information systems through the two main components: planning and execution (Aas and Wallace 2010). Simchi-Levi, Simchi-Levi, and Kaminsky (2008) define the execution component to provide data, transaction processing, user access and infrastructure for running the company. The planning component make use of data provided by the execution component and supports decision making on the strategic, tactical and operational level. As planning is more included in the ERP systems, the management of information and design of information systems should be considered as managerial tasks of equal importance (Closs & Savitskie, 2003; Ballou, 2004; Helo & Szekely, 2005; Feng & Yuan, 2006, quoted in Aas and Wallace 2010). Although information systems have the ability to reduce risk and remove uncertainty, these are standardized tools and cannot replace people completely (Zuboff 1988). In a complex supply chain scenario it is of utmost importance still to have human brains to deal with e.g. changes that occur in the operations, problem solving, take decisions, perform the necessary communication.

4.5. Information system development

The requirements for an operational planning and execution Logistics Information System are important prerequisites for a successful implementation of such a system. Even though information systems have been with us for decades incorrect requirements, changes of requirements, misunderstood requirements have not disappeared.

Information Systems Development Methodology is defined as:

> A collection of procedures, techniques, tools, and documentation aids which will help the systems developers in their efforts to implement a new information system (Avison and Fitzgerald 2006, 24).

4.5.1. Requirements

Requirements in relation to an information system can be defined as:

> everything that the set of relevant stakeholders want from a system. Relevant stakeholders encompass all those people involved with legitimate interests, including those both internal and external to the organization. It includes end-users, line management, senior management, customers and regulators (Avison and Fitzgerald 2006, 97).

The identification, gathering, analysing, documenting and communication of requirements have been an ongoing source for concern since the introduction of the first information systems. Many consider the requirements to be the most essential part for a development of an information system, but they are often misinterpreted according to Robertson and Roberson (1999). The requirements are definitely important as they determine the functionality of the information system, and getting requirements wrong will have a negative financial impact. Leffingwell (1997) claims that 70-85% of the cost related to rework has its origin from erroneous requirements. Research argues that the rework costs related to correcting erroneous requirements are 80-100 times less if errors are detected at the implementation stage. Figure 4.5.1.1 illustrates the relationship of cost of correcting requirement errors in different phases of the development of the information system (McConnell 1996).

Figure 4.5.1.1 Relative costs of fixing requirements errors
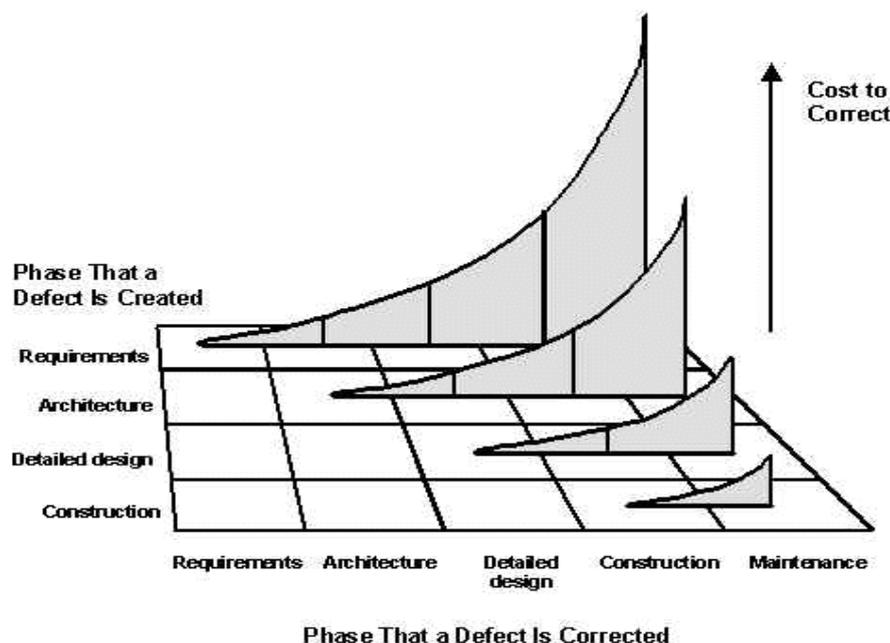
Source: McConnell (1996)

Detecting an erroneous requirement at the requirements stage will involve an insignificant piece of work. Fixing a requirement error at later stages will require more and more rework the later in the process one are when the errors are detected. The rework costs after production and release of the system can be significant.

The traditional requirement process

A traditional process to formulate requirements is illustrated in Figure 4.5.1.2 and this is often how the process evolves in large organizations following the life cycle approach. Some stakeholders have an idea of what the system should look like and how the functionality should be. This paper will focus the development of requirements early in the process on a high end functional level illustrated as the blue frame in Figure 4.5.1.2. In a traditional process these requirements are then systemized by the business and system analysts. Through a time consuming iterative process with interviews, meetings, workshops, surveys, storyboards, etc. the stakeholders and analysts finally agree on a specification for the system which then can be signed off (Avison and Fitzgerald 2006, 97-101).

Figure 4.5.1.2 Requirements in systems development
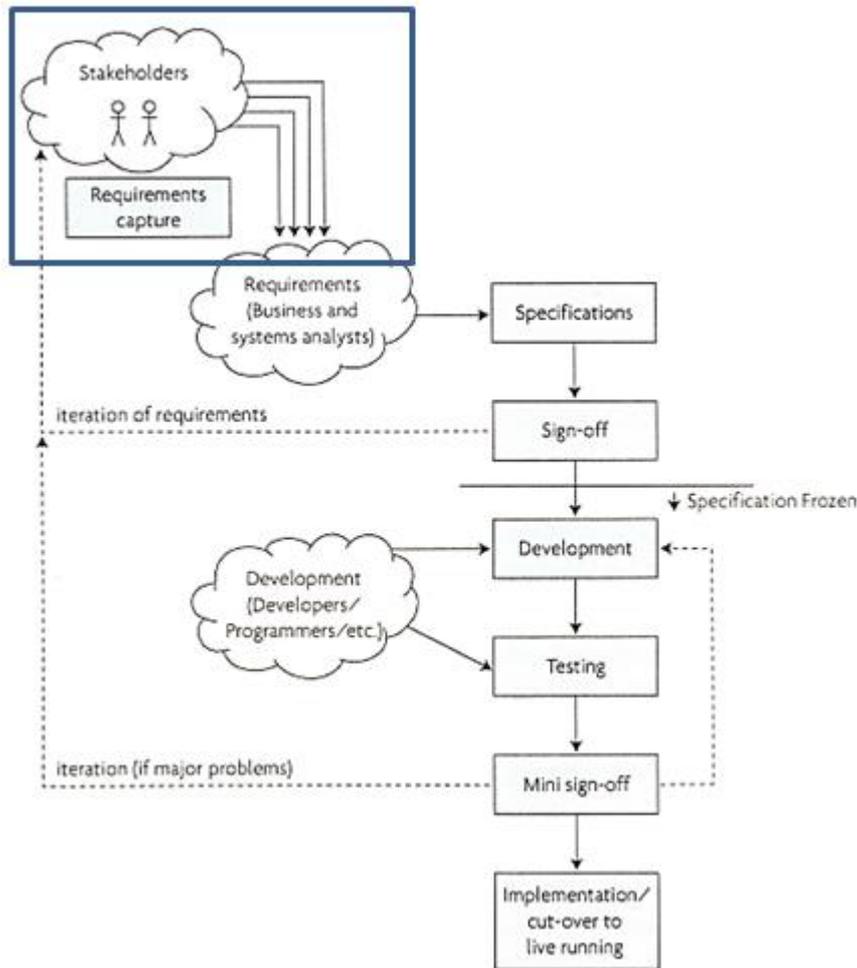
Source: (Avison and Fitzgerald 2006)

Real world problems

The traditional model is described in a generic way and the description of such a theoretical model is not surprisingly in many cases different than the real world. Problems arise regularly and the following bullet points summarize some challenges experienced during the requirements capture phase:

Requirements capture

- Some important stakeholders may not be identified and the analysts may not capture the requirements from these. This may lead to higher cost than necessary at a later stage in the process.

- Stakeholders may not be very dedicated to the project for various reasons. It might be they are generally not interested or are very busy with other work. The result may be that some requirements are not captured or misunderstood.
- Lack of good communication between the analysts and the stakeholders can be a reason that requirements are misunderstood or captured inaccurately. This can easily be the outcome as there are numerous details which are subject to difference in interpretation.
- If the specification is not complete, the analysts will miss some requirements accordingly.
- Users can often over-elaborate requirements and request functionality that is less relevant.
- Stakeholders may not propose relevant requirements due to lack of knowledge of available options.
- Users may disagree on some requirements where the analysts pay attention to the senior managers or the majority of the users. This may not be the best way forward.
- Problems related to requirements might be ignored or neglected if other departments need to be part of the discussions or if the challenges appear to be very costly. This might lead to a revisit to the requirements at a later stage and correspondingly higher cost to the system.

These are some of the real world challenges during a development process (Avison and Fitzgerald 2006, 101-104).

Changing and evolving requirements

Although the capture of the requirements has been a thorough and good process, requirements can change after the specification is finalized. In a real wold business scenario changes occur and the traditional process does not cope well with changes in the requirements after freeze of the specification. This can be the source for a growing problem if there is a long period from specification until the system is implemented.

Unknowable requirements

A basic anticipation in the traditional requirements process it that subject to dedicated stakeholders doing their best through a thorough and good process, all requirements will be captured. Another approach is that some requirements are so complicated and difficult to understand, that they are beyond the reach of the stakeholders. No matter how hard the team work they will not be able to

capture these complex requirements. Such an example is if there is a new technology and the experience in the team is limited. The customer might not really understand what they need.

Non-functional requirements

Although I will not cover Non-Functional Requirements (NFR) I find it relevant to give a brief introduction to this subject. NFRs are important features of the system describing *how* the system will perform rather than *what* the system will do. A system might have good functionality and doing whatever the system is designed for, but the users will not be satisfied if the system e.g. is very slow with lots of waiting. The NFRs are in other words attributes in a system affecting the overall user satisfaction. These NFRs are significant for the performance in the final system and should be addressed accordingly during the process. NFRs typically concern system performance, interfaces, designs, and software quality attributes (Avison and Fitzgerald 2006, 104-107).

4.6. Staple yourself to an order and re-staple yourself to an order

4.6.1. Introduction

Harvard Business Review released an article named "Staple Yourself to an Order" in 1992 where business managers were challenged to follow the Order Management Cycle (OMC) through each step from the initial contact with the customer to the fulfilment of the order. "The truth is that every customer's experience is determined by a company's order management cycle - the ten steps, from planning to post sales service, that define a company's business system"(Shapiro, Rangan, and Sviokla 1992). The message in the article was that the best way for executives to get a good understanding of the customer's experience with the company and thus be able to identify gaps in the business processes, was simply to follow the steps of an order through the company. Years have passed since the original article and the world of business has developed to become more complex with e.g. new methods for communication, technical development, and increased globalization. The introduction of ERP systems and the virtual world are some examples making the order management cycle more challenging than ever for the business managers. Companies should take notice of these changes and elevate their business performance to a new level. This will ensure that customer demands are met and also strengthen the competitiveness. The original article expresses a distinct aphorism that more companies still should pay attention to today (SupplyChainDigest 2011). The approach to walk through the business processes to identify inefficiencies is also recognized as a good measure in other

logistical philosophies. In lean logistics this type of approach is called the Gamba walk. The idea is for managers to examine the processes from a factory floor perspective, rather than assessing reports in an office. Many complex organizations have a vertical orientation and while value streams are horizontal in nature. Waste is thus challenging to identify and remove along the horizontal line, and the gamba walk has a horizontal end-to-end approach (Womack 2011).

4.6.2. The order is king

How can companies end up in the situation with a misalignment between what companies do regarding the order management cycle and what they know? A central element is the lack of clear ownership across the order management process. Does for instance any person in your organization understand the details of your order management cycle, work flows, information channels, and detailed processes in an end-to-end perspective? The ownership of the order process is often divided between the different functions having a role through the process like sales, production, supply chain and finance. It is common that the order management process is not owned by a single function coordinating the chain of events from start to end. The necessity of cross-functional involvement in the order management cycle makes it challenging for managers to get a comprehensive overview of the complete order process according to Shapiro, Rangan, and Sviokla (1992).

You might have a good overview of the end-to-end order process providing there is an uncomplicated structure on your supply chain. Many companies today face complex supply chains with multiple suppliers, distribution centres and with several points of stakeholder interfaces. In these scenarios it is not common for one person or a group to have an in-depth insight to the full order management cycle process. Shapiro, Rangan, and Sviokla reported that managers seldom have an in-depth view of the OMC. The customer representatives often appear to have the best insight to this process, but this also turns out not to be complete in many instances according to the authors. Shapiro, Rangan, and Sviokla (1992) claim that:

> Each step in the OMC requires a bewildering mix of overlapping functional responsibilities…Each step is considered the primary responsibility of a given specific department, and no step is the sole responsibility of any department.

The solution outlined by the authors is for the executives to simply follow an order as it moves through the 10 different steps described by the authors (Figure 4.6.2.1). They should metaphorically "staple themselves to an order" with the objective to search for inconsistencies and opportunities to

improve the lifecycle of the process. According to Shapiro, Rangan, and Sviokla (1992) more satisfied customers, reduced cross-functional issues and higher profit are very often the outcome of improved order management processes.

Figure 4.6.2.1 10 Steps to the Order Management Cycle

The 10 Steps to the Order Management Cycle

In their classic article *Staple Yourself to an Order*, Shapiro, Kasturi, and Rangan identified 10 steps in the order management lifecycle.

- **Order Planning:** Design of the order management process
- **Order Generation:** How and where orders will be solicited and acquired
- **Cost Estimation & Pricing:** Providing quote or price to customers
- **Order Receipt & Entry:** Capturing a new order and starting the workflow (manual or automated)
- **Order Selection & Prioritization:** What orders are most important, and how will they be handled sequentially?
- **Scheduling:** Moving the order into a production or fulfillment plan
- **Fulfillment:** Delivery to the customer
- **Billing:** Customer invoice process
- **Returns & claims:** Handling any returns or complaints about damage or other product issues
- **Post Sales Service:** Service and support activities (warranties, replacement parts, etc.)

There is a certain "timelessness" to these 10 steps, and certainly they can be used as a starting point to document a company's own order management process.

At the same time, much is different today than when these steps were first articulated. Order generation and receipt, for example, now often involve use of many more channels than even 5-10 years ago. Fulfillment has also become much more complex, and this OMC model does not fully consider the complex and virtual nature of today's supply chains, with drop shipping from suppliers, web ordering with store pick up, or the need for merge-in-transit serving as three primary examples of today's order cycle changes.

Source: SupplyChainDigest (2011)

The article guided numerous companies in the 1990s and 2000s to elevate their performance of the order management cycle. "Staple Yourself to an Order" has its origin back to 1992, and the paper reflects the challenges for business organizations more than 20 years ago. Although the paper still is highly relevant the challenges in 1992 was in the context of largely vertically integrated organizations where companies had their own production and distribution facilities. Each production facility managed its own production and thus the corresponding order handling and fulfilment in their market. Even though supply chains were not as complex this was before the entrance of ERP systems and a time with customized highly functional order management systems which were slow, difficult and expensive to change.

Companies today conduct their business in a complex, virtual, multi-tier and channel environment where ERP systems is paramount in corporate businesses. These systems often give rise to a mix of different ERP providers and versions in the corporation, and they are often focused within the corporation. These systems often exclude the management of co-operation with external stakeholders in the order management process. Given the profound and rapid development since the 1990s an article titled "Re-Stable Yourself to an Order" published by SupplyChainDigest (2011) claims it once again is time to re-staple to orders representative for the business order management cycle of today. A scrutiny of the order management cycle will often reveal substantial gaps in the process which can improve the supply chain performance as well as customer service when dealt with. A difference from 1992 is that the content of the 10 order management steps today entails far more virtual information compared to a more physical focus back in 1992. The results of these endeavours may in many instances unveil a demand for companies to reconsider their requirements for technical support for the order management cycle (SupplyChainDigest 2011). The technology should have the adequate capabilities to support the multi-channel context. The development in virtual business for supply chain networks is described in section 4.3.

5. Best practices for logistics information systems in the oil and gas industry

The intention with this section is to gain a high level understanding of the current development and best practice for Logistics Information Systems from some of the actors in the oil and gas industry. I have made an assumption that the oil and gas producers with the biggest market value also have large operations generating considerable supply chain activities. The assumption is further that these companies would have the biggest benefits of well-designed Logistics Information Systems. To select the candidates to interview I have retrieved a list of the top 12 oil and gas producers from the Financial Times top 500 lists for 2014. From this list (Table 5.1) I have selected to contact the companies present on the NCS. These are all big global market players and holding a total of about 50% of the total global oil and gas market value. I have assessed that these companies should be able to offer a flavour of the current trends.

Table 5.1 Financial Times (2014) list of oil and gas producing companies in market value

Sector rank	Global rank 2014	Global rank 2013	Company	Country	Market value $m	Turnover $m	Net Income $m	Total Assets $m	Employees
Oil & gas producers									
1	2	2	Exxon Mobil	US	422 098,3	390 247,0	32 580,0	346 808,0	75 000
2	12	17	Royal Dutch Shell	UK	238 993,5	476 860,0	17 300,7	351 727,2	92 000
3	15	10	Chevron	US	227 014,7	211 772,0	21 423,0	250 799,0	64 600
4	16	4	PetroChina	China	220 893,7	372 996,9	21 407,2	385 015,4	544 083
5	34	48	Total	France	155 984,8	235 867,4	11 593,4	234 452,5	98 799
6	36	37	BP	UK	147 771,1	400 666,6	24 782,8	304 705,2	83 900
7	74	53	Sinopec	China	96 667,8	468 003,6	10 923,9	228 433,9	368 953
8	83	57	Gazprom	Russia	91 289,4	159 767,7	35 474,9	408 893,5	459 500
9	84	78	Eni	Italy	91 209,2	157 997,7	7 137,4	183 757,4	82 300
10	86	84	Statoil	Norway	90 007,9	102 077,1	6 575,5	144 595,5	23 413
11	90	49	Petrobras	Brazil	88 517,8	129 081,3	9 979,0	312 629,0	86 108
12	92	92	ConocoPhillips	US	86 358,3	56 185,0	9 156,0	118 057,0	18 400

Source: Financial Times (2014)

I have collected information about the following companies: A/S Norske Shell, ConocoPhillips, BP, Talisman, ExxonMobil in Norway. I have in addition provided some information regarding Swire Oilfield Services; a company supporting the oil and gas companies. The following section outlines the information I have collected for these firms regarding their Logistics Information Systems.

A/S NORSKE SHELL

Norske Shell A/S does currently not have a Logistics Information System keeping track of goods being shipped to and from offshore installations for the NCS. The company has firm plans to implement new technology to track shipments, and the company has in this regard assessed two solutions:

1. A Global Positioning System (GPS) solution for Cargo Carrying Units (CCUs)
2. A Radio Frequency Identification (RFID) solution for CCUs

Shell has been testing both solutions, and during the first quarter of 2015 the company selected to continue with the GPS solution. They have decided to implement GPS devices on 70% of the total amount of CCUs they use on the NCS. Shell will be able to upload the cargo manifests to the third party CCU owner system and will through this solution be able to track equipment being shipped to or from the NCS. A manifest is s document listing all cargo to e.g. for a supply boat on a route to different offshore installations on the NCS.

On a global scale Shell decided in 2015 to deploy a supply chain network system with the ability to increase the visibility for materials along the supply chain. It is a GPS based global track and trace initiative with the intention to enable end-to-end and real-time visibility on the flow of materials from procurement, transportation, including disposal. The solution will facilitate a simplified way of collaborating and will give the involved parties improvements in the planning, flow of materials, and control of spend.

> The Track and Trace program is powered by E2open's E2 Process Management, as well as the advanced analytics and cloud-based connectivity in the E2open Business Network. Capturing "events," both planned and unplanned in the supply chain, along with improved search capabilities, near real-time information, and improved reporting and analytics capabilities, enables better decision-making at Shell. This program will be deployed to multiple worksites and end user groups, ranging from work preparers and logistics to materials management to vendors and logistics service providers (E2open 2015).

CONOCOPHILLIPS

ConocoPhillips is one of the oil and gas producing companies taking part in the ELH project and has plans to continue in the project. The company has implemented RFID tags on the CCUs in full scale

on the NCS. ConocoPhillips is currently working with an event management solution. The company uses SAP as ERP system, and it is considered natural that SAP will be part of the final solution. The company has per January 2015 neither decided how the integration with ELH is going to be nor what the final track and trace solution look like. The solution to be selected has a target to have the interface as standardized as possible and to have interfaces as few places as possible.

BP and TALISMAN

The reason for BP and Talisman[2] to be listed in the same section is that these companies have a logistical co-operation in Norway. They have formed a joint venture and share a common logistics centre. Also BP and Talisman are taking part in the ELH project and plan to implement an RFID solution. The companies currently use the logistic system called Wellit Logistics System (WELS) for track and trace of materials and equipment. They are working on the interface between WELS and ELH. The ambition is that the system is going to be simple and user friendly. The solution will initially not be compatible for BP on a global level due to lack of standard. It is a goal to have a regional solution in place with a global potential, and BP wants to implement the RFID solution on the NCS initially. BP currently uses an internal RFID solution in the Gulf of Mexico, but does not comprise other companies or the industry.

BP started in 2013 to deploy RFID technology to monitor its supply chain during construction of the Clair Ridge oil platform in Asia. The objective was to implement a track-and-trace solution supporting an end-to-end real-time visibility for components moving from vendor locations to the platform. This solution was used for tracking crates, heavy lift and out-of-gauge equipment, containers and vessels with the objective to enhance the planning, improve efficiency and safety during the construction phase. The visibility was created through the use of RFID tags and GPS sensor telemetry tags and centralized through a vendor provided web-based visibility platform (RFID24-7 2013).

EXXONMOBIL

ExxonMobil in Norway has outsourced the main responsibility of the supply chain activities on the NCS to the company Norsea AS. Norsea AS has the responsibility to perform the supply chain related activities. The Norsea Group currently participates in the ELH project.

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[2] The Spanish energy company Repsol has during 2015 done an acquisition of Talisman.

OTHER INITIATIVES

Swire Oilfield Services, a global supplier of CCUs, modular systems, offshore aviation services and fluid management for the energy industry, opened in 2014 a track and trace development centre in Aberdeen. A software application enables customers to identify, locate and track assets, equipment and materials on a global basis. The solution will be integrated into customers' existing business applications. A combination of GPS, RFID and other automatic identification technologies are used to gain the global real-time visibility. General Manager of track and trace solutions at Swire Oilfield Services, Nick Coaton stated: " ... delivers full supply chain visibility and can help our customers make better, more accurate business decisions, saving time, reducing operating costs and enhancing the safety of their staff." (Swire Oilfield Services 2014).

SUMMARY

The information generally received on Logistics Information Systems in the oil and gas industry reveals that all companies are working with solutions to increase the real-time visibility in the extended supply chain.

6. The current situation – D&W and O&M

The intention with this section is to map the current processes from an empirical perspective. As an introduction to understand the work processes properly I have selected to give an overview of the departments and roles involved in the different processes.

6.1.   Introduction

A main difference between the responsibilities for D&W and O&M on the NCS is that D&W prepares for production of oil and gas through the drilling of wells, while the O&M is responsible for the production of oil and gas. The supply chain related activities on the highest level for the two Statoil organizations D&W and O&M is related to the movement of goods to and from the offshore locations. Both D&W and O&M share the same general structure with more or less the same destinations for the goods; the same supply bases and finally the same offshore installations. This also includes much the same infrastructure. They share the corporate govern documents and both use SAP as ERP-system. The operating pattern and organization for D&W and O&M are somewhat different, and the organizations have some differences in strategies and thus some different work processes.

The supply chain processes for both organizations are complex and comprises numerous sub-processes and stakeholders. The main intention with the description of the work processes has been to capture the level of detail providing sufficient information to understand, analyze and recommend a set of high level functional requirements. The description of the processes is for this reason not exhaustive. The descriptions of the processes for D&W and O&M are based on the as-is situation where the flow of information and goods through the supply chain is mapped. This includes the upstream logistics processes from a requirement rises, through the delivery of the goods to the required work offshore, and it often ends with the final return of the goods to the supplier onshore again. The intention with the descriptions of the work processes has been compare these work processes with the findings from the "Staple yourself to an order" in order to accentuate areas assessed to have potentials for increased visibility of goods in the supply chain giving rise to more streamlined and efficient processes.

6.2.   Roles and functions

This section gives a brief overview of the different roles and their main functions in the supply chain. Figure 6.2.1 illustrates the current point-to-point flow of information between different actors as referred by Cecere (2014) in section 4.3.

Figure 6.2.1 Point-to-point information flow between actors in the sourcing supply chain of Statoil
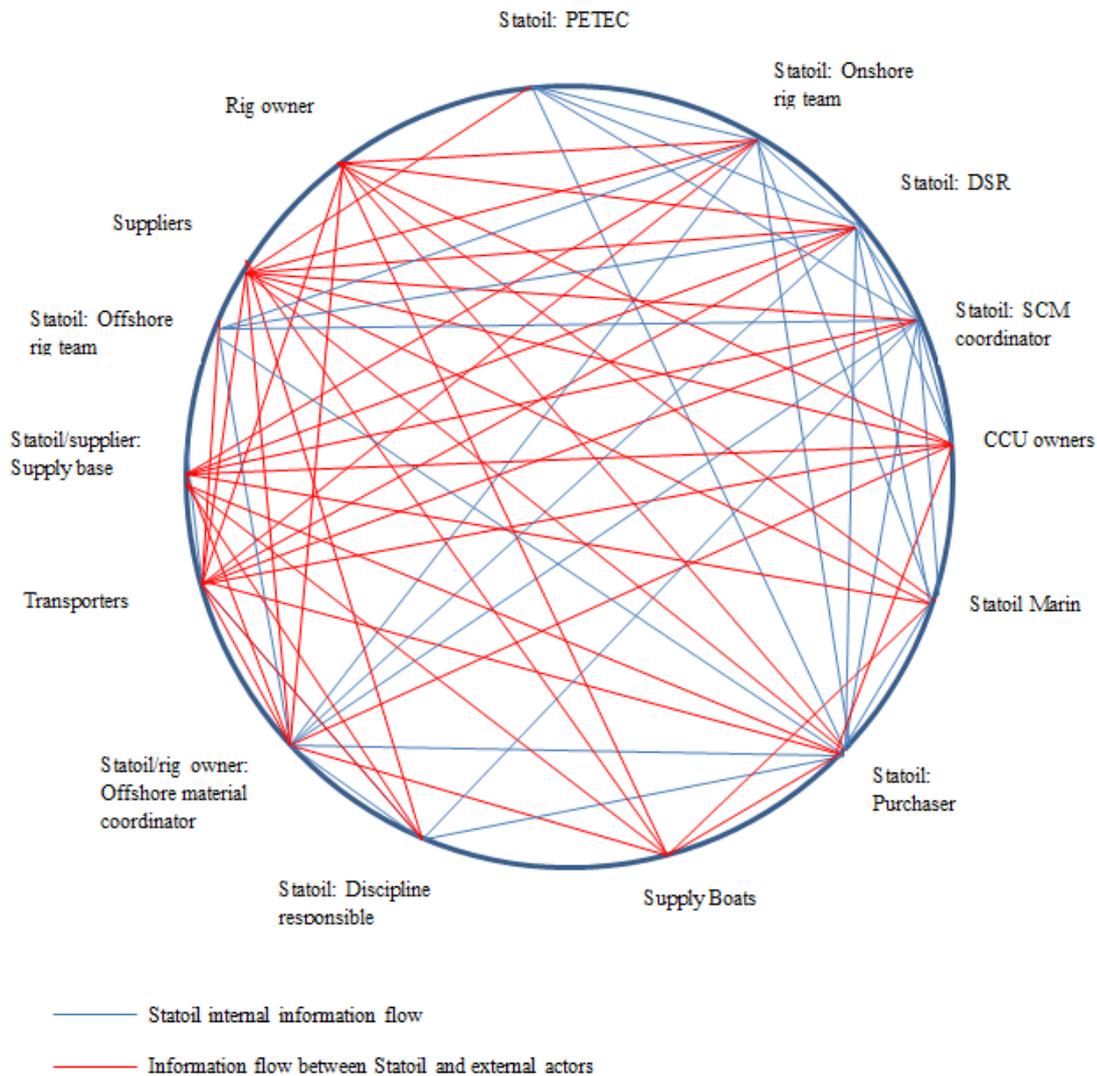
Source: Adapted from Jæger and Hjelle (2015)

Statoil: Petroleum Technology (PETEC)

PETEC is the part of the Statoil organization which monitors the production wells and decides the drilling and interventions to be performed.

Statoil: Onshore rig team/Drilling Engineers – D&W function

The Drilling Superintendent is in the D&W part of the organization. This superintendent in the onshore rig team has the overall responsibility for the rig team, and also for the offshore drilling activities. The size of the onshore rig team varies in accordance with the activities performed, but always consists of the Drilling Superintendent, the Drilling Engineer, and the Drilling Supply Responsible (DSR).

Statoil: Drilling Supply Responsible (DSR) – a D&W function

The DSR co-ordinates the supply chain related activities for the regarded installation as part of the onshore rig team. The main responsibility for the DSR is to optimize the timing for shipment of required goods/equipment and personnel based on input from the rig team. Due to the limited available space for storage on the offshore installations, there is a general target to have the right equipment and personnel on the installation at the right time.

Statoil: SCM Coordinator – an O&M function

The SCM coordinator is part of the O&M organization. The main responsibility for the SCM coordinator is to coordinate and secure supplies to and from the installations. The SCM coordinator has a coordinating and catalysing role to ensure that the activities in the supply chain have a good quality and that the purchasers act in accordance with the priorities on the requirements.

Statoil and supplier: Supply base

The main tasks for the supply base are to receive and ship goods to and from the offshore installations. The supply base also has a co-ordinating role towards the onshore rig team, offshore rig team and suppliers. Equipment and goods can be stored at the supply base. O&M have their warehouse for stored parts located at the supply base they normally use.

Statoil and supplier: CCU owners

The Statoil framework agreement suppliers providing CCUs for the transportation of goods and equipment.

Suppliers

This is a general description of vendors having a contract with Statoil related to the offshore activities. The contract could either be a framework agreement or a stand-alone purchase order.

Supplier: Transporters

The Statoil framework agreement suppliers providing transportation services onshore for goods and equipment. This is currently Bring.

Statoil Marin

The part of the Statoil organization managing the demand and supply of vessels related to the marine activities in Statoil.

Supplier: Supply boats

Supply boats are owned by third party suppliers of Statoil and on contract with the aim of moving goods and equipment to and from the offshore installations on the NCS in accordance with the Statoil requirements.

Statoil and supplier: Offshore rig team – a D&W Function

The offshore rig team is part of the D&W part of the organization and is responsible for the offshore drilling and well related activities. The Drilling Supervisor is leading the offshore rig team.

Statoil or supplier: Offshore material coordinator – O&M and D&W function

The offshore material coordinator is located on the offshore installation and has the responsibility to receive, store, pack and ship goods and equipment on the installation. On fixed offshore installations there is normally one offshore material coordinator for O&M and one for D&W. For mobile drilling units the material coordinator is managed by the rig owning company.

Statoil: Discipline responsible – an O&M function

The Discipline Responsible persons are in the O&M part of the organization. In relation to this thesis the Discipline Responsible persons for a specific area e.g. automation, mechanical having a requirement to perform a job, raises work orders in SAP in order to manage the jobs. The work orders might raise demand for activities in the supply chain.

Supplier: Rig owner

There are fixed and mobile installations offshore. The mobile drilling units are owned by non-Statoil companies. Contracts between Statoil and the rig owners regulate the use of mobile drilling rigs performing work for Statoil on the NCS.

6.3. Drilling & Well – based on interviews

Even though most of the following descriptions of the supply chain related activities are on an operational level, the natural starting point is the tactical level describing the framework for the provision of the goods.

6.3.1. Framework agreements

D&W have a 24/7-activity level and is dependent on regular supplies of the necessary competencies and goods/equipment to maintain sustainable operations. The Statoil strategy to cater for this demand is to enter into long term framework agreements with suppliers covering demands of a certain volume or strategic importance. The framework agreements contain agreed terms and conditions, a description for the scope of work, the price format, and the duration of the agreement along with some administrative regulations. The services and materials defined for the framework agreements are normally listed in the framework agreements in SAP through unique service numbers or material numbers. These service- and material numbers are produced in SAP where the purpose primarily is to support the administration of the commercial perspectives in the framework agreements. These numbers are not identical to any similar identification numbers reflected in any manufacturer manual or maintenance manuals. Service numbers and material numbers linked to such framework agreements contain certain characteristics such as descriptions, unit of measure, etc. The pricing of service numbers and material numbers will always be correct providing correct service– or material number is linked to the relevant framework agreement when a requisition is raised in SAP. The different Statoil operations with requirements can regularly make call-offs from the framework agreements during the period the agreements are valid. A combination of the framework agreements and additional stand-alone purchase orders covers the demand for materials and services and allows D&W to maintain persistency in the operations.

The price format of the framework agreements can vary depending on e.g. the nature of the service, the deliverables. The price format for framework agreements can also be subject to changes as the

Statoil demands and organization develop over time. The content of the agreements can e.g. be deliveries only limited to equipment or services, or the content can be extended to more integrated services including a wider range of goods and services. Framework agreements containing more integrated services are likely to have a different pricing format compared to framework agreements without integrated services. The pricing format in the framework agreements is currently a challenge in relation to the Statoil internal planning and execution system called Logistic Planning System (LPS), and this is discussed further in section 7.2.

6.3.2. Call-offs from framework agreements and stand-alone purchase orders

A call-off is a purchase order issued under a framework agreement. The call-offs are beneficial to use as the negotiations with the suppliers have already been done when the framework agreement was entered into. About 77% of the items on the call-offs for D&W were in 2014 generated as automatic purchase orders in SAP and thus being cost efficient. Table 6.3.2.1 lists the number of purchase orders for D&W and O&M for 2014.

Table 6.3.2.1 Purchase orders issued on the NCS for D&W and O&M

Issued purchase orders in 2014	D&W		O&M		Total
	Number	% of total	Number	% of total	
Purchase orders	16 657		74 876		91 533
Automatic generated purchase orders	11 962	72 %	41 984	56 %	53 946
Purchase order items	22 852		188 076		210 928
Automatic generated purchase order items	17 656	77 %	129 864	69 %	147 520

Source: Statoil internal, SAP

There is also a demand to raise stand-alone purchase orders. Stand-alone purchase orders are not linked to any framework agreement. Stand-alone purchase orders are used e.g. if the required volume or frequency is fairly low or if the requirement is not considered strategically important.

6.3.3. The planned activities

One of the tasks for the Statoil organization PETEC is to optimize the production of oil and gas, and this part of the Statoil organization decides which wells are going to be drilled, maintained and abandoned. Based on these decisions a drilling program is set up for each of the wells. The wells to be

drilled are designed and planned by Engineers ahead of the operation. This is documented in a drilling program. A drilling program is a document describing all activities related to the drilling of a well and contains elements like Health, Safety and Environment (HSE), quality and operational risks, the geology in the area, the design of the well and the activities connected to the well as well as the organization used for this project. The planned wells are added to a schedule and appear on what is called the 60 day plan. The 60 days plan and the drilling program are the basis for the order generation. The rolling 60 days plan is updated on a weekly basis.

### 6.3.4. The requisitioning and ordering process

The activities related to the planned drilling of the wells are entered into a module in SAP originally named network/elektronisk Boring Og Brønn (eBOB). The newest version introduced during 2015 is named Drilling Supply Portal [3](DSP). This is a type of a project/work order listing the different activities for the planned work; it could well be e.g. the different sections to be drilled in the well. The activities in the DSP do not provide the requirements on a very detailed level. The requirements are for instance not listed on a component level. What is called a needlist is created to cater for the necessary details in a planning context. The needlist is an excel spreadsheet containing the requirements in details specifying what, how much and when materials and services are needed. The requirements for materials and services are formally materialized in requisitions raised in the DSP. Suppliers having framework agreements with Statoil and being located on-site of the Statoil premises have the ability to add the requirements for equipment they are going to use offshore directly into the DSP. In accordance with the agreed plan for the well the suppliers add service numbers connected to their framework agreement for the relevant demands. The suppliers then have a good insight into the demand they are going to supply at a later stage. The requirements added by the suppliers are checked and once the demand has been agreed and approved, the relevant Statoil Drilling Engineer releases the requisitions. Prior to release of the requisitions the Drilling Engineer will verify if the required materials/equipment can be pulled from Statoil owned vendor stock. For framework agreements set to automatic release of purchase orders in SAP, the release of the requisitions automatically trigger the submission of the purchase orders to the suppliers. Several interviewees describe it not to be common that suppliers submit written order confirmations to Statoil. From this stage of the process the purchase orders are further being co-ordinated by the Statoil Drilling Supply Responsible (DSR)

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[3] Even though the new version of eBOB named DSP is not fully implemented in D&W at this stage, I will use the term DSP in this paper.

person. The DSR updates suppliers on required delivery times and ensures the suppliers prepare the ordered goods for shipment in accordance with the agreed schedule. Although D&W has available a limited vendor stock for the different licences, the majority of the requirements end up as purchase orders to the suppliers. Figure 6.3.4.1 illustrates the work flow in a supply chain in a typical offshore D&W related transportation scenario.

Figure 6.3.4.1 A typical offshore supply chain scenario
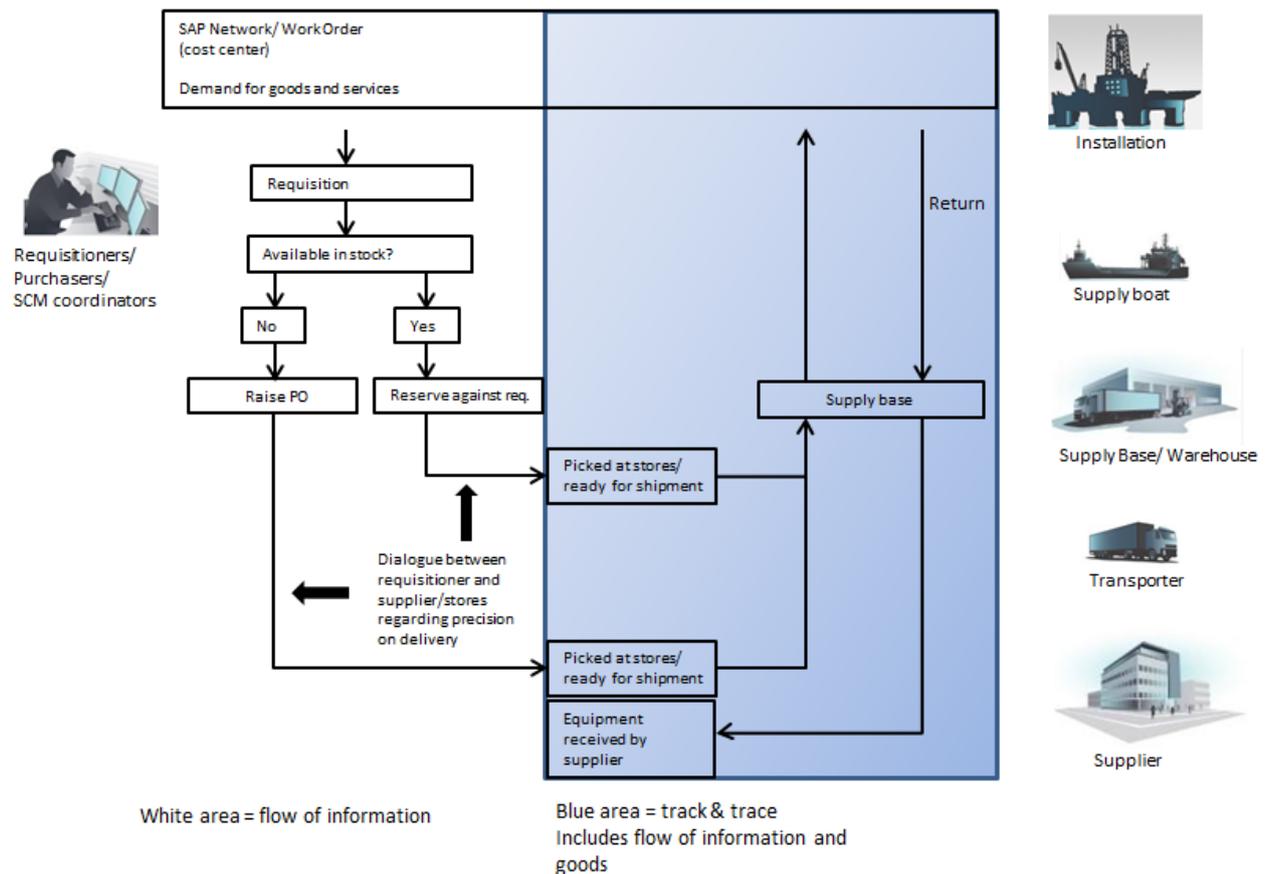
6.3.5. Daily Drilling Report (DDR)

Changes in the plans occur regularly as a consequence of several factors. The harsh weather conditions on the NCS may lead to interruptions in the drilling as well as a need for a different timing of deliveries for the supply of goods and equipment. Safety regulations limit the possibilities for supply boats to load and unload goods in conditions with high waves, and the boats regularly need to seek safe havens in extreme weather. For this reason the offshore installations may even have to temporarily stop the operations. The progress in the drilling operations may also vary for other reasons. Project Planner is used as a planning tool in this connection, and the DDR is a report used to

update the stakeholders on the progress of the drilling. This is thus an important input for the DSR to adjust delivery times for goods and services to the upcoming drilling activities in the well.

6.3.6. Daily morning meetings

There are daily morning meetings for each of the offshore installations where the current progress and upcoming events are being discussed and decided. Participants in the morning meetings offshore are the Drilling Supervisor, relevant engineers and suppliers located offshore. The meeting is managed by the rig team onshore. The team onshore consists of the Drilling Superintendent, relevant engineers, relevant suppliers and the DSR. The DSR has the responsibility to co-ordinate and follow up all purchase orders for the ongoing operations, and the input from the stakeholders in the morning meetings is important for a timely delivery of goods and services. After the morning meeting the DSR updates the LPS if there are any changes to when goods or equipment should be shipped from the supply base. The most important to update are the shipments from the supply base the same day and the day after.

6.3.7. Prepare delivery of goods from supplier to supply base

The suppliers prepare ordered materials/equipment for delivery to the supply base. All deliveries should per default be routine transportations and follow the scheduled transportation routes. It regularly also happens that materials/equipment has to be shipped with express deliveries. For cost reasons the use of express deliveries should be minimized.

Any equipment which is going to be located temporarily offshore must comply with the NORSOK standard Z-015 regulations and checked accordingly. The arrival of Z-015 equipment to the supply base should be reported by the supplier 3 working days prior to delivery, and this will enable the Technical Services at the supply base to perform the check and verify compliance to regulations. The check could either be on supplier or supply base premises. Once the materials/equipment is ready for shipment at the supplier facility, an empty CCU is requested by the supplier to be moved from the CCU owner to the supplier. Along with necessary documents and certificates e.g. delivery ticket, bill of lading, Z-015 certificates, and certificates in accordance with dangerous goods regulations, the equipment is loaded in the CCU which then is ready for transportation to the supply base.

If the rig owner as a third party supplier needs equipment shipped to the rig, relevant information about the cargo is given from the rig owner to the DSR by e-mail. The DSR adds relevant information

into the LPS using a Production Resource Tool (PRT). A PRT is a free text line giving the DSR a possibility to describe the item to be transported in a recognizable way for the relevant stakeholders in the supply chain.

6.3.8. Transportation from supplier to the supply base

Statoil currently has a framework agreement with Bring for transportation services, and the main rule is that all suppliers shall use the Statoil framework agreement. The supplier arranges with Bring to pick up the goods and deliver at the supply base in accordance with Figure 6.3.8.1; for rental equipment normally within a deadline 10.00 AM the day the materials/equipment is scheduled for further shipment to the installation by a supply boat. With the exception of bulk all deliveries related to D&W are normally transported by road to the designated supply base. Goods to be picked up by Bring should be registered within 12.00 PM to be on the road the same day. The supplier issues a delivery ticket containing the details of the goods including e.g. reference to purchase order, number of CCUs, sizes and weights. Due to lack of alignment of master data for materials/equipment between suppliers and Statoil, the text in the delivery ticket is captured from the supplier ERP system and does often not match the descriptions of the similar materials/equipment in the LPS. The reference to the purchase order helps limit the additional work to verify that the delivery ticket contains the correct items. The delivery ticket along with other required documents follows the transportation on the road. The supplier e-mails the same documents to the DSR once the goods are being picked up by Bring at the supplier premises. Upon reception of this e-mail the DSR adds the documents as attachments in the LPS and this information is available for the supply base which is about to receive the goods. This allows the supply base to have a logistical planning horizon approximately equal to the number of hours from the lorry departs from the supplier premises to the arrival at the supply base. This gives the supply base an insight to expected incoming goods.

Figure 6.3.8.1 Deadlines for deliveries at the supply bases for D&W and O&M

Supply base delivery deadlines	
Main rule	
Goods delivered at the supply base	16.00 PM one working day prior to sailing day. Exceptions for Sundays and public holidays
Register return goods	10.00 AM the sailing day
Exceptions	
Rental equipment	Registered within 09.45 AM and delivered at supply base within 10.00 AM the sailing day
Food supplies	Registered within 09.45 AM and delivered at supply base within 12.00 AM the sailing day
Temporary rental equipment (Z-015)	Registered 3 days prior to sailing day and delivered 16.00 PM one working day prior to sailing day.
Bulk requisitions	2 days/ 48 hours before sailing
Register OCTG (needlist/check list)	45 days before actual requirement on the offshore facility

Source: Statoil internal

The suppliers could be located on or close to the supply base and thus have a short transportation distance, but all suppliers are however not located close to the designated supply base. Equipment could also well be located close to a different base. For this reason goods often have to be transported from one base to another in connection with mobilization of materials/equipment to offshore installations. Table 6.3.8.1 illustrates normal transportation lead times between different supply bases.

Table 6.3.8.1 Lead times by road between Statoil supply bases

Normal lead times by road between Statoil supply bases (in days)

	Stavanger	Ågotnes	Mongstad	Florø	Kristiansund	Sandnessjøen	Hammerfest
Stavanger		1	1	1	2	3	5
Ågotnes	1		1	1	1	2	5
Mongstad	1	1		1	1	2	5
Florø	1	1	1		1	2	4
Kristiansund	2	1	1	1		1	4
Sandnessjøen	3	2	3	3	1		3
Hammerfest	5	5	5	5	3	3	

Source: Statoil internal

6.3.9. The supply bases

Statoil make use of 7 supply bases along the Norwegian coast, and these are located at Stavanger, Ågotnes, Mongstad, Florø, Kristiansund, Sandnessjøen, and Hammerfest. The Statoil organization named Marin organizes the number of supply boats and the routes. Statoil uses the SAP module Vessel Traffic Management Information System (VTMIS) to manage the different vessels. Statoil has recently decided to change some of the routes for the supply boats where the goal has been a more

efficient use of the resources. Statoil is rolling out this change in the period from 2014 to 2016. Figure 6.3.9.1 illustrates the old and revised sailing routes.

Figure 6.3.9.1 Changes in routes for supply boats
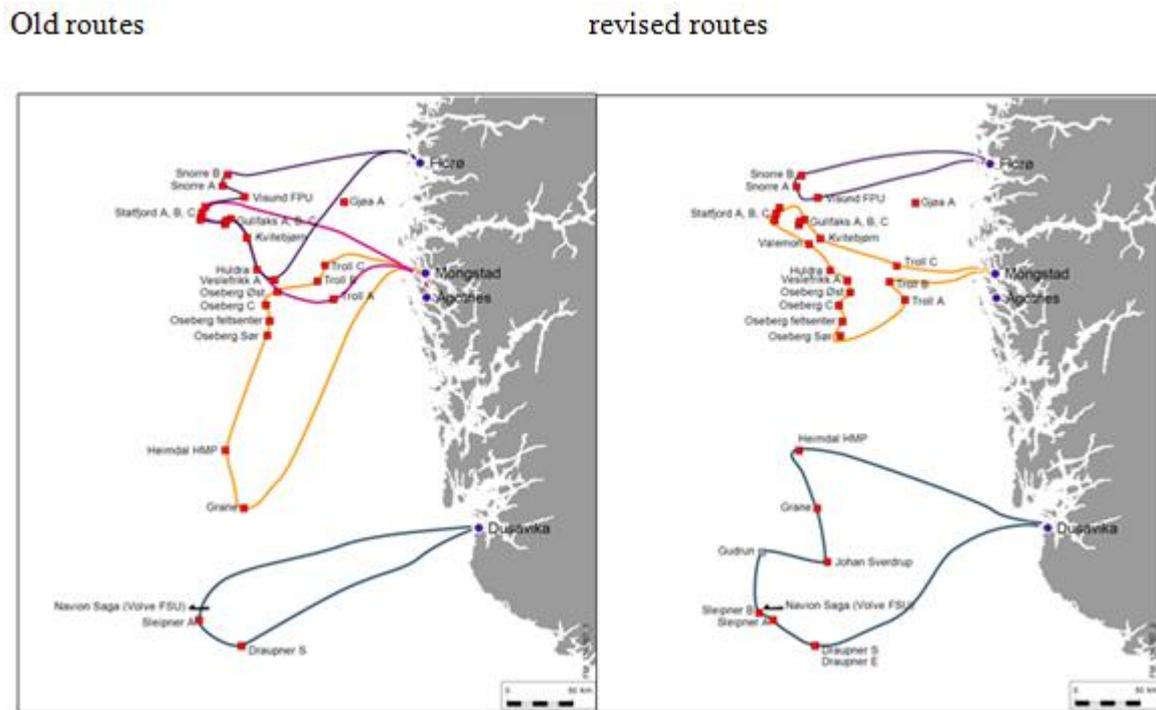
Source: Statoil internal

The supply base plans the incoming demands and schedules the cargo on the relevant supply boats.

6.3.10. Delivery at the supply base and shipment to installations

The DSR co-ordinates delivery of goods with the supply base primarily through the use of LPS. There is in addition daily contact between the DSR and the supply base by e-mail and phone to ensure a smooth reception of the goods and further loading of the goods on the appropriate supply boat to meet the offshore requirement for delivery. If the LPS tells the supply base that a CCU is expected in the morning e.g. that a lorry is expected to the supply base but has not arrived before 10.00 AM, a row of phone calls through the chain is actioned to identify where the lorry is and when it will arrive to the supply base. This kind of exception generates use of extra resources where future availability of real-time information about the transportation could avoid this use of resources. The equipment is in turn physically received at the supply base, and the Goods Receipt in SAP for the appropriate purchase order is taken care of by the supply base which has access to Statoil's SAP system. The CCUs

scheduled on the supply boats and received at the supply base within the deadlines, will be added to the cargo manifest listing all equipment to be transported. If the equipment is delivered at the supply base later than the deadlines listed in Figure 6.3.8.1, the DSR can raise a B-priority on the supply base to ensure a prioritized handling to get the equipment on the scheduled supply boat. In some cases small size equipment is delivered without CCUs e.g. on euro pallets at the supply base, and such equipment will be cross-docked at the supply base. Interviewees say that it is not very common that D&W materials/equipment is cross-docked. If required the supply base can store equipment temporarily.

The supply base issues the cargo manifest to the scheduled supply boat in due time and the goods is loaded on the boat accordingly. The supply boat departs from the base and delivers the materials/equipment to the destinations offshore along the sailing route. Although it is not possible to track the CCUs in real-time on VTMIS, the system can be used to look at the estimated arrival times to the different offshore installations. Unexpected delays for the supply boats are updated on VTMIS and the expected arrivals for installations later on the route are updated accordingly. It is possible to trace CCUs through VTMIS.

6.3.11. Arrival at the offshore installations

When the supply boat arrives at the installation, the CCUs are being lifted on-board to the installation. The material coordinator completes the loading of the shipment in VTMIS, and the CCUs are received on the installation. The CCUs are physically being located on the relevant area on deck available for storage of equipment. There is normally limited space available for storage on deck, and good co-ordination between the offshore Drilling Supervisor, the material coordinator and the DSR is required to ensure that relevant goods can be returned onshore to release required space for new equipment arriving to the installation. For smaller mobile drilling units it might be necessary to occasionally have a supply boat available to store required goods to the drilling operations for certain periods. Providing the goods/equipment is not going to be returned to the supplier after use, the CCU is returned onshore.

6.3.12. Returns from the offshore installations

About 75% of all materials/goods brought to the installations are also being returned onshore. After the equipment has been used for the dedicated job on the installation, the equipment is prepared for return from the installation to the supply base. The third party supplier employees having performed a

job on the installation also prepare and pack their own equipment. They enter a final delivery address, and this ensures a correct destination for the final delivery once the equipment is back onshore. The offshore material coordinator, the suppliers, the DSR and the supply base co-ordinates and schedule the return of the equipment. The material coordinator has the ability to create a return document from the DSP in SAP. It appears that the material coordinators do not make use of this possibility very frequent. The reasons appear to be that they do not have sufficient knowledge of which DSP activity they are going to create the return document from. In addition they struggle with the fact that there is not a one-to-one relationship between the service numbers in the DSP and the description of the equipment to be returned. A return document in the DSP would have created a simple confirmation to the DSR that the equipment had been returned onshore.

The Material coordinator on the installation creates a cargo manifest which is connected to the shipment/voyage for the regarded supply boat in VTMIS. The CCU containing the equipment is in turn lifted from the installation to the scheduled supply boat on its sailing route back to the supply base.

In a track and trace context the returns from offshore seems to have a potential for improvement in the current process. If service numbers are not set up in the DSP and PRT's are used in the LPS for shipments on its way offshore, the LPS will not produce any return document when the equipment is ready to be transported onshore again. The aforementioned workaround through the use of PRT's in LPS creates thus lower visibility for the returns. A reason for this lower visibility on returns is that the focus is to get the parts for the operation offshore in a timely and sometimes urgent manner. There is normally no similar urgency for returns. It is normal that the rental period stops an agreed number of days after use on the offshore installation. Returns are normally managed only by exception, and there is an expectation among the DSRs that the equipment will end up at the supplier facility in accordance with the procedures. After supplier employees have packed the equipment, the suppliers can have visibility of their equipment on their way to the supply base through VTMIS. It appears that some suppliers use this opportunity while other does not.

6.3.13. Arrival of goods returning from offshore installations to the supply base

When the supply boat arrives at the supply base, the CCUs being returned are unloaded from the supply boat and placed in the back-load area. The supply base finalises the unloading of the supply

boat in VTMIS, and the CCUs are received in VTMIS. The supply base contacts the local agent from Bring, and this agent ensures further contact with the different suppliers. The returning goods should be picked up from the back-load area within 24 hours and then transported back to the final supplier delivery address by Bring. If equipment has been cross-docked offshore, there will be a need to split this upon arrival at the supply base to ensure that all items are being transported directly to the correct destination.

Empty CCUs being returned to the supply base can be placed in the Statoil buffer pool of empty CCUs. This pool of empty CCUs is on hire from the CCU owner and is used to avoid unnecessary number of hire transactions between Statoil and the CCU owner. Empty CCUs not placed in the buffer pool are being returned to the CCU owner to stop the rental. Statoil has currently contracts with the CCU owners Euro Offshore AS and Swire Oilfield Services.

Due to the current lack of an integrated system offering the suppliers a visibility of their equipment, the suppliers have to wait until the supply base informs about the availability of the equipment at the supply base before they are able to make detailed plans for further use of the same equipment. An integrated system with increased visibility should have the ability offer the suppliers increased velocity/turn-around of equipment and thus a more efficient use of their equipment. Today the suppliers make use of phone, e-mails and their contact network to trace their equipment in the internal Statoil supply chain loop.

6.3.14.   Transportation from the supply base to the supplier

Bring transports the goods/equipment to the supplier end destination primarily by road equal to the process for transport from supplier facility to the supply base.

6.3.15.   Invoices

Pro forma invoices or the final invoices are issued by the suppliers in accordance with the terms and conditions in the purchase orders after the suppliers have done the job. Once the job has been performed by the supplier on the offshore installation, the Drilling Engineer responsible for the activity in the DSP performs a Service Entry for services in SAP. The equipment has normally been returned to the supplier at the point in time when the invoices are issued. The Drilling Engineer verifies that the invoice is in accordance with the deliveries e.g. correct reference to purchase order number and that items in the invoice match the purchase order items. This is sometimes challenging as

there is not a one-to-one relationship for supplier identification of materials and equipment and the Statoil identification of the same materials and equipment.

6.3.16.   Tools offering visibility of materials and equipment

For the further work I will separate the world *visibility* into 3 different categories: 1) historic visibility is considered as reports generated by ERP systems and other IT-systems 2) pseudo-real-time visibility is considered as status information entered manually into ERP- and other IT-systems 3) true real-time visibility in which data capturing is being performed automatically and where relevant events automatically are reported to relevant stakeholders.

6.3.16.1.   Logistics Planning System (LPS)

The LPS is a Statoil internal system for operational planning and tracking of goods in the upstream supply chain on the NCS. The LPS was developed for D&W as a report in SAP and thus integrated with other functions in SAP. It was launched in 2012, and the intention was to enable an efficient process from planning to payment for D&W. Prior to the LPS Statoil used for a period a Lotus Notes based internal tracking system called 'Laste og Leie Log (LLL). This was not an integrated information system. All data was at that point entered manually to the system and data was duplicated both in LLL and SAP. The idea with the LPS was to avoid duplication of data already entered in SAP and to improve the flow of information. The goal with the LPS was to obtain a higher performance in the supply chain where the right equipment is shipped offshore in a timely manner. The re-use of information had the ambition to speed up the supply chain process and provide improved overview of goods to be shipped. This should result in reduced costs for equipment rented from suppliers where a higher visibility of the rental equipment should give a higher precision on deliveries and thus reduced rental costs. The visibility in LPS is based on historical reports and pseudo-real-time where status information is entered manual into SAP. There is no true real-time capture of events.

The LPS system is used by the DSR, the supply bases and the offshore material coordinator. The purchase orders raised from the requirements in the DSP appear in an overview in the LPS as illustrated in Figure 6.3.16.1.1. The DSR coordinates delivery of equipment with the suppliers and updates LPS with the correct delivery time for the respective purchase orders to when they are due for delivery. The DSR adds a PRT line if the service number from the purchase order does not make sense in order to understand the content of the material/equipment to be shipped. The LPS default setting is

that deliveries in the period one week back in time and deliveries due for shipment three days ahead appear in the overview. The DSR needs to coordinate with the rig teams and to secure that all upcoming deliveries are in this LPS overview.

Figure 6.3.16.1.1 The LPS overview used by the DSR

Source: Statoil internal, SAP - LPS

Once materials/equipment is ready for transport from the supplier premises to the supply base and the supplier has produced a delivery ticket specifying the CCU identification numbers and the content for the shipments and relevant certificates, this information is being e-mailed to the DSR. The DSR enclose the delivery tickets as attachments to the corresponding purchase order in the LPS overview, and the attachment is then available for the supply base. The DSR monitors that suppliers delivers in accordance with agreed schedule and that the supply base registers the arrival in SAP. When materials/equipment is physically received at the supply base, a person from the base makes a reception in LPS for rental equipment and Goods Receipt for purchase orders with material numbers. Service Entries are sometimes challenging if the delivery tickets are not identical to the items in the purchase orders. The suppliers use their own identification numbers for goods/ equipment, and they do not use the Statoil service numbers. Purchase orders without a reception appear in the LPS overview with a red flag while purchase orders having been received appear in the overview with a green flag (Figure 6.3.16.1.1). The red flag helps the DSR to detect if expected materials/equipment has not

arrived at the supply base before the arrival deadline. Figure 6.3.16.1.2 illustrates the general time windows for different activities at the supply base.

Figure 6.3.16.1.2 General time windows at the supply bases

Description of activity	Deadlines	
Supplier order transporation	10.00 (day 1)	
Transporter loading goods at supplier premises	12.00 (day 1)	
Goods transported by road from supplier to supply base	16.00 (day 1)	Reception of goods at supply base. DSR is allowed to update LPS.
Goods received at supply base sailing day	before 10.00 (day 2)	
Goods/CCUs manifested on supply boat for shipment to final destination	12.00 (day 2)	Supply base is planning. Supply base uses data from LPS for planning purposes.
Supply boat departing from supply base	16.00 (day 2)	Loading supply boat.

Source: Statoil internal, ARIS

When the materials/equipment is on the supply boat and has departed from the supply base, the offshore material coordinator monitors the LPS and/or VTMIS to see which goods are to be expected to the installation.

When equipment is due for shipment onshore again, the material coordinator should create a return from the DSP. The material coordinator creates a manifest for the shipment containing information about delivery, CCU identification number, the shipment and voyage from VTMIS.

The LPS system lists the relevant purchase orders due for shipment offshore. The service numbers are the purchase order items automatically showing as items to be shipped and tracked in the LPS. The service numbers text description is linked to the price format of the framework agreements and is primarily set up to serve a commercial, contract and pricing purpose. The service number text

descriptions in SAP do for this reason not very often describe the items to be transported to the offshore installation in a logical term describing e.g. the fit, form or function. It is common that these numbers do not contain a description which makes it easy to understand the content of a shipment for the DSR's, the persons at the supply base or even Drilling Engineers. There is a work around in this connection. The DSR has the ability to use a free text line called PRT to better describe the transported items. There is unfortunately no common standard or any calibration of master data between Statoil and the suppliers for equipment/components. The delivery tickets issued by suppliers are for this reason not identical to the Statoil purchase orders.

Current weaknesses with the LPS system:
1. A lack of integration with other stakeholders and systems in the supply chain (transporters, suppliers). It is a Statoil internal system.
2. Lack of ability for actors in the extended supply chain e.g. suppliers to access information in LPS.
3. The prerequisite that the description of service numbers in SAP which primarily is serving a pure commercial intention in the framework agreements also dictates the description of items to be transported in the LPS.
4. The extended use of PRTs due to the fact that the LPS is linked to the pricing format in the framework agreements. The PRT's are entered manually and there is not any re-use of data.
5. Limited functionality for returns in relation to the use of PRT's.
6. It is not possible to track historical shipments. This has to be done manually through historical e-mails and/or through the use of telephone and VTMIS.
7. It is not possible to identify if materials/equipment are categorized as dangerous goods or as Z-015.
8. LPS does not handle bulk e.g. mud fluids etc. well. The Statoil solution for bulk handling is complex and not user friendly.
9. There are no notifications or alerts to the supply base if the DSR makes changes in the LPS. The supply base has to monitor the LPS or get a phone call or e-mail from the DSR.
10. There is no true real-time visibility.

6.3.16.2. Vessel Traffic Management Information System (VTMIS)

VTMIS is a set of functions in SAP used by Statoil Marine and the supply bases primarily for planning and follow up of sailing routes for all supply boats on contract for Statoil on the NCS. The module gives information regarding the sailing routes, supply boats, estimated arrival times, cargo, etc. One can have access to data in VTMIS through SAP and the internet. Figure 6.3.16.2.1 gives an overview of data from VTMIS for a voyage.

Figure 6.3.16.2.1 Example information from a voyage in VTMIS

Statoil

Vessel Traffic Management Information System — Voyages Installations Weather

Voyage

Voyage-nr:	82149	Comments:
Vessel:	Havila Charisma	16.03.2015 17:07 Festervoll Rune Harald:
Mobilised:		Sent e-mail to:
Equipment:	ST by Certificate	BRIDGE.CHARISMA@HAVILASHIP.COM
Voyage-type:	10 Supply	16.03.2015 16:13 Kvalvik Trygg-Frode – BID (Deviation set):47433
Transport operator:	STATOIL	
Extra trip:		
Speed:	12	

Expand comments box

Sites

Site	Cancel	B-pri	ETA-date	ETA-time	ATA-date	ATA-time	Stay-time	ETD-date	ETD-time	ATD-date	ATD-time	Loading	Unloading	Comments outbound	Comments inbound
FBF							0	16.03	17:00	16.03	17:00	0	36		
SNO	●		17.03	23:58			3	18.03	02:58			16	13		INNMELDT : 15 HIV
SNB			18.03	03:36			4	18.03	07:36			9	4	300 M3 DRIKKEVANN	INNMELDT : 23 HIV + 250 M3 SLOP
BID		D01	18.03	08:36			3	18.03	11:36			0	0		INNMELDT : 13 HIV
STA			18.03	12:42			1	18.03	13:42			2	0		INGEN INNMELDING
DSA			18.03	15:03			3	18.03	18:03			7	0	13 STK 36" CONDUCTOR	INNMELDT : 4 STK 20" CASING
FBF			19.03	02:10			0					17	0		

Bulk

Site	Req/Del	Material WATER	Material DRILL WATER	Material FUEL	Material BARITE	Material CEMENT	Material METHANOL	Material EDC 95-11	Material SLOP	Material	Material	Material	Material
Stock		700	0	546	0	0	0	0	0				
FBF	Req												
	Del												
SNO	Req												
	Del												
SNB	Req	300											
	Del												
BID	Req												
	Del												
STA	Req												
	Del												
DSA	Req												
	Del												

Source: Statoil internal, SAP - VTMIS

Statoil Marine in the business area DPN has the responsibility for the supply boats from the departure of the supply base until the boats arrive back to the supply base. Marine follows up the VTMIS and is continuously updated on the activities for all vessels on contract for Statoil. They have the task to optimize the capacity and utilization of the boats on contract. This management and coordination of the supply boats include any changes of the sailing routes as a result of e.g. unexpected extra demand for supply boats. The changes are continuously updated in VTMIS. Statoil Marine is in close cooperation with the supply bases, the supply boats and the offshore installations. It is occasionally difficult to identify whether CCUs have been unloaded at the installation or if they are still on-board the supply boat. In such cases the CCUs are either on round-trips or are even being unloaded back at the supply base.

VTMIS is an internal Statoil tool and although supplier has an opportunity to have access to the information available from the system, it does not seem to be common that suppliers access VTMIS regularly. The visibility in VTMIS is also based on historical reports and pseudo-real-time where status information is entered manual into the system.

6.4.   Drilling & Well – based on "Staple yourself to an order"

6.4.1. Introduction

According to SupplyChainDigest (2011) a scrutiny of the order management cycle will frequently unveil gaps in the process with a potential to improve the supply chain performance and the customer service. The results of these endeavours may in many instances reveal a demand for companies to reconsider their requirements for technical support for the order management cycle.

The 10 steps of the OMC referred to in the theoretical framework are captured in a manufacturing scenario. The 10 steps should be adjusted to the adequate scenario to properly reflect the order management process of an extended supply chain. I have performed a comparison of the 10 steps in the original manufacturing scenario with the mapping of the OMC in an extended supply chain of Statoil resulting in the following 10 steps:

Order planning – Through the rolling 60 days plan as a basis for finding a drilling program to follow. The drilling program and Project Planner is the basis for the order generation.

Order generation – Identify the DSP-identification number raised for the jobs, i.e. identify activities to follow.

Cost estimation – follow cost estimation and pricing (confidential information not reported here)

Transport of goods from supplier to the supply base – follow the shipment

Delivery at the supply base – follow the shipment

Shipment from supply base to offshore installation and receipt at offshore installation – follow the shipment

Return shipment from offshore installation to the supply base – follow the shipment

Receipt and handling at the supply base – follow the shipment

Return transport of goods from supply base to supplier – follow the shipment

Billing – follow the invoice process

One D&W and one O&M OMC were subject to my close monitoring. For the monitoring of the D&W OMC I metaphorically stapled myself to the order and tracked this from the perspective of a DSR through the normal means of the DSR. I followed the order by being in close dialogue with the DSR through the OMC. I observed the standard means for a DSR to follow the preparations and tracking through the supply chain. The standards means are e-mail, phone, physical meetings, SAP (LPS and VTMIS). I decided to staple myself to the D&W DSP number 9021694 leading to the purchase order 4503249970. The transportation of a Hydraulic Pulling Tool was being shipped from the supplier premises at Tananger to Statfjord A early June 2015. The shipment should be picked up by Bring at Tananger, and Bring should transport the tool by road to the supply base Coast Center Base (CCB) at Ågotnes where it should be received. The tool should then be shipped on a supply boat to the offshore installation Statfjord A. The tool should follow the same route back to the supplier after use at Statfjord A. Appendix B lists the recorded details from the monitoring of the regarded order.

6.4.2. Summary

This summary contains the main findings from the order I followed. Some of the findings are described in the mapping of the processes in section 6.3, but this section also outlines additional findings related to latency in SAP registrations and a fragmented overview of the Logistics Information System to provide tracking details through the supply chain.

The overall experience is that there is no real-time tracking information for the extended supply chain, and there was no common visibility of the transportation for all actors. The supplier does not have any visibility of their equipment in the internal Statoil supply chain. Statoil does not have any good visibility of the supplier equipment from departure at the supplier facility until arrival at the supply base. This is also the case for the return transport. Statoil has visibility of the shipment in the internal supply chain from the supply base to the offshore installation and back to the supply base through the available functionality entered manually in SAP; LPS and VTMIS. There is a potential for late registrations in a system based on manual entries. I detected that the internal visibility in SAP suffers from this type of latency. The CCUs on their way from the supplier to the supply base arrived in the evening, but the arrival of the CCU's was not updated in LPS until the following morning after a

phone call from the DSR to the supply base where the base confirmed the arrival of the equipment the previous evening. The general tracking of the tool in SAP was fragmented, and I had to enter several different screens in SAP to get the overview of the relevant tracking information. As the hydraulic pulling tool rented through the regarded purchase order was out of pricelist for the framework agreement, no service numbers were registered in SAP for the tooling. A high level short free text description in the Statoil purchase order was listed in the LPS. There was not a one-to-one relationship between the supplier identification of the tool and the Statoil identification of the tool. This is a distortion in master data necessitating use of extra manual resources to co-ordinate between the involved parties. The actors in the extended supply chain generally used e-mails, phone calls and use of extra man power to compensate for the lack of visibility. Figure 6.4.2.1 gives an overview of the findings.

Figure 6.4.2.1 Overview of findings from D&W

#	Description
1	No true real-time visibility for the extended supply chain.
2	Visibility based on manual entries for the Statoil internal supply chain. Experienced latency in manual registrations.
3	Fragmented overview in Statoil Logistics Information System. Many screens to use in SAP to get overview of the transportation through the supply chain
4	Not a one-to-one relationship between supplier and Statoil for master data identification of equipment.
5	Statoil not able to track return transportation from supply base to supplier premises. Supplier owns transportation. No default insight to tracking details for Statoil.

6.4.3. Description of findings

The express transport of the hydraulic pulling tool was followed closely on the way from the supplier facility to the Statfjord A installation. The supplier and Statoil knew when the tool was transported from their own site, and they could provide information on the equipment whereabouts for the road transportation from Tananger to Ågotnes. The mobile telephone number for the driver was available. Nor the supplier neither Statoil had any default availability of real-time information on the transport details. After departure of the equipment from Tananger the supplier submitted an e-mail containing the delivery ticket to the DSR. The DSR then attached the delivery ticket for the transportation in the LPS system, and at this point in time the supply base at Ågotnes was able to plan for the arrival of the equipment at the supply base. Once the equipment was manifested on a shipment from Ågotnes to the

installation, the material coordinator was able to get an overview of the equipment on its way to the installation. After arrival at the supply base the supplier did not have any insight to the whereabouts for the tool. There was a delay in the manual registration of the arrival in SAP at the supply base. The tool arrived at the supply base in the evening, and it was registered manually in SAP the following morning. The tool was loaded on the supply boat in the evening as scheduled at this occasion, but the delayed manual receipt in SAP caused limited visibility for the DSR during this period. If anything unexpected had happened, latency in SAP registration could have led to a long response time before corrective action had been taken. The need for corrective action as a result of missing goods may not in such situations be detected until the lack of Goods Receipt in SAP is discovered. If the person is on leave next day or if Goods Receipt is forgotten, this may have severe consequences for the offshore drilling operations not receiving the tools in accordance with their requirements.

The visibility for the tool on its way from the supply base to the offshore installation was not in real-time, but I was able to monitor which installations the supply boat containing the equipment had visited through the VTMIS system. Once the equipment had been unloaded at the offshore installation and the material coordinator had received the equipment, I was able to check time of arrival on the VTMIS. There was also latency in the manual registrations in SAP for the return transportation for the tool from the offshore installation to the supply base. At the time when the tool had arrived at the supply base on its way from the offshore installation to the supplier premises, I called the supply base to understand when the manual registration in SAP would happen to avoid further confusion. Following a management by exception approach as described by IBM (2011), messages will notify relevant supply chain stakeholders about deadlines exceeded. Figure 6.4.3.1 illustrates potential events with deadlines in such an approach.

Figure 6.4.3.1 Potential events following a management by exception approach

Description of activity	Deadline	Potential Problems	Who to notify
Supplier prepares shipment at own premises		Supplier cannot fulfil and does not send, delay in preparations, Z-15 certificate not issued, applicable dangerous goods certificate not prepared	DSR, SCM coordinator, purchaser
Supplier order transporation	10.00 (day 1)	Forget to order transportation	
Transporter loading goods at supplier premises	12.00 (day 1)	Transporter is late, lorry is too small, problems with dangerous goods certificates, etc.	DSR, SCM coordinator, purchaser
Goods transported by road from supplier to supply base	16.00 (day 1)	Delay of transport due to different scenarios e.g. trafical problems	Supply base, DSR, SCM coordinator, purchaser, supplier.
Goods received at supply base	before 10.00 (day 2)	Late arrival at supply base	Supply base, DSR, SCM coordinator, purchaser, supplier.
Goods/CCUs manifested on supply boat for shipment to final destination	12.00 (day 2)	Forget to manifest goods, goods lost on supply base, etc	Supply base ops, DSR, SCM coordinator
CCU loaded on supply boat	16.00 (day 2)	Goods lost on supply base, etc	Supply base ops, DSR, SCM coordinator
Supply boat departing from supply base	16.00 (day 2)	Late departure of boat, critical failure on boat	Supply base ops, DSR, SCM coordinator, material coordinator
Supply boat sails designated route to several offshore installations	According to route	Delay on sailing route due to different reasons	Supply base ops, DSR, SCM coordinator, material coordinator
Supply boat arriving at given offshore installation	According to route		Supply base ops, DSR, SCM coordinator, material coordinator
CCU is unloaded to the offshore installation	According to route	Problems with lifting crane, do not find CCU on supply boat deck, forget to unload CCU	Supply base ops, DSR, SCM coordinator, material coordinator

For the transport from the supply base back to the supplier premises I was able to see the Bring tracking number in SAP, but I was unable to track the shipment back to the supplier through the Bring tracking system MINe. The supplier was responsible for the shipment from the supply base to the supplier premises, and Statoil does not get any default insight to their shipments with the current setup.

The hydraulic pulling tool was out of pricelist for the framework agreement, with the consequence that no service numbers were registered in SAP to identify the tool. A short free text description was entered in the Statoil purchase order, and this was used to identify the hydraulic pulling tool consisting of 3 CCUs. The consequence was that there was not a one-to-one relationship for the tool between the supplier and Statoil (see 6.3.1 and 7.2). The supplier used several pages in their delivery ticket to describe the content for the pulling tool. For the rental of this particular tool the only visible consequence was that the Engineer verifying the invoice had some challenges to match the purchase order with the supplier invoice. I experienced that the tracking of the hydraulic pulling tool in SAP was fragmented. I had to make use of many different screens in LPS and VTMIS to provide the overview of the desired information (see 10.2 Appendix B).

The following have been identified as tracking points which gives a certain visibility from the perspective of the actors in the extended supply chain: 1) The supplier knows the actual time of

departure from supplier 2) Supplier and Statoil knows the arrival time at the supply base based on manual registrations or phone calls 3) Statoil knows the time for departure from the supply base based on manual entries in SAP 4) Statoil and supplier know the arrival time at the offshore installation based on manual entries in SAP 5) Statoil knows departure time from the offshore installation based on manual entries in SAP 6) Statoil knows the supply boat arrival time at the supply base based on the manual entries in SAP7) Statoil and Bring knows the departure from the supply base based on manual entries in SAP 8) The supplier knows the arrival time at their premises.

6.5.   Operation & Maintenance – based on interviews

As for D&W most of the following descriptions of the supply chain related activities are on an operational level. The natural starting point is also for O&M the tactical level describing the framework for the provision of the goods and the changes from the D&W organization. O&M also has a 24/7-activity level and is like D&W dependent on regular supplies of the necessary competencies and goods/equipment to maintain sustainable production of oil and gas. The total requirement for materials and services also for O&M are to be covered through long term framework agreements in combination with stand-alone purchase orders.

Some of the differences between D&W and O&M to be aware of:

- O&M currently makes use of a decentralized purchase model involving category purchasers while D&W has a more centralized purchase model where the DSR is the point of contact for purchase orders.

- O&M makes use of inventory in larger degree than D&W.

- O&M uses work orders while D&W uses DSP in SAP.

Many services and materials defined for the framework agreements are listed in the framework agreements in SAP through unique service numbers or material numbers.

6.5.1. The planned activities

O&M has established long and short term plans to support the business objectives to deliver safe, reliable and efficient operations and maintenance. There is established a plan hierarchy and the level of details in the plans increases from the master plan to the lowest level which is the work order plan.

The master plan can have a horizon between 3 months and 6 years depending on the activity level as described in Figure 6.5.1.1. The operation plan can have a horizon between 0 days to 12 months, and the work order plan is the lowest level and this is a rolling plan with a horizon of 14 days. Work orders should be registered a minimum of 14 days before the plan period for when the work will be performed. This is to ensure sufficient time to identify and perform necessary adjustments to the plan and also to secure availability of the required materials.

Figure 6.5.1.1 Overview of the plan hierarchy with time spans in O&M

Plan type	Standard activity level	High activity level
Master plan	12 months – 6 years	3 months – 6 years
Operation plan	0 days – 12 months	0 days – 3 months
Work Order plan	0 days - 14 days	0 days - 14 days

Source: Statoil internal

The work orders and the work order plan in SAP is the most important tool for planning. Each of the Discipline Responsible persons for a specific area e.g. automation, mechanical having a requirement to perform a job raises work orders in SAP in order to manage the jobs. A planner coordinates these jobs and sets up the rolling 14 day work order plan. The aggregated work order plan does not give a detailed overview of when materials/equipment should be available for the jobs. The work order plan is used to manage and prioritize which jobs to perform and when during the rolling 14 day time span. The demand for materials /equipment in O&M is more predictable than D&W due to the established scenario to maintain existing production installations for oil and gas. The jobs to be performed are based on predictable engineering principles for preventive maintenance and thus more deterministic in nature than the D&W activities. There is however regularly requirement for urgent deliveries of materials/equipment also in O&M e.g. in connection with unscheduled corrective maintenance.

6.5.2. The requisitioning process/work orders

Each work order gives an estimate of what to do, where, when, it contains a cost centre and the corresponding requirement for resources to the job. The resources include the materials and equipment required for the jobs. Materials can be selected from e-catalogues, bills of material, the material master or entered as free text items. Once the work order is released, requisitions are raised to cover the demand for the required job to the start-up date specified in the work order. The demand can be

fulfilled through reservations in existing and available stock located at the supply bases. If the required stock is located at a remote warehouse, a transfer order is generated in SAP to ship the materials/equipment to the requested offshore installation. If there is no available stock to reserve, the requisitions are being picked up by purchasers for the adequate purchase categories (Figure 6.5.2.1) depending on which category the materials/equipment belongs to.

Figure 6.5.2.1 The 15 Statoil purchasing categories
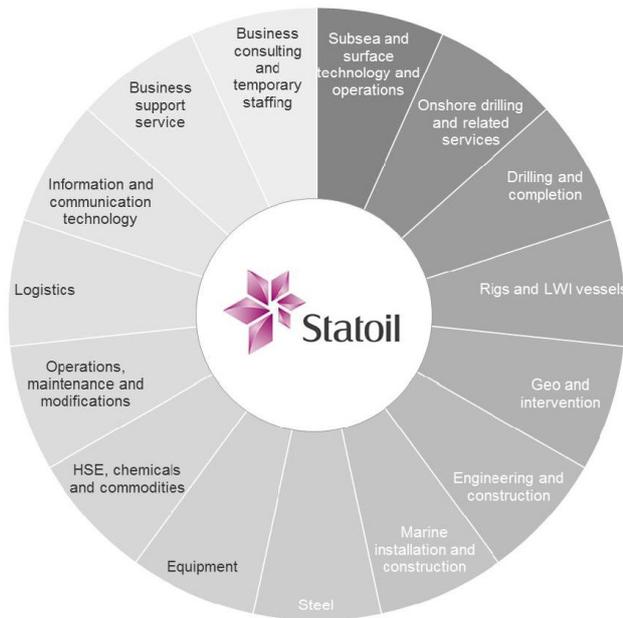
Source: Statoil internal

It is possible for the requisitioner of the work order to highlight how urgent the job is through the allocation of a priority code. Figure 6.5.2.2 lists delivery times for the different priority codes. A work order with a priority code "High" can be sanctioned urgently and will have a close monitoring from a dedicated SCM coordinator.

Figure 6.5.2.2 Priority codes for work orders

Priority code	Days to deliver
High	<= 5 days
Medium	<= 45 days
Low	<= 6 months
Unprioritized	<= 12 months

Source: Statoil internal, SAP

A current KPI O&M uses in relation to work orders is to measure how often it is necessary to re-plan work orders. The necessity to re-plan work orders does not appear to be cost effective. The KPI lists the share of orders in per cent being re-planned. Figure 6.5.2.3 shows the KPI values for an installation (black line) and the Statoil average (blue line) for a period. One of many reasons to re-plan work orders could be supply chain related e.g. late delivery of required materials. Providing supply chain related reasons can be directly extracted as a reason for re-planning this KPI could be used as one of many measurements for improved supply chain performance.

Figure 6.5.2.3 Re-planning of work orders in per cent for installation and Statoil
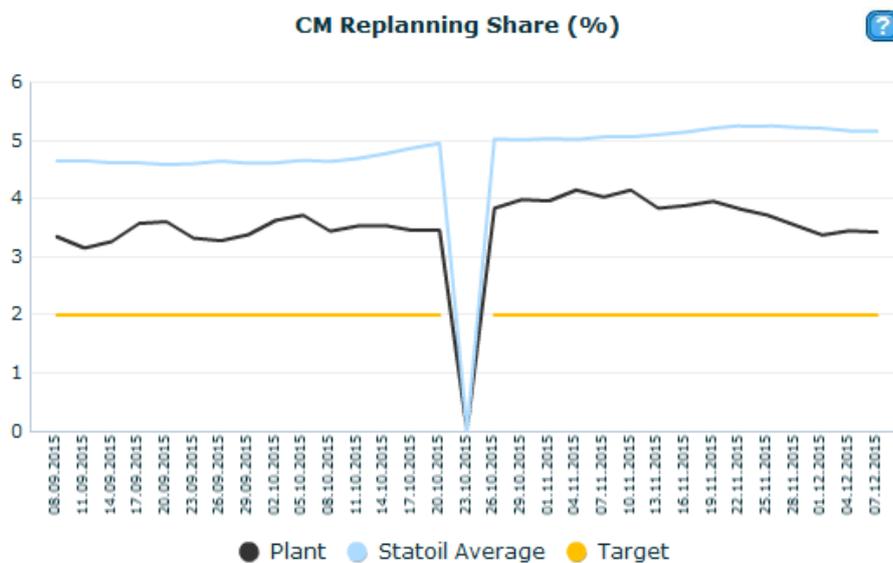
Source: Statoil internal

6.5.3. Purchase orders

For framework agreements with automatic release of purchase orders the released requisitions are converted to purchase orders which automatically are submitted to the supplier and not seen by the purchaser. The other requisitions are picked up by the purchasers based on the category for the material/equipment. Based on the requirement the purchase order will either be a call-off from a framework agreement or a stand-alone purchase order. In connection with requirements for components the purchaser has to check if there are any existing open purchase orders for repair or overhaul of the required type of component. At the point in time when the purchase order is released, a purchase order number is created in SAP, and the requisitioner can find out that a purchase order has been released. The purchaser knows the date of requested availability, but does not know anything

further about priority or criticality of the material/equipment. One interviewee informed me that it is a coincident if the purchaser is involved in the process at a later stage.

In relation to purchase orders Statoil use a Key Performance Indicator (KPI) called On Time In Full (OTIF) measuring per cent of material PO items delivered on time and in full. This KPI is more relevant for O&M than for D&W as O&M make more frequent use of material numbers on their purchase orders. The OTIF for O&M deliveries currently per October 2015 is 73% while the similar value for Statoil is 76%. There is a potential for improvement on these delivery figures. The In Full per cent for O&M and Statoil as whole is both 99%. The In Full part of the KPI does not have a great potential for further improvements. A logistic information system with a high visibility; e.g. sophisticated coordination and control has the potential to help improve performance for On Time deliveries. Figure 6.5.3.1 is an example for how the KPI is visualised and illustrates the OTIF delivery KPI for Statoil in 2014.

Figure 6.5.3.1 Statoil KPI On Time In Full purchase order deliveries
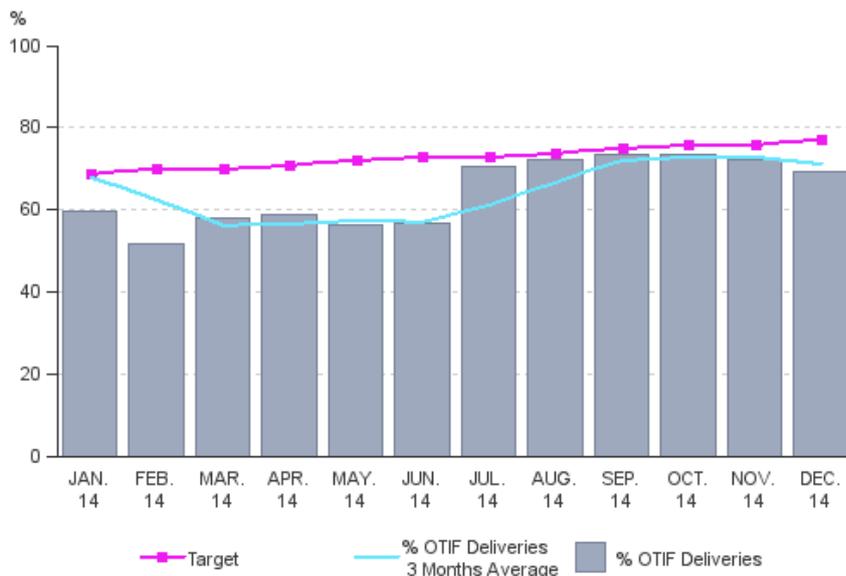
Source: Statoil internal

6.5.4. Follow up purchase orders

A good communication between the SCM coordinators and the purchasers has the intention to calibrate the necessary alignment between timely supplier deliveries and the corresponding demand in the O&M work orders. The SCM coordinator makes use of reports in SAP to chase suppliers and

ensures a timely delivery of purchase orders in accordance with the requirements. In urgent situations and if required the SCM coordinator can instruct the purchasers for the different categories to prioritize the purchase orders. The SCM coordinator is also a point of contact towards the supply bases, logistics and planning units.

6.5.5. Transportation from supplier to the supply base

The purchase order specifies the final delivery address and the Incoterms. The supplier contacts the designated transporter for pick-up of the materials once they are ready for transport to the supply base. The transportation of the materials/equipment from supplier to the supply base is arranged the same way as in D&W, and this is the first point in time where it is possible to start the tracking of the materials/ equipment. There has however not been a process in O&M to register the date of shipment from the supplier. The SCM coordinator, the requistioner and the supply base has for this reason a limited visibility of the materials before arrival at the supply base. The Statoil SCM coordinator can track the shipment on its way from the supplier to the supply base through the use of the Bring tracking system MINe. The SCM coordinator will actively have to provide the tracking number either from the supplier, directly from Bring or it can be located on the shipping invoice. The SCM coordinator normally uses Bring to track shipments when required. The supplier will normally not have any visibility of the equipment delivered to Statoil once the equipment has been received at the supply base. The supplier will have to make use of phone calls or e-mails to keep track of their equipment when the equipment is in the Statoil internal supply chain.

Bring has also launched a new service so far only for O&M called Mybring during late 2013. Once materials and equipment has been prepared for transport, the Statoil suppliers located in Norway shall book the transport referencing the purchase order number through the Mybring-solution on the internet. It is possible to track the shipments on the internet through the registration of estimated time of departure, actual time of departure, estimated time of arrival and actual time of arrival. The Bring drivers have PDAs and register these events on departure from supplier and arrival at the supply base. The delivery ticket can be uploaded to Mybring as well by the supplier. Per November 2015 a report in SAP (ZMST / Work order – Logistic Report) has been updated to list the 'Actual pickup date at vendor' and 'Plan arrival Statoil' registered. At this stage about 60% of deliveries to O&M having Incoterms Free Carrier (FCA) will show these dates/times in the report (Figure 6.5.5.1).

Figure 6.5.5.1 SAP report showing pickup and planned arrival of goods to Statoil

Source: Statoil internal, SAP

6.5.6. Delivery at the supply base and shipment to installations

An inventory location in SAP named Hold area has the intention to temporarily store materials arrived at the supply base for upcoming work orders on installations. All materials to be received at the supply base will automatically be put on hold until all materials for a work order have arrived at the supply base. Some of the benefits of the Hold area are fewer CCUs on the installation, better utilization of resources in the supply chain, avoid unnecessary temporary storage of materials/equipment on the installation, and fewer crane lifts on the installation. A report in SAP named ZMM_HOLD can extract materials stored in the Hold area at the different supply bases. Figures from this report can be used as a KPI to measure whether the temporary inventory in the Hold areas increase or decrease in relation to time.

The supply base performs Goods Receipt for materials/equipment providing the deliveries match the details in the purchase orders. Once the supply base has performed the Goods Receipt and allocated the materials/equipment to the temporary Hold area, the relevant stakeholders can identify which parts are located in stock. It is then possible to coordinate a timely arrival of the materials/equipment and other necessary skilled resources required to perform the job on the installation. Once the goods issue has been performed in SAP, the stakeholders can understand the required materials/equipment is on its way to the offshore installation. The materials/equipment being shipped to the offshore installations for work orders in O&M are being manifested to a shipment and handled the same way as shipments in D&W.

6.5.7. Arrivals and returns from the offshore installations

The procedures for arrival of materials/equipment at the installation for D&W and O&M follow the same pattern. The CCUs are being lifted on-board the offshore installation and located on the relevant area on deck available for storage of equipment. For bigger installations it has been normal to have

one material coordinator for D&W and a separate for O&M. After the work order has been finalized, the goods/equipment is returned to the supply base depending on type of equipment. If e.g. a pump has been replaced as a result of corrective maintenance, the pump needs to be repaired or scrapped. A return code is entered in SAP and the pump is being prepared for return from the installation to the supply base. The pump is placed in a CCU, and O&M material coordinator takes care of the return which follows the same pattern as in D&W.

6.5.8. Returns from installations to supply base

Once the pump has arrived at the supply base, the pump is registered in the correct work order. The relevant purchaser will, based on the return code in SAP, take adequate action for the pump. If the pump is Statoil owned material in need of repair, the relevant Statoil purchaser raises a repair order. According to interviewees the repair order cycle is a reactive process which has a potential for improved follow-up.

6.5.9. Transportation from the supply base to the supplier

Transportation from the supply base to the supplier is handled in accordance with agreed routine shipments on existing framework agreements. Regular communication between the supply base and on-site Bring representatives at the supply base ensures materials due for transport are collected and transported by Bring. The same means for visibility during transportation is available as for transportation from supplier to the supply base.

6.5.10.   Warehouse stock replenishment orders

If a part is pulled from a warehouse and the stock level for this material number in the same warehouse reaches its reorder point, the SAP Material Requirement Planning (MRP) process will act in accordance with the material master data set up. Every night, most plants run a MRP program that processes all the material numbers that are set to MRP management. On the basis of the existing amount in stock, reservations and management parameters (reorder point, lot size data and safety stock), suggested reorder alternatives are generated in the form of requisitions and planned orders. The outcome from the process is likely to be a stock transfer requisition being converted to a stock transfer order re-allocating stock from another Statoil warehouse. A stock transfer order will create the need for transportation of the subject material number from the supplying warehouse to the receiving

warehouse. If stock is not available to be transferred from other warehouses, a purchase requisition will be raised which in turn will be converted to a purchase order.

6.5.11.   Tools offering visibility of goods/equipment

SAP is the basis for the existing visibility both for O&M and D&W. They both use VTMIS, and the SAP reports offering visibility for O&M are based on the LPS. They also share the weaknesses. O&M make use of two different reports in SAP (1. Material Tracking - PM order 2. Work order – Logistics Report) to keep track of materials having arrived into the Statoil supply chain.

From a work order it is possible to drill down to the items on the purchase orders. It is then possible to check status for the different items. Figure 6.5.11.1 illustrates the traffic lights. Materials received at the supply base have a green light. The yellow light indicates that the materials are ordered but not received at the supply base. A red light indicates that no purchase order is raised. This material tracking functionality has been available in SAP for many years.

Figure 6.5.11.1 Material tracking in a work order (based on manual entries)

Source: Statoil internal, SAP

The Work order – Logistics Report offers in addition the visibility of the name of the purchaser to the purchaser order, the Goods Received Note (GRN) number and information about the outbound shipment from the supply base to the offshore installation.

Until November 2015 the SAP reports have not offered good visibility when materials are being shipped from suppliers or sub-suppliers. Bring is as previously mentioned the current Statoil framework agreement supplier for transportation in Norway, and is the company used for tracking of materials between suppliers and the supply bases. Statoil can make use of the MINe/Mybring service

which offers tracking of shipments handled by Bring, and per November 2015 information about 'Actual pickup by Bring' and 'Plan arrival at Statoil' have been added to the Work order – Logistics Report as described in section 6.5.5. This latest feature in the Logistics Report will enhance the visibility somewhat. There is still not any comprehensive interface with non-Statoil systems and the supply bases do currently not receive any detailed information on incoming deliveries up front. Bring has employees on the supply bases and at Sandsli in Bergen. The on-site Bring employees coordinate and act as liaisons between Bring and the different Statoil stakeholders with a requirement for shipping information. Bring also coordinates transportation of parts back to suppliers and are able to provide tracking information in this connection. The normal means of communication between Bring and Statoil are phone and e-mails. The suppliers do not normally have any visibility of their equipment in the Statoil internal part of the supply chain.

Manual resources have frequently been used to track the status of shipments from suppliers. It is an opinion among interviewees that improved external tracking information for materials from suppliers has a potential to improve planning and the performance in the supply chain.

6.6. Operation & Maintenance – based on "Staple yourself to an order"

For the close monitoring of the O&M OMC the intention was to staple myself to the order and track this from the perspective of a SCM coordinator. I did not follow the order physically through the process, but I used the standard means to follow the preparations and tracking through the supply chain. I have used the same 10 steps adjusted to our scenario also for O&M. I decided to staple myself to the transportation of a Hydraulic Valve which was going to be shipped from the supplier premises at Sola to Statfjord A. The shipment should be picked up by Bring at Sola, and Bring should transport the equipment by road to the supply base Coast Center Base (CCB) at Ågotnes where it should be received and shipped to the Statoil platform Statfjord A. There was no unit going to be returned to the supplier and the information for these steps is for this reason limited.

6.6.1. Summary

The main findings from the order I followed are outlined in this section. The findings are also described in the description of the O&M processes (section 6.5). Also for O&M I detected a fragmented overview of the Logistics Information System to provide tracking details through the supply chain. I was not able to register the same finding as for D&W with regards to latency in manual SAP registrations. The O&M processes for transportation of goods from supplier to offshore

installation do not vary much from the D&W processes, and I regard for this reason the potential for latency in SAP registrations to be present also for O&M.

I have stapled myself to an order where I followed the demand for a hydraulic valve through the tailored order management cycle. The main finding is that there is no real-time tracking information for the extended supply chain. Statoil does not have any real-time visibility of the supplier equipment from departure at the supplier facility until arrival at the supply base. In this case there is no need for the supplier to have visibility as the Incoterms for the order states the responsibility for the part is transferred to Statoil when the valve is picked up by Bring. Statoil has visibility of the shipment in the internal supply chain from the supply base to the offshore installation through the available functionality in SAP (Material Tracking - PM order, Workorder – Logistics Report and VTMIS). Figure 6.6.1.1 gives an overview of the findings.

Figure 6.6.1.1 Overview of findings from O&M

#	Description
1	No true real-time visibility for the extended supply chain.
2	Statoil not able to track transportation from supplier premises to supply base. Supplier owns transportation and no information was per default provided to Statoil.
3	Fragmented overview in Statoil Logistics Information System. Many screens to use in SAP to get overview of the transportation through the supply chain
4	Visibility based on manual entries for the Statoil internal supply chain. Although I did not experience latency in manual registrations following this shipment, the potential for delays is present.

6.6.2. Description of findings

The transport of the hydraulic valve was performed within the expected timeframe on the way from the supplier facility to the Statfjord A installation. The supplier knew when the valve was transported from their own premises to Ågotnes. Nor the supplier neither Statoil had any default availability of real-time information on the transport details. In this particular case Statoil did not receive any information about the transport details from the supplier and was even not aware of the shipment to the supply base. For this reason the supply base at Ågotnes was not able to plan for the arrival of the hydraulic valve at the supply base. The hydraulic valve was placed in a Hold area upon arrival at the supply base and prepared for further shipment to Statfjord A. Once the equipment was manifested on a shipment from Ågotnes to the installation, the material coordinator was able to get an overview of equipment on its way to the installation. As for the D&W order SAP offers visibility for the valve on

its way from the supply base to the offshore installation by status information being entered manually in SAP, i.e. not in real-time. More or less the same functionality for tracking in SAP is available for O&M and D&W. As there were no surprises during this shipment, it was not necessary to take care of unexpected happenings. Without any insight to the shipment from the supplier to the supply base at all, it would have taken some time to register that the valve for instance had been missing. There is i.e. no significant difference from the D&W process. To cater for purchase orders not received in accordance with agreed delivery times, the purchaser runs a weekly report in SAP to detect and chase this type of orders. Real-time visibility for shipments using the management by exception approach would provide a more proactive detection of orders not prepared and delivered in due time by the supplier (see Figure 6.4.3.1). The fragmented and somewhat time consuming tracking through the entry of several different screens in SAP has to be used to get the overview of the desired information.

The following have been detected as tracking points which gives a certain visibility from the perspective of the actors in the extended supply chain: 1) The supplier knows the actual time of departure from supplier 2) Statoil knows the arrival time at the supply base based on manual registrations 3) Statoil knows the time for departure from the supply base based on manual entries in SAP 4) Statoil knows the arrival time at the offshore installation based on the manual entries in SAP.

7. Analysis

7.1. Introduction

This section of the paper will compare and discuss results from the mapping of the current situation both from the interviews and the orders which was followed. The context for the discussion is the transparency and availability of correct and real-time information in the supply chain.

7.2. Comparison - current flow of information and equipment based on interviews and "Staple yourself to an order"

This chapter will compare and discuss the current processes based on the interviews and the orders I have monitored closely using the "Staple yourself to an order" concept. Figure 6.2.1 provided an overview of the relationships in the Statoil extended supply chain. Figure 7.2.1 illustrates a model for the current generic flow of materials and information in D&W and O&M. The figure is a simplification of the outcome from the mapping of the processes, and it is also valid from the "Staple yourself to an order" perspective.

Figure 7.2.1 Flow of information and materials in Statoil

The green lines represent flow of information while the blue lines represent flow of goods. The fixed infrastructural nodes are the supplier facility, the supply base and the offshore installation. Goods flow

between these nodes. Information flows between the requisitioner, the DSR/ SCM Coordinator /Purchaser, suppliers, stakeholders at the supply base and stakeholders at the offshore installation.

7.2.1. The comparison

My conclusion from the comparison of the orders I stapled myself to and the mapping of the processes from the interviews, was that there were some deviations. The information provided from the orders I stapled myself to, confirmed to a great extent the information provided through the descriptions of the processes based on interviews. There were in addition some findings related to delays in manual registrations in SAP and a fragmented overview in SAP in relation to the tracking of goods in the Statoil internal supply chain. The outcome from the comparisons is listed in Figure 7.2.1.1 and Figure 7.2.1.2.

Figure 7.2.1.1 Comparison of the D&W process and the corresponding outcome from the "Staple yourself to an order"

Drilling & Well		
Mapping of the process	Staple yourself to an order	Comparison - comments
Order preparations	Order planning	The order planning confirmed the description of the mapping.
Prepare delivery of goods from supplier to the supply base / transporation	Order generation	The order generation confirmed the description of the mapping. **See comment 1**
Transportation from the supplier to the supply base	Transport of goods from supplier to the supply base	The Bring transport confirmed the description of the mapping
The supply bases	N/A	N/A
N/A	Cost estimation	N/A
Delivery at the supply base and shipments to the installations	Delivery at the supply base	The arrival at the supply base and loading on the supply boat confirmed the description of the mapping. **See comment 2.**
Arrival at the offshore installations	Shipment from supply base to offshore installation and receipt at offshore installation	The shipment from supply base and arrival at the offshore installation confirmed the description of the mapping.
Returns from the offshore installations	Return shipment from offshore installation to the supply base	The shipment from supply base and arrival at the offshore installation confirmed the description of the mapping.
Arrival of goods returning from offshore installations to the supply base	Receipt and handling at the supply base	The shipment from supply base and arrival at the offshore installation confirmed the description of the mapping. **See comment 3.**
Transportation from the supply base to the supplier	Return transport of goods from supply base to supplier	I was unable to track the shipment from the supply base to the supplier
Invoices	Billing	It was challenging to understand if the invoice reflected the purchase order as there was not a one-to-one relationship. **See comment 1.**

Comment 1 from Figure 7.2.1.1:

As outlined in section 6.3.1 service numbers listed in SAP for framework agreements between Statoil and suppliers serve for Statoil a commercial purpose in example to identify a service to be invoiced by the supplier. A service to be invoiced often contains several items to be transported, and the description of the service numbers do very often differ from the actual description of

equipment/materials to be transported in the supply chain. The description of equipment shipped from the suppliers is captured from the supplier ERP system. The same equipment is in the Statoil SAP system described with the mentioned service numbers. One can argue that there is lack of alignment of master data for materials/equipment between suppliers and Statoil. The consequence is that items in the supplier delivery tickets do often not match the descriptions of the similar materials/equipment in the LPS. The reference to the Statoil purchase order helps limit the additional work to verify that the delivery ticket contains the correct items. This is in a track and trace context by relevant supply chain actors regularly considered as distorted supply chain information providing a blurry overview. The D&W order I followed did not have service numbers in SAP. The tool was identified through the use of a free text description on the Statoil purchase order. The lack of a one-to-one relationship to identify items is valid both for service numbers and free text descriptions. For the purchase order I followed the supplier identified the tool through the use of unique serial numbers for the different sub-assemblies which made up the assembled tool. A work-around to avoid confusion for the identification of the tool during the transportation was to limit the focus to the tracking of the relevant CCUs where the tool was located. A comment from the person who validated the purchase order invoice was that it was challenging to understand if the invoice reflected the purchase order as there was not a one-to-one relationship on the invoice and purchase order. The validation of invoices to Statoil through the 3-way-match is more time consuming without a common standardized identification of items. Another issue is that future cost estimation and pricing can be hard if statistics on a detailed level cannot be found due to the use different format for identification of the same items.

Comment 2 from Figure 7.2.1.1:

The supply base has received information about arriving CCUs through the LPS where the DSR has attached delivery tickets (in pdf format) to the overview of arriving equipment/materials to the supply base. Although this is not fully automated the supply base has the ability to have an overview of incoming CCUs provided the LPS is updated by the DSR whenever changes occur. The availability of this information will help the supply base to plan the further work. VTMIS offers visibility of the voyage details, and it is possible to track the CCUs through VTMIS/SAP to and from the offshore installation although the system does not offer real-time information.

When I followed the order, I discovered that the red light in the LPS which turns to green when the persons at the supply base receives the equipment was not changed to green even though the equipment had been received at the base. This was manually updated in SAP by the supply base after a chasing phone call the following morning. I also registered delay in manual SAP registrations at the supply base during the return shipment from the offshore installation to the supplier premises. The effect of the latency in manual SAP registrations is limited visibility for the stakeholders. Delayed registrations in SAP could lead to delayed response time in case of deviation from normal and expected activities in the supply chain. An example is that goods which are actually missing may not be detected until the actual Goods Receipt registration is to be entered.

There is communication between the DSR and the supply base through phone calls and e-mails, and this is necessary with the current visibility.

Comment 3 from Figure 7.2.1.1:

To provide the required tracking details in SAP I had to make use of several screens. The different screens in LPS and VTMIS do not provide a simple overview of the shipments. The need to enter many screens and reports make the information system fragmented.

Figure 7.2.1.2 Comparison of the O&M process and the corresponding outcome from the "Staple yourself to an order"

Operations & Maintenance		
Mapping of the process	Staple yourself to an order	Comparison – comments
Order preparations	Order planning	The order planning confirmed the description of the mapping.
Prepare delivery of goods from supplier to the supply base / transporation	Order generation	The order generation confirmed the description of the mapping.
Transportation from the supplier to the supply base	Transport of goods from supplier to the supply base	The transportation confirmed the description of the mapping.
The supply bases	N/A	N/A
N/A	Cost estimation	N/A
Delivery at the supply base and shipments to the installations	Delivery at the supply base	The arrival at the supply base and loading on the supply boat confirmed the description of the mapping.
Arrival at the offshore installations	Shipment from supply base to offshore installation and receipt at offshore installation	The shipment from supply base and arrival at the offshore installation confirmed the description of the mapping.
Returns from the offshore installations	Return shipment from offshore installation to the supply base	N/A
Arrival of goods returning from offshore installations to the supply base	Receipt and handling at the supply base	N/A
Transportation from the supply base to the supplier	Return transport of goods from supply base to supplier	N/A
Invoices	Billing	No issues

7.2.2. Findings from the comparison

The main findings common for both the mapping of the D&W and the O&M processes are:

- There is no real-time information available for the actors in the extended supply chain. To compensate for lack of real-time information manual resources like e-mails, phone calls and meetings are used.
- There is limited information sharing of tracking information for the actors in the extended supply chain.

- o Statoil does not automatically have access to tracking information for materials/equipment on its way from the supplier premises to the supply base. Manual efforts have to be performed to provide such information.
  - o Suppliers have a limited visibility of their equipment while it is in the Statoil internal supply chain.
- Statoil makes use of a fragmented system to provide visibility for the internal supply chain. Statoil has no IT-cockpit view facilitating a simple track and trace of materials/equipment.
- There is no consistent use of master data for materials and equipment in Statoil and between Statoil and suppliers. A common standardized system to identify material and equipment in the oil and gas industry would benefit all parties.
  - o A trend in Statoil is to integrate services where one of the consequences is that service numbers from the framework agreement appearing in the LPS do not match the descriptions for equipment to be transported. It is in many cases impossible to understand what is going to be transported from the descriptions of the service numbers.
  - o Statoil make their own material numbers and service numbers without any relation to engineering specifications. These numbers are used purely in a commercial context and are only valid during the period of the framework agreements. The suppliers use a different set of material numbers to identify parts and there is no link to the Statoil numbers.
  - o Another issue is that future cost estimation and pricing can be hard if statistics on a detailed level cannot be found due to the use different format for identification of the same items.
  - o The validation of invoices to Statoil through the 3-way-match is more time consuming without a common standardized identification of items.

- Lack of user friendly functionality regarding bulk and chemicals shipments. Today's solution is too complex and comprehensive for user.

Figure 7.2.2.1 summarizes the findings related to visibility of materials/equipment to be transported for each of the actors in the extended supply chain. There is no default real-time visibility for the actors in the extended supply chain. Although there is not a real-time visibility, SAP offers a visibility through the logistic reports and VTMIS in the Statoil internal supply chain. There is no interface with non-Statoil supply chain systems, and this is illustrated in Figure 7.2.2.1. The figure shows that the supplier has limited visibility of their equipment in the Statoil internal supplier chain, while Statoil has

limited visibility in the extended supply chain. Manual resources are regularly used to compensate for the lack of visibility.

Figure 7.2.2.1 Visibility for actors in the extended supply chain based on manual entry of status

Transport leg in supply chain		Visibility for supplier	SCM coordintators, DSR, purchaser, requisitioner	Visibility for the supply base	Visibility for offshore installation/ matr coordinator
From supplier to installation	Prepare transport at supplier facility	Yes (own premises)	No	No	No
	Transport from supplier to supply base	No default visibility (My Bring)	No default visibility (My Bring)	No default visibility (My Bring)	No
	Arrival at supply base	No	Yes (through SAP)	Yes (through SAP)	Yes (through SAP)
	Transport from supply base to installation	No	Yes (through SAP)	Yes (through SAP)	Yes (through SAP)
	Arrival at offshore installation	Manually (if supplier employee is on installation)	Yes (through SAP)	Yes (through SAP)	Yes (through SAP)
From installation to supplier	Transport from installation to supply base	No	Yes (through SAP)	Yes (through SAP)	Yes (through SAP)
	Arrival at supply base	No	Yes (through SAP)	Yes (through SAP)	Yes (through SAP)
	Transport from supply base to supplier	No default visibility (My Bring)	No default visibility (My Bring)	No default visibility (My Bring)	No
	Arrival at supplier facility	Yes (own premises)	No	No	No
Between Statoil inventories	For stock transfer orders between inventories	N/A	No default visibility between supply bases. Default visibility from supply base to installation through SAP.	No default visibility between supply bases. Default visibility from supply base to installation through SAP.	Yes (through SAP)

7.2.3. Potential consequences from the findings

7.2.3.1. The support of dynamic operations with high complexity

Bodendorf and Zimmermann (2005) claim the importance of information management is growing in a complex dynamic environment. The offshore oil and gas industry on the NCS is being operated on a 24/7-basis in challenging weather conditions along the Norwegian coast. Even though the industry has gained experience for more than 4 decades, the upstream oil and gas production on the NCS is still challenging to plan and execute in accordance with exact timelines. Although thorough operational preparations have been made through robust operational plans, unpredictable elements in the operations below the seabed lead to frequent changes affecting the supply chain regularly. The different oil and gas fields on the NCS are supported through the use of 7 different supply bases

located across the long coast of Norway. Table 7.2.3.1.1 and Table 7.2.3.1.2 list some relevant key figures for 2014. Table 7.2.3.1.1 offers an overview of tons transported by Bring during 2014. Bring has transported 972 015 tons where 82% of the activity is for the NCS and the remaining 18% is non-Norwegian activities. For NCS a total of about 800 000 tons was transported where road transportation was used for 93% of the instances.

Table 7.2.3.1.1 Globally transported tons by road and sea by Bring for Statoil during 2014

Activity	D&W	O&M	Project	Prod. facilities	Suppliers	Sum
Transported (ton)	260 585	253 949	161 562	25 509	270 410	972 015

Source: Statoil internal, SAP

A total of 4 252 offshore voyages has been conducted during 2014 where the total weigh transported is 3 115 000 tons (Table 7.2.3.1.2).

Table 7.2.3.1.2 Transport by supply boats for Statoil on the NCS during 2014

NR. VOYAGES	TOTAL WEIGHT TRANSPORTED (TON)	DECK OUT (TON)	DECK IN (TON)	BULK OUT (TON)	BULK IN (TON)	# LIFTS
4 252	3 115 342	756 158	702 311	1 332 747	324 125	298 319

Source: Statoil internal, SAP

It is for this reason fair to argue that the upstream oil and gas operations are dynamic and complex in nature and that the management of information through the supply chain deserves a high attention.

7.2.3.2. The extended supply chain

As for the case of Statoil Figure 4.3.2 shows that many companies currently face the challenge of having a greater visibility inside the enterprise than for the extended supply chain. The gaps for the extended networks are considerable, and the there is an increasing business pain caused by these inefficiencies according to Cecere (2014). She states that companies have automated the internal IT systems, but the extended supply value chain still has a potential for improvement. The flows of data are dynamic, but networks still have to operate with static ad hoc manual processes, e-mails and EDI. We can draw this conclusion for the case of the Statoil supply chain on the NCS from the mapping of the process. We can also conclude that it is correspondingly challenging for the extended trading partners to keep the supply chain information synchronized as changes occur. The information may be integrated but not synchronized. Cecere (2014) argues that there is no network system of record as the information flows are point-to-point and there is an immense latency on data. Data received is then

often out-of-sync and out-of-date. For the case of Statoil I registered latency for tracking data in the extended supply chain. The Statoil supply chain is complex with many trading partners encompassing mutual dependencies on the actors, and according to Cecere (2014) such a scenario requires a high clock-speed where the supply chain information is based on real-time information which continuously is refreshed on hourly basis to synchronise the flow between the trading partners.

7.2.3.3. Challenges linked to lack of visibility

The lack of visibility for materials in a supply chain may according to Simchi-Levi, Simchi-Levi, and Kaminsky (2008) be solved through the use of several methods. One method is to make use of extra labour resources and increased inventories in order for the supply chain to meet the requirements from the end users. For Statoil this may lead to inefficiencies like:

- Use of extra manpower along the supply chain both for suppliers and Statoil. Both Statoil and the suppliers make use of more manpower resources than required through an inefficient planning and follow-up phase to cater for the lack of visibility.
- Use of more equipment than necessary in the supply chain to compensate for the lack of available information.
- Demand for more inventory storage area than necessary for supplier as well as Statoil.
- Use of more resources than necessary in the supply chain e.g. the transporters have more lorries than necessary, Statoil spend more resources on supply boats to have robustness in the supply chain.

Both Cecere (2014) and Simchi-Levi, Simchi-Levi, and Kaminsky (2008) report that it is an asset to have a good visibility across multiple information systems within the company as well as an inter-enterprise visibility between the trading partners in the supply chain. The lack of real-time visibility and information for the extended supply chain leads to sub-optimal planning and execution. It is challenging to have a well-performing operational planning process for the DSR/SCM coordinator, the supply base as well as the offshore installation. Lack of such information may lead to inefficiencies like:

- Lack of optimal planning regarding loading of supply boats at the supply base and at the offshore installations (e.g. optimal location of goods on supply boats based on routes).
- Extra lifting operation at the supply bases and at the offshore installations.
- Delays on supply boats from supply base to offshore installations.

- Lack of storage space at offshore installations.
- Lack of space on supply boats. Goods have to be left at the supply base and may lead to demand for extra supply boats.

Features listed above like lack of information sharing, higher inventories than necessary, and use of more resources than necessary are also some of the normal characteristics in supply chains with the presence of the bullwhip effect which for decades have been known to have detrimental effects in the supply chain (Lee, Padmanabhan, and Whang 1997).

7.2.3.4. Missing, wrong or distorted information

There is a lack of suitable and functional descriptions of materials and equipment which is going to be tracked in the LPS. This is initially described in the framework agreement section of chapter 6.3 and further documented in comment 1 to Figure 7.2.1.1 in the comparison section. The price format of the framework agreements is directly linked to the service numbers appearing in the LPS. The price format and the service numbers linked to the framework agreements serves primarily a commercial purpose and is for this reason not suited to describe materials and equipment to be transported in the supply chain. Despite this lack of suitability for use in a track and trace context, the service numbers are currently the default available description of materials and equipment to be tracked through the LPS. It is in many cases impossible to understand what is going to be transported from the descriptions of the service numbers. According to Pereira (2009) the use of service numbers in the LPS can be considered as wrong or distorted information which normally is a source for inefficiencies in a supply chain. The current work around is the use of PRT's which is the entry of manual free text items where the DSR can enter a free text matching the items to be shipped more precise than the service numbers do.

7.2.3.5. Other topics

There is currently a functionality to handle shipments for bulk and chemicals in SAP. This solution is not used to a great extent as it is complex, comprehensive and thus not user friendly.

7.2.4. Excel the supply chain performance and increase the value creation in the supply chain

Academia has for decades prescribed improved cooperation with stakeholders in the company and between companies, increased information sharing and increased visibility in the supply chain to be remedies to fight inefficiencies in the supply chain and excel the performance (Bodendorf and Zimmermann 2005, Cecere 2014, Lee, Padmanabhan, and Whang 1997, Simchi-Levi, Simchi-Levi, and Kaminsky 2008, Simchi-Levi, Kaminsky, and Simchi-Levi 2000). On a more generic level the concept of the 3V's of supply chain: visibility, velocity and variability; also advice increased visibility as a method to excel supply chain performance. Increased visibility in the supply chain will lead to increased velocity for e.g. inventory and thus higher turn-around time which in turn will lead to reduced total costs per unit. Increased visibility will also lead to reduced variability for materials and thus reduced total costs. The likely outcome is the reduction of detrimental effects and increased value creation in the supply chain (SupplyChainDigest 2005). According to Cecere (2014) many companies face a requirement for increased visibility in ERP-systems, across multiple information systems as well as an inter-enterprise visibility or supply chain synchronization between the trading partners. The requirement encompasses visibility across multiple tiers of suppliers, logistics providers as well as contracting manufacturers. Cecere (2014) claims that now is the time to implement real-time information systems in the supply chain where information continuously is refreshed on hourly basis, and the reason is that B2B business networks have reached a sufficient level of maturity.

7.2.5. Potential issues with information sharing

"In a global optimization, the objective is to coordinate supply chain activities so as to maximize supply chain performance" (Simchi-Levi, Simchi-Levi, and Kaminsky 2008, p. 166). Unfortunately managers in different areas of the company have conflicting interests, and for the extended supply chain companies taking part in the chain also have conflicting interests. An example of conflicting interests is e.g. a logistics service provider wants to maximize its logistical services, while Statoil wants to minimise them. Another example is reluctance between business partners in a supply network to share information which has a business sensitive potential.

7.2.5.1. Abundance of information

In a context where the actors in an extended supply network are going to share information, there is a potential for numerous data to collect and share. The business context is the framework for the available resources in the supply chain, and the collection of the information has to fit into a business setting of limited resources adapted to a real world business scenario. In such a setting the key information relevant for efficient planning and execution along the supply network has to be captured and shared.

7.2.5.2. The dangers of sharing information and lack of interest

If there is a lack of benefits for companies to share information with other actors in the supply chain, there could be reluctance for actors to participate. There should be an incentive for all actors in the supply chain to benefit from the information sharing. The reasons for reluctance to share information could be commercial, business sensitivity, but also cultural. If business analytics are able to extract and analyse information from competitive companies or trading partners in a supply chain network information system, such information could have a potential to weaken a company's competitive position. There could be reluctance among business partners in a supply network to share information which has a business sensitive potential (Simchi-Levi, Simchi-Levi, and Kaminsky 2008). The cultural unwillingness seems to rest on the principle to only share information on the "need to know" basis (Jæger and Hjelle 2015). Figure 7.2.5.2.1 illustrates different approaches to mitigate risks related to data sharing and access for the actors. The ELH project has considered these risks and proposed solutions to regulate the access of potential business sensitive information.

Figure 7.2.5.2.1 Approaches to mitigating concerns about risks related to data sharing and access

		Data access	
	Closed	Restricted open	Open
Obligatory	1 Closed access for certain partners with obligatory agreements regarding data sharing	2 Restricted open access for all partners with obligatory agreements regarding data sharing	3 Open access for public with obligatory agreements regarding data sharing
Non-obligatory	4 Closed access for certain partners with non-obligatory agreements regarding data sharing	5 Open access for everybody with non-obligatory agreements regarding data sharing	6 Open access for public with non-obligatory agreements regarding data sharing

Data sharing (vertical axis label)

Generativity →
← Abuse

Source: Jæger and Hjelle (2015)

8. Development of high level requirements

A prerequisite for Statoil to capitalize on the projected increased visibility of goods is to have in place an internal operational planning and execution Logistics Information System with functionality capable of realizing the expected benefits. The business context for the oil and gas industry with the fall in oil price and the corresponding adaption to a setting of more limited resources is potentially a premise provider for the dimensioning of the future operational planning and execution Logistics Information System. The expected benefits with the perspective of different actors highlighted in Figure 8.1 should be quantified and part of a business case to properly understand the business potential. In this setting with limited resources Statoil should evaluate how the features of the existing Logistics Information System can be utilized and a part of the future.

Figure 8.1 Expected benefits from improved visibility and real-time information
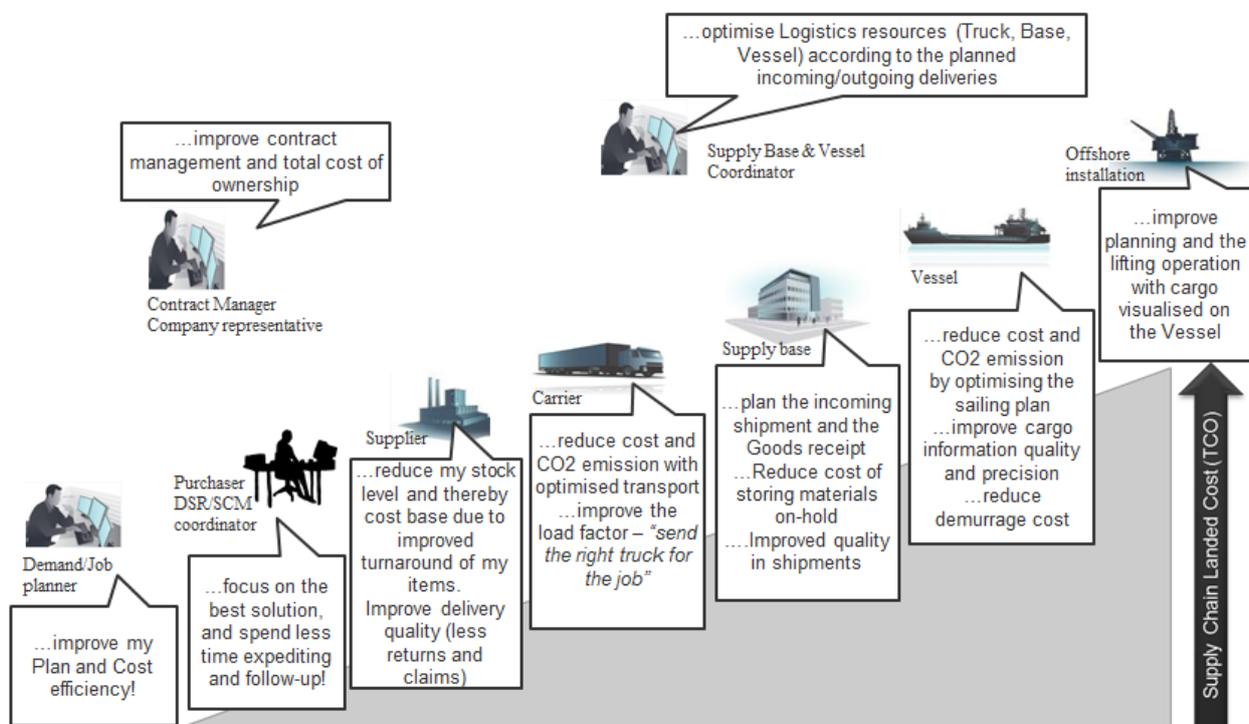
Source: Statoil internal

Given the timeline for my thesis and the current need for Statoil the subject for the master thesis is linked to the high level requirements for the internal Statoil operational planning and execution Logistics Information System which is likely to have an interface with the ELH. This section contains descriptions of ELH and the Statoil internal Event Management project which are on-going projects with an aim to support a vision of increased visibility.

8.1.1. EPIM LogisticsHub

Statoil is currently involved in many improvement projects and one of these is the ongoing joint industrial initiative in the Norwegian oil and gas sector with the aim to increase the supply chain performance for goods transported to and from the offshore installations. The name of the project is EPIM LogisticsHub (ELH), and the project is headed by the non-profit organization Exploration & Production Information Management Association (EPIM) representing some of the major companies on the NCS. EPIMs opinion is that the implementation of ELH has a potential to increase the efficiency of the logistics in the industry with up to 25 per cent. This will give a rise to new possibilities for information management and also increase the focus on Health Safety and Environment (HSE). The operating companies on the NCS will realize benefits like more efficient and safe operations and thus become more competitive.

The intention is that this is going to be a common solution for all involved parties with the aim to manage tracking information of CCUs and their content during transport to and from the various installations. The project has stated that automated tracking of goods in the supply chain through RFID technology will be made available for all relevant stakeholders (EPIM 2014). The first phase of this joint industrial initiative will focus tracking of CCUs, while the second phase will enable tracking of the content in the CCUs. EPIM is a driving player in the ELH project and this underlines the dedication among some of the operators to invest in the project where the intention is that all players in the industry will benefit from the implementation. The ELH will comprise an event database which enables the sharing of information among the stakeholders in the supply chain. The sharing of information will provide visibility for materials and equipment being transported through the supply chain. Access to data will be limited to information only relevant for each of the stakeholders. The use of RFID tags on each CCU provides the involved stakeholders to automatically register real-time events along the supply chain. The objectives for the introduction of the ELH represent simplified management of the CCUs and goods, improved visibility, less waste of time and resources:

- Data sharing leads to increased visibility in the supply chain
  - o Enhanced management of the CCUs and documents
  - o Potential for enhanced work processes
- Enhanced traceability in the supply chain
- Replacement of manual procedures
- Effective search mechanisms for lost and delayed goods

- - Reduced time for searching
- Identification of containers and equipment not in use and without movement
- Enhanced utilization of the CCUs
- Enhanced data quality due to automation of registration processes
- Predictable flow of information and goods leads to improved planning
- Enhanced HSE: fewer unnecessary lifts, fewer critical delays, fewer stressful situations
- Standardized master data
- A single interface for data sharing between many stakeholders

For the actors in the supply chain ELH will in example provide information on how many CCUs are arriving today or tomorrow. Where is for instance the CCU I am waiting for and when will it arrive to my site? Is for instance some of my rented CCUs idling somewhere? The CCU master data will provide information when a CCU certificate will expire, or if a CCU needs repair and the CCU whereabouts. The database will also give an overview of rental information.

The main principles for sharing of information between the ELH stakeholders are:
- The operators (oil companies) can view all CCUs on journeys to or from their installations
- The owners of the supply bases can view all CCUs arriving to or departing from their base
- The owners of the CCUs can view their own CCUs continuously
- The hiring companies are allowed to view all hired CCUs during the hiring period
- All users can view all CCUs on their own premises
- The same principles apply to historical data

Some of the companies represented in the ELH started a pilot in 2014, and the companies have been testing the functionalities of the ELH solution. Each company develops their own method for data capture and exchange of data with ELH. Figure 8.1.1.1 illustrates the lines of communication between the ELH actors. Each user has a user interface with the ELH database in addition to other internal data systems (EPIM s.a.). There has in parallel been an ongoing development managed by Norwegian Oil and Gas with the intention to standardize the deployment of RFID for the oil and gas industry.

Figure 8.1.1.1 Lines of communication
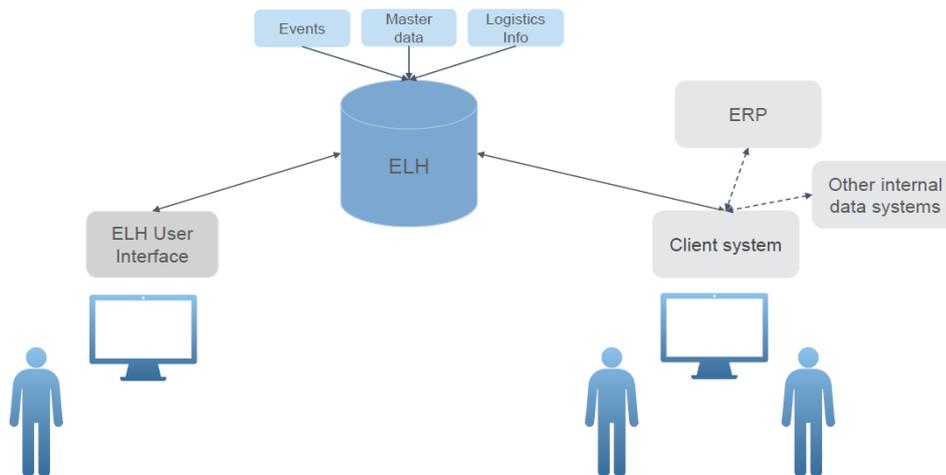
Source: EPIM (2015)

8.1.2. The Statoil Event Management phase I project

The main objective of the Statoil internal event management solution is to keep track of containers through the supply chain from the point in time when the CCUs are leaving the CCU owner and through supply base operators out to offshore facilities and back to the owner. This will give real-time information about the overall status of CCUs. The event management project will be aligned with the deliveries for the ELH project. The Statoil internal event management project will consist of three phases where the ambition for each of the phases is:

- Phase 1: An event management for the 7 supply bases where they utilize data from RFID CCU tracking.
- Phase 2: Combine the tracking of CCUs outside Statoil. This is the connection to the ELH project. Indirect Purchase Order-item tracking (connect Purchase Order to CCU). Electronic exchange of CCU documents, measure suppliers, tailored cockpits, Graphical User Interfaces (GUI).
- Phase 3: Physical object tracking, electronic flow of documents, full supply chain visibility.

The events planned to use are identical to the ones in ELH.

8.2.   High level requirements for the operational planning and execution logistics information system

The Statoil internal operational planning and execution Logistics Information System plays a vital role towards the goal of a high performing and effective supply chain, and the intention with the coming sections is to recommend a set of high level requirements covering the main aspects of a future logistic planning and execution system. From a business perspective it makes sense to consider the requirements for the operational planning and execution Logistics Information System in the context of the already ongoing ELH initiative and the Statoil internal Event Management project, and the timing for the capture of the high level functional requirements is good as Statoil already is involved with the ELH and the internal Event Management I project. This section contains information from the analysis which will be the basis for the development of the requirements. During the work to develop the high level requirements I have also extracted information from Statoil internal workshops.

8.2.1. Iterative requirement capture process

Reference is made to chapter 4.5.1 regarding challenges related to development of requirements. This type of challenges has existed for decades and is still present today. It is for this reason not recommended to view the requirements in this paper as exhaustive. According to Avison and Fitzgerald (2006) the evolvement of requirements in large organization should be subject to iterative processes including interviews, meetings, workshops, surveys, storyboards, etc. The model called the traditional process makes use of an iterative requirements capture process before sign off of the specification. Iterations are one of the cornerstones in rapid and evolutionary development methods. One of the advantages of the evolutionary development is that changing requirements are no surprise and are dealt with in the model. In real wold business scenarios changes occur and the traditional process does not cope well with changes in the requirements after freeze of the specification. This can be a source for a growing concern if there is a long period from specification until the system is implemented (Avison and Fitzgerald 2006).

The number of iterations will vary depending on each situation. Considering Statoil in this connection some of the hallmarks for the NCS oil and gas industry in a high level supply chain context are; an industry with about 50 years of experience, well developed infrastructure, good overview of actors in the industry, fairly predictable supply chain scenarios. The physical supply chain in the oil and gas industry on the NCS has not changed substantially during the last decades, and the requirement for

transportation services has been fairly predictable. The supply chain related infrastructure has been available for the same period, and the suppliers of transportation services are well known to the industry. The volume to be transported has a correlation to the drilling, well and production activity and will for this reason vary during different periods. Statoil as an organization has long experience supporting the oil and gas activities on the NCS and has good competence about the processes. Given the information available one can argue that the basis for the development of the requirements is fairly predictable. The required number of iterations to capture the requirements in a thorough manner and with a high quality should for this reason not be high. Some of the uncertainties which could address the need for a higher number of iterations are if there is available technology which is not considered in this paper or e.g. a recent development of technology. If there prior to any decision to roll out a solution is a change in business processes affecting the supply chain, there might be a need for additional iterations to capture the change in requirements. Stakeholders developing requirements should have complementary competence and ensure stakeholders from relevant areas are represented.

8.3.   Development of high level requirements

The identification of the required information to be available in the operational planning and execution system has been captured during the mapping of the process, during the interviews, observations and during the workshops as part of the action research. The contextual frame is that both O&M and D&W have a demand to move materials and equipment. Both organizations primarily use the same infrastructure on the NCS. The demand for transportation is also along many of the same distances on the NCS. The drilling and production of oil and gas generate much of the same demands for transportation regardless of location. Demand for transportation on the NCS does not differ much from demand in other global locations. The available infrastructure in different global locations varies from very poor to well developed.

The following bullet points contain conceptual statements captured during workshops with internal Statoil stakeholders:

- The operational planning and execution system should not limit other systems
- The system ought to have the potential to include all Statoil organizations with a demand for transportation of materials and equipment.
- The planning and execution system should initially have a geographical range which is the NCS, but with a potential for a global reach.

- Statoil owned materials and equipment should be included and 3rd party materials and equipment can be included.
- The system ought to have a potential to include transportation of personnel in the future.
- It will be sufficient to capture the majority of the demand for transportation - 70-90%.
- Today 80% of the demand is on the NCS, and it makes for this reason sense that the operational planning and execution system initially is designed to cover the demand for supply chain activities on the NCS.
- A more efficient supply chain with higher performance in the supply chain following an implementation of a new planning and execution system should lead to new working procedures e.g. the principle of management by exception.
- "One logistic system" may consist of many interacting systems.
- The operational planning and execution system should focus the end-user perspective and create rational the work processes for these users.
- The system should increase visibility of materials and equipment, improve the operational planning and execution of supply chain related activities.
- Avoid duplication of work through reuse of data.

8.4.   Planning, execution, collaboration and event management

The supply chain operational planning process has the intention to provide supplies in accordance with the requirements on time, in a safe manner and with a rational use of efforts. The execution of the supply chain activities can be regarded as the realization of the plans. The Statoil internal and external supply chain collaborates with the intention to improve interactions and drive integrated dynamic planning through the supply chain. This will in turn increase the integration with the supply chain business partners and promote a lean execution. Figure 8.4.1 illustrates the relationship between planning and execution of supply chain activities in an event management setting where the flow of information and excellent collaboration are paramount for high performance in the supply chain. The high level requirements for the system are developed to improve the performance of the planning and execution of supply chain activities.

Figure 8.4.1 Relationship between planning, execution, event management and collaboration in the supply chain

SCP = Supply Chain Planning

SCE = Supply Chain Execution

SCC = Supply Chain Collaboration

SCEM = Supply chain Event Management
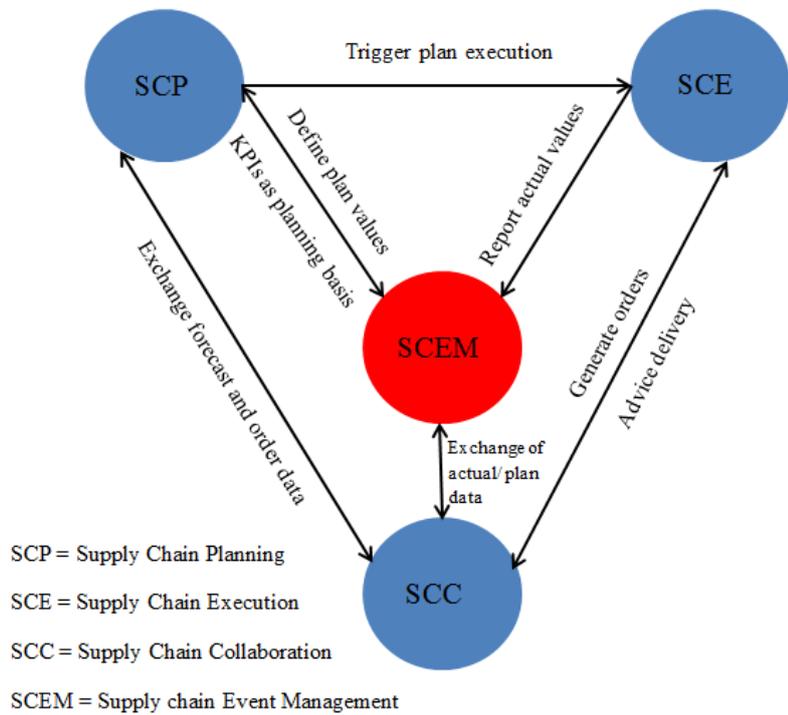
Source: [4](Bretzke 2003)

Continuous input from operative plans for drilling and production activities is necessary for a persistent high quality planning of the upcoming supply chain activities. When the input from the operative plans have been transferred to operational planned supply chain activities, relevant information are communicated to the supply chain stakeholders in due time to prepare for the execution of the plans. When in example the transport of equipment is being prepared for shipment at the supplier facility, event management functionality will act as an enabler for further planning of supply chain activities for stakeholders along the supply chain and simultaneously be the enabler for an effective execution of the supply chain activities. The actors with a supply chain role in the chain will receive information valuable for planning prior to the execution of the supply activities they are responsible for. The supply base will for instance receive information through the event management system that the supplier prepares a shipment (Figure 8.5.1.1). The supply base will then be able to plan incoming transports which in turn will have to be executed upon arrival at the supply base. The offshore installations receive similar planning information from the relevant supply base which will have to be executed when the supply boat arrives at the installation. During the transport through the

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[4] This is unpublished work which is available on request.

supply chain the data capture through the event management system will increase the real-time visibility of supplies for all involved parties and thus contribute to achieve a higher level of collaboration.

According to the requirements document for ELH an event can be defined as: "a representation of predefined actions that create trace information regarding a Traceable Item required to support chain traceability, or internal traceability" (EPIM 2012, p. 8).

8.5. The high level recommendation

8.5.1. Model

In the contextual frame of the Statoil internal Event Management and ELH Figure 8.5.1.1 illustrates a sketch of a recommendation where both these projects have their role in the model. On the conceptual level the model reflects the ELH set up (Figure 8.1.1.1) and represents a change in information flow from the current point-to-point information model for the extended supply chain (Figure 6.2.1) to a hub-and-spoke network flow of information reducing the connection complexity considerably (Jæger and Hjelle 2015).

The events captured in the internal Statoil part of the supply chain are registered in the Statoil internal event management database. Information from these events which is also relevant for other stakeholders in the supply chain will be made available for the stakeholders through the ELH event management database. Likewise will event information from non-Statoil companies e.g. a supplier which is going to transport equipment to an offshore installation be registered in the non-Statoil company initially. Information from these events being relevant for Statoil will be made available for Statoil through ELH. The ELH will be a reference database for Statoil. The pyramids represent different roles with different need for information. Different user groups in different companies can have different cockpits. Role 1 represents a role with lower granularity than role 3. A manager does for instance not need access to the high level of granularity in a cockpit as a DSR needs.

Figure 8.5.1.1 Sketch for recommended flow of information
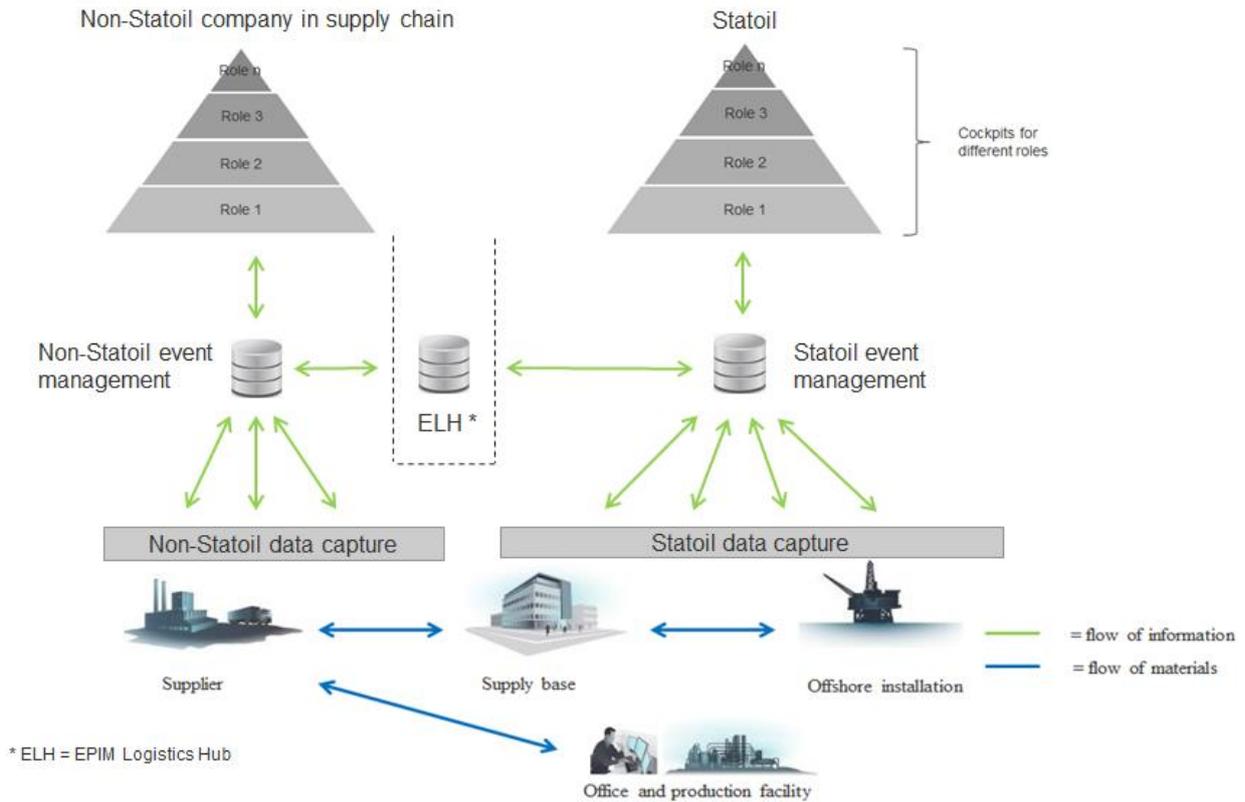
8.5.2. Data capture methods

The ELH project contains two phases where phase 1 focuses data capture on the CCU level. Phase 2 will focus the content of the CCU which can be described as materials or equipment inside the CCU (EPIM 2015). The data capture can be manual or automatic, and the following are examples of automatic data capture methods: RFID scanning, one and two dimensional bar code recognition and Optical Character Recognition (OCR). In an event management concept with an industrial approach different companies not will share all the same prerequisites, and companies may use different methods for data capture.

The methods for automated capture of data discussed to use internally in Statoil during the work with this paper still appears to have an unreleased potential for improvement. A further analysis is recommended to be able to decide on the automatic data capture methods to use in the Statoil internal supply chain. All CCUs used by Statoil on the NCS is currently equipped with active RFID tags compliant to the Norwegian Oil and Gas Guideline no. 112. Statoil has also installed RFID readers at

the gates on all the supply bases and in each of the fork lifts on the supply bases. Providing this technology demonstrates a high quality and stable performance, there is no need to change data capture method at the supply bases. It is possible to track the supply boats' location through the use of GPS technology. A GPS location of the supply boat in combination with a CCU loading and departure event is sufficient for a tracking purpose. The use of OCR data capture on supply boats and the offshore installations will give additional location functionality for the CCUs (Figure 8.5.2.1). This could reduce the time for loading and unloading as the location of the CCUs on the deck is easy to decide, and the loading and unloading has for this reason a potential to be less time consuming with the use of OCR technology.

Figure 8.5.2.1 Examples of methods for data capture
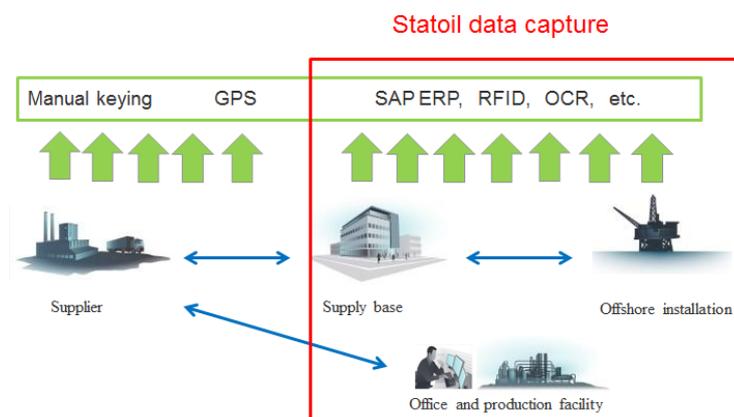
8.5.3. The capture of events

The capture of events will provide visibility in the various user cockpits in the Statoil logistics planning and execution system. Each event for a CCU moving through the supply chain consists of the following five attributes: 1) Who – the organization which creates the event 2) What – type of CCU 3) Where – the location of the CCU 4) When – a timestamp 5) Why – the business process event (EPIM 2012). The following events are examples from the ELH project: Arriving, departing, loading, unloading, packing, unpacking, internal movement, inspecting and inspecting result. Figure 8.5.3.1 contains an overview where the event attributes have been systemized. The final events to be selected and where these should be captured, should be subject to further requirements iterations and agreement with other users and suppliers of the potential event management solution. The use of these

events in an event management solution will cover the demand for visibility expressed by the stakeholders in Statoil.

Figure 8.5.3.1 Overview of CCU attributes and events through the supply chain

Event attributes		Inbound				
Who	Supplier	Transporter	Supply Base (Arrival)	Supply Base - Inventory (cross docking) - Depart	Sailing	Installation/ Production facility (Arrive)
What	CCU type	CCU type	CCU type	CCU type	CCU type	CCU type
Where	Supplier facility G	Road/Lorry	Supply Base	Supply Base	Sea/Supply Boat	Installation
When	Time stamp	Time stamp	Time stamp	Time stamp	Time stamp	Time stamp
Why Arriving		✔			✔	
Departing		✔			✔	
Unloading			✔			✔
Holding				✔		
Loading	✔			✔		
Inspecting	✔			✔		
Inspecting results	✔			✔		
Internal Moving			✔	✔		✔
Packing	✔			✔		
Unpacking			✔			✔

Event attributes		Outbound				
Who	Installation/ production facility (Depart)	Return sailing	Base (Arrival returns)	Supply Base (Depart)	Transporter	Supplier
What	CCU type	CCU type	CCU type	CCU type	CCU type	CCU type
Where	Installation	Sea/Supply Boat	Supply Base	Supply Base	Road/Lorry	Supplier facility
When	Time stamp	Time stamp	Time stamp	Time stamp	Time stamp	Time stamp
Why Arriving		✔			✔	
Departing		✔			✔	
Unloading			✔			✔
Holding						
Loading	✔			✔		
Inspecting	✔			✔		
Inspecting results	✔			✔		
Internal Moving			✔			
Packing	✔			✔		
Unpacking			✔			✔

✔ = Recommendation for events to be registered

8.5.4. Information elements

The following section discusses information elements available today and information elements required in a new system. The current Logistics Information Systems contain lots of information which is also needed for the future. Some of the gaps of available information and required information have already been highlighted through the mapping of the processes. Figure 8.5.4.1 has systematized the information required in a new system where boxes ticked and in green colour is information which is current available. For boxes with yellow colour the information is only partly available. Boxes with red colour contain a requirement for information where there is a gap today. The Statoil internal information already available is highlighted through the green boxes in the column named 'Statoil ERP System (SAP P03)'. For the column to the right named 'Statoil Logistic system' there is a lack of electronic information and events from the actors in the extended supply chain.

Figure 8.5.4.1 Information required

Information required		Systems				
		Statoil ERP System (SAP P03)	Manual	Transporter	Suppliers ERP System	Statoil Logistic system
Documents	Network order/Work order	✔				
	Purchase Order	✔				(not available)
	Purchase Order Confirmation	(partly)			(not available)	
	Delivery Ticket	(not available)	✔		(partly)	(not available)
	Shipping Notification		✔		(not available)	(not available)
	Goods Receipt	✔				(not available)
External Events	Packing				(not available)	(not available)
	Book Transport	(partly)		(partly)		(not available)
	Arriving					(not available)
	Loading			(not available)		(not available)
	Departing	(partly)		(partly)		(not available)
	In transit			(not available)		(not available)
Internal Events	Arriving			(not available)		(not available)
	Departing	✔				✔
	Unloading	✔				✔
	Holding	✔				✔
	Loading	✔				✔
	Inspecting		✔			(not available)
	Inspecting results		✔			(not available)
	Internal Moving	✔				✔
	Packing	✔				✔
	Unpacking	✔				✔

✔	Need information - OK, available
(yellow)	Need information - PARTLY available
(red)	Need information - NOT electronic available to Statoil

Source: Statoil project internal

Beside the timestamps for events specifying the exact occurrence of events, it is also desirable in a planning scenario to view time estimates like time for booking of transportation, estimated transit time (ETT), estimated time to departure (ETD), and estimated time to arrival (ETA). It would also be desirable to have online tracking details for lorries and supply boats as this will increase the visibility of materials in transport further. Bring already has as previously mentioned GPS signals for their own lorries, but not for lorries on ad-hoc hire. This is in line with the functionality available in Mybring described in section 6.5.5. The supply boats also use GPS. The attributes for the CCUs must as a minimum be: the unique identification number, the dimensions of the CCU, the weight of the CCU, the serviceability/unserviceability of the CCU, the remaining time to inspection. It is paramount that the content of the CCUs is visible for the relevant roles in the system. An electronic supplier delivery ticket e.g. Advanced Shipping Notification (ASN) displaying the content of the CCU will ensure consistency for the material/equipment master data information transported from supplier to the offshore installation and back to supplier. It is also desirable to show information on technical requirements for materials and equipment e.g. correct dangerous goods classification if applicable, if equipment needs a Z-015 declaration of conformity in accordance with the NORSOK regulations for

temporary equipment. Figure 8.5.4.2 gives an overview of the proposed visibility for non-event information elements.

Figure 8.5.4.2 Overview of proposed visibility for non-event information elements

Other information - to be available for:	Outbound						Outbound
	Supplier	Transporter	Supply Base (Arrival)	Supply Base - Inventory (cross docking) - Depart	Sailing	Installation/ Production facility (Arrive)	DSR/ SCM coordinator/ Purchaser
Online tracking details per activity	✔	✔	✔	✔		✔	✔
ETD	✔	✔	✔	✔	✔	✔	✔
ETA	✔	✔	✔	✔	✔	✔	✔
ETT	✔	✔	✔	✔	✔	✔	✔
ERTT	✔	✔	✔	✔	✔	✔	✔
CCU details i.e. dimensions, weight	✔	✔	✔	✔	✔	✔	✔
Delivery ticket information	✔	✔	✔	✔	✔	✔	✔
Technical requirements (Dangerous Goods, Z-015)	✔	✔	✔	✔	✔	✔	✔

Other information - to be available for:	Inbound						Inbound
	Installation/ production facility (Depart)	Return sailing	Base (Arrival returns)	Supply Base (Depart)	Transporter	Supplier	DSR/ SCM coordinator/ Purchaser
Online tracking details per activity	✔		✔	✔	✔	✔	✔
ETD	✔	✔	✔	✔	✔	✔	✔
ETA	✔	✔	✔	✔	✔	✔	✔
ETT	✔	✔	✔	✔	✔	✔	✔
ERTT	✔	✔	✔	✔	✔	✔	✔
CCU details i.e. dimensions, weight	✔	✔	✔	✔	✔	✔	✔
Delivery ticket information	✔	✔	✔	✔	✔	✔	✔
Technical requirements (Dangerous Goods, Z-015)	✔	✔	✔	✔	✔	✔	✔

✔ = Information available

The future system should provide functionality making the relevant documentation available electronically upon request. Depending on who is requesting the information, the request will be granted e.g. similar to The CASSANDRA EU project (Figure 8.5.4.3).

Figure 8.5.4.3 The Cassandra pipeline concept pulling data from key supply chain partners
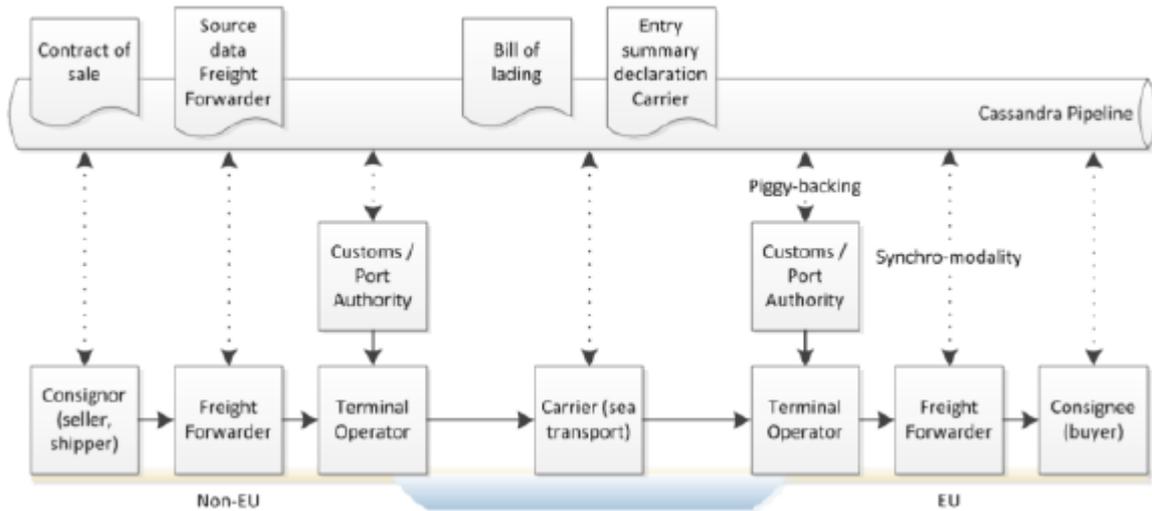
Source: Jæger and Hjelle (2015)

It should be possible both to track and to trace CCUs and their content. As discussed in the previous section about the mapping of existing processes, equipment is occasionally lost during transportation. It is for this reason a good idea to be able to trace CCUs and their equipment through e.g. a listing of events for specific CCUs sorted by descending timestamps. The events will give a chronological history for the CCU listing when events have happened at which locations. This ought to provide firm information about the CCU for the relevant CCU stakeholders.

One of the challenges discussed in the mapping of the processes for D&W is that the commercial service numbers listed in the price format of the framework agreements appears in the LPS system as items to be transported even though these service numbers not necessarily are physical items which are going to be transported. In line with the conceptual statement that the operational planning and execution system should focus the end-user perspective and create rational the work processes for these users, it is not recommended to tie the service numbers in the price format of the framework agreement directly to the logistical planning and execution of transport of materials and equipment.

Using a management by exception approach Figure 8.5.4.4 outlines an example for events, delivery deadlines, automatic capture of events, potential problems where the exceedance of thresholds lead to a notification to selected actors in the supply chain. In combination with the use of ASN from supplier to Statoil the involved stakeholders will be able to focus their working time more on deviation handling rather than spending working time on less value creating activities like shipments where the progress is according to agreed plan.

Figure 8.5.4.4 An example of possible events, deadlines and stakeholders for notifications

Description of activity	Deadline	Proposal for automatic capture of events/ visibility for actors	Proposed events	Potential Problems	Who to notify
Supplier prepares shipment at own premises			Packing	Supplier cannot fulfil and does not send, delay in preparations, Z-15 certificate not issued, applicable dangerous goods certificate not prepared	DSR, SCM coordinator, purchaser
Supplier order transporation	10.00 (day 1)	✔		Forget to order transportation	
Transporter loading goods at supplier premises	12.00 (day 1)	✔	Loading	Transporter is late, lorry is too small, problems with dangerous goods certificates, etc.	DSR, SCM coordinator, purchaser
Goods transported by road from supplier to supply base	16.00 (day 1)	✔	Departing	Delay of transport due to different scenarios e.g. trafical problems	Supply base, DSR, SCM coordinator, purchaser, supplier.
Goods received at supply base	before 10.00 (day 2)	✔	Arriving / Unloading	Late arrival at supply base	Supply base, DSR, SCM coordinator, purchaser, supplier.
Goods/CCUs manifested on supply boat for shipment to final destination	12.00 (day 2)	✔	Packing	Forget to manifest goods, goods lost on supply base, etc	Supply base ops, DSR, SCM coordinator
CCU loaded on supply boat	16.00 (day 2)	✔	Loading	Goods lost on supply base, etc	Supply base ops, DSR, SCM coordinator
Supply boat departing from supply base	16.00 (day 2)	✔	Departing	Late departure of boat, critical failure on boat	Supply base ops, DSR, SCM coordinator, material coordinator
Supply boat sails designated route to several offshore installations	According to route	✔	Arriving/Departing	Delay on sailing route due to different reasons	Supply base ops, DSR, SCM coordinator, material coordinator
Supply boat arriving at given offshore installation	According to route	✔	Arriving		Supply base ops, DSR, SCM coordinator, material coordinator
CCU is unloaded to the offshore installation	According to route	✔	Unloading	Problems with lifting crane, do not find CCU on supply boat deck, forget to unload CCU	Supply base ops, DSR, SCM coordinator, material coordinator

Statoil does not use ASN in the current solutions. The use of ASN should also be considered to be introduced for the return of goods from the supply base to supplier. This will also help the suppliers to become more efficient.

8.5.5. Further considerations

The Norwegian oil and gas industry through EPIM is working towards the implementation of an event management solution across the industry on the NCS. Avison and Fitzgerald (2006) argue that the requirement capture process is challenging in a real world. Requirements could change or evolve and for several reasons they argue that the process should be iterative. ELH specified the requirements in 2012, and Statoil is in 2015 working on the requirements for the internal operational planning and execution Logistics Information System. A logical step will be that Statoil performs a calibration between the requirements for the internal Logistics Information System and the requirements specified in ELH. Any potential gaps will have to be dealt with to ensure consistency for a further development of the Statoil system.

In relation to a future implementation of ELH a risk for Statoil is the potential lack of on-boarding from the actors in the supply chain. The presence of a strong principal actor having the ability to set the "rules of the game" is important for on-boarding of the actors in the supply chain. EPIM and the

members representing some of the major actors on the NCS should be in a position to take on this principal role (Jæger and Hjelle 2015). The on-boarding of actors is paramount, and the benefits of increased performance in the supply chain will not be realized if the on-boarding of the transporters and the major suppliers fail.

Event management is a tool for collection and analysis of information and is dependent on well-functioning automatic capture of data. The RFID solution installed at the supply bases has per November 2015 still not reached its potential for performance, and there is currently a gap between its performance and Statoil's requirements for performance. Prior to a decision about implementation of an event management solution Statoil has to ensure that the data capture methods to be selected meet the requirements.

The benefits from a potential implementation of an event management solution for the operational planning and execution system in Statoil has to be reflected in adapted work processes for the involved stakeholders with the aim to realize the full potential of the implementation.

This paper does not include any cost benefit analysis for a potential implementation of the event management solution. It is a prerequisite that a final Statoil decision to implement the event management based operational planning and execution Logistics Information System is subject to a cost-benefit analysis.

Statoil ought to utilize the existing momentum in the ongoing projects ELH and internal Event Management project to create increased visibility throughout the supply chain on the NCS.

8.5.6. Measurements of performance

EPIM has estimated that the implementation of ELH will increase the performance in the supply chain with up to 25 per cent. In relation to a potential future implementation of the operational planning and execution Logistics Information System for Statoil, the company should measure the improved performance. Prior to an implementation Statoil will have to decide a set of relevant KPIs to use for this purpose. These KPIs should be used to set a base line before implementation. Performance should thereafter be measured regularly and used as a guide for further tuning as necessary. KPIs should measure performance for the extended supply chain i.e. deliveries from suppliers and transporters, and

the KPIs should measure performance for the internal supply chain both for D&W and O&M. I have in this paper listed some KPIs which could be used in this connection.

- On Time In Full purchase order deliveries (see 6.5.3)

- Materials stored in the Hold area at the supply bases (see 6.5.6)

- Number of supply boat voyages (see 7.2.3.1)

- Re-planning of work orders in per cent (see 6.5.2)

- Number of CCUs in the Statoil internal supply chain (not previously mentioned)

These are some examples of KPIs to use. To ensure a relevant range of KPIs are selected involved stakeholders in the supply chain should be included in the selection process.

9. Conclusions

The intention with this master thesis has been to recommend to Statoil a set of high level functional requirements to a future operational planning and execution Logistics Information System. The contextual framework on one hand is the complexity facing the supply chain on the NCS where the company must have a robust and sustainable supply chain to satisfy the demands for the offshore operations on a 24/7 basis. On the other hand the oil and gas business is facing a dramatic fall in the oil prices, and the industry has to cut costs as a consequence of this changing business scenario. As the majority of Statoil's total expenditures come from supplier activities, it is of vital importance that all relevant actors in the business make their contributions to bring the costs for the industry to a competitive level.

One perspective for the study has been to collect information in order to describe and analyze the current supply chain scenario for Statoil on the NCS and to understand if the current extended supply chain for Statoil on the NCS offers a real-time visibility of materials and equipment. The second perspective has been to gain knowledge on the current best practice for Logistics Information Systems in the oil and gas industry. The third and last focus has been to recommend high level functional requirements for Statoil on a future operational planning and execution Logistics Information System. During the approach to the research problem I have presented relevant theory which has been used as a framework for the further work. The theory and the collected information has been the basis for the analysis and discussions which in turn has led to the conclusion to each of the research questions.

Research Question 1:
To what extent do the current Statoil internal and the extended supply chain offer real-time visibility on the NCS?

My main conclusion for research question 1 is that **there is no default true real-time information available for the actors in the extended supply chain**. There is no interface between Statoil and non-Statoil supply chain systems. Statoil has limited visibility for materials/equipment in the extended part of the supply chain. The suppliers have limited visibility of their equipment in the Statoil internal supply chain. Once equipment on its way from a supplier to an offshore installation has arrived to the supply base and thus is in the Statoil internal part of the supply chain, Statoil has visibility through the functionality present in SAP. The Statoil internal visibility is somewhat fragmented. The actors in the

extended supply chain regularly compensate for lack of real-time information through the use of manual resources like e-mails, phone calls, meetings and extra manpower.

I have also identified that there is no consistent use of master data for equipment in Statoil and between Statoil and suppliers. This type of distorted information results in use of extra manual efforts for the planning and execution along the supply chain.

Research Question 2:

What is the current trend among peers in the oil and gas sector in relation to Logistics Information Systems?

The intention with research question 2 was to gain a high level understanding of the current development for Logistics Information Systems from some of the actors in the oil and gas industry. The information collected reveals that **several companies are working with different solutions to increase the visibility through the use of real-time information for the extended supply chain**.

Research Question 3:

What are the requirements for a Logistic Information System at Statoil?

Academia has for decades prescribed increased visibility in the supply chain to be a remedy to fight inefficiencies in the supply chain and to excel the performance. EPIM has estimated the increased efficiency of an implementation of ELH to be up to 25 per cent. It is a **recommendation to increase the visibility in the extended supply chain and make use of the momentum available through the ongoing ELH and the Statoil internal Event Management project**. A sketch to a model for information sharing in the extended supply chain is proposed along with events and information elements and documents. A prerequisite for Statoil to capitalize on a projected increased visibility of goods is to have in place an internal operational planning and execution Logistics Information System. As part of a business case Statoil should evaluate how the features of the existing Logistics Information System can be utilized and be a part of the future system. The requirements for such a Logistics Information System ought to be calibrated towards the ELH requirements to ensure consistency between the different set of requirements. Further analysis is recommended for Statoil to be able to decide on how to use automatic data capture in the internal supply chain. In relation to a potential implementation Statoil is recommended to consider using the management by exception

principle to effectively manage the flow of information and goods through the supply chain. A potential risk for a future implementation is related to the on-boarding of transporters and suppliers in the supply network. To elevate the performance in the supply chain following the implementation of an event management solution for the extended supply chain, it is a critical success factor that the major business partners have accepted to join the network.

Abbreviations

3PL	Third Party Logistics providers
ARIS	A business process analysis platform software and not really an abbreviation
ASN	Advanced Shipping Notification
B2B	Business to Business
CAPEX	Capital Expenditure
CCB	Coast Center Base
CCU	Cargo Carrying Unit
DDR	Daily Drilling Report
DPI	Development and Production International
DPN	Development and Production Norway
DPNA	Development and Production North America
DSP	Drilling Supply Portal
DSR	Drilling Supply Responsible
D&W	Drilling and Well
eBOB	elektronisk Boring og Brønn
EDI	Electronic Data Interchange
ELH	EPIM LogisticsHub
EPIM	Exploration & Production Information Management Association
ERP	Enterprise Resource Planning
EXP	Exploration
FCA	Free Carrier

GPS   Global Positioning System

GR   Goods Receipt

GRN   Goods Received Note

GSB   Global Strategy and Business Development

HSE   Health Safety and Environment

KPI   Key Performance Indicator

LPS   Logistic Planning System

MMT   Material Movement Ticket

MPR   Marketing, Processing and Renewable Energy

MRP   Material Requirement Planning

NCS   Norwegian Continental Shelf

NFR   Non-Functional Requirements

NORSOK   Norsk sokkels konkurranseposisjon

OCR   Optical Character Recognition

OCTG   Oil Country Tubular Goods

OE   Organisational Efficiency

OMC   Order Management Cycle

O&M   Operations and Maintenance

OTIF   On Time In Full

PDA   Portable Data Assistant

PO   Purchase Order

PETEC   Petroleum Technology

PRT   Production Resource Tools

RFID   Radio Frequency Identification

RFQ   Request For Quotation

SCM   Supply Chain Management

STEP   Statoil Technical Efficiency Program

TPD   Technology, Projects and Drilling

VMI   Vendor Managed Inventory

VTMIS   Vessel Traffic Management Information System

WELS   Wellit Logistics System

WO   Work Order

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10. Appendices

10.1. Appendix A Statoil organization chart

Organisation chart

Statoil consists of seven business areas, staff and support divisions and corporate communication.

			Eldar Sætre			
			CEO			
			Stavanger			

Randi Grung Olsen	Torgrim Reitan	Hans Henrik Klouman	Reidar Gjærum	Jannicke Hilland	Magne Hovden	Anders Opedal
Corporate audit (COA)	CFO organisation (CFO)	Legal (LEG)	Corporate communication (CCOM)	Corporate Safety and Security (CSS)	Corporate people and organisation (Corporate PO)	Chief Operating Officer
Stavanger	Stavanger	Stavanger	Oslo	Stavanger	Stavanger	Stavanger

Arne Sigve Nylund	Lars Christian Bacher	William Maloney	Tor Martin Anfinnsen	Margareth Øvrum	Tim Dodson	John Knight
Development and Production Norway (DPN)	Development and Production International (DPI)	Development and Production North America (DPNA)	Marketing, Processing and Renewable Energy (MPR)	Technology, Projects and Drilling (TPD)	Exploration (EXP)	Global Strategy and Business Development (GSB)
Stavanger	Oslo	Houston	Stavanger	Stavanger	Oslo	London

Source: Statoil internal

10.2. Appendix B Staple yourself to an order – Drilling & Well

Introduction

The intention with this appendix is to outline the findings I registered during the period I followed the D&W order. Reference is also made to the theoretical frame in section 4.6 and section 6.4 summarizing the findings from the close monitoring of the D&W order I followed. I did not follow the order physically along the supply chain, but I followed it through the coordinating function of the DSR through the whole process. I used normal methods the DSR use to follow preparations and tracking through the supply chain. Normal methods are e-mail, phone, physical meetings, SAP (LPS/ZPSLL and VTMIS).

The following 10 amended steps have been used to follow the order:

Order planning – A rolling 60 days plan for the drilling program on the offshore installations is updated on a weekly basis. Each well to be drilled has a separate drilling program for the regarded wells. The 60 days plan and the drilling program are frames for the progress and Project Planner is basis for the order generation.

Order generation – The DSP number raised for the jobs

Cost estimation – cost estimation and pricing

Transport of goods from supplier to the supply base – follow the shipment

Delivery at the supply base – follow the shipment

Shipment from supply base to offshore installation and receipt at offshore installation – follow the shipment

Return shipment from offshore installation to the supply base – follow the shipment

Receipt and handling at the supply base – follow the shipment

Return transport of goods from supply base to supplier – follow the shipment

Billing – follow the invoice process

I stapled myself to the D&W DSP 9021694 and the shipment of a Hydraulic Pulling Tool - purchase order 4503249970

I decided to staple myself to the transportation of a hydraulic pulling tool which was going to be shipped from the supplier premises at Tananger to Statfjord A. The shipment should be picked up by Bring at Tananger, and Bring should transport the equipment by road to the supply base Coast Center Base (CCB) at Ågotnes where it should be received. The equipment should then go by supply boat to Statfjord A. After use the equipment should be returned the same route via CCB to Tananger.

Order planning

The transport of the equipment was related to the drilling program "Activity Program for Permanent Plug and Abandon" – well NO33/9-A-8C which contains the design of the job and the corresponding plan. This drilling program was established to perform a job to plug and abandon a well. This required equipment as well as skilled persons. The persons were already located offshore and there was no need to coordinate transportation of skilled persons and equipment in order to minimize the total costs for the job to be performed.

Order generation

The job was part of an activity in the DSP number 9021694 which was generated in SAP 8 December 2014. This DSP was the basis for the ordering of materials and services to perform the job. The rental of this equipment was part of a framework agreement with the supplier, but this tool was outside the agreed price list. Statoil received for this reason a quote specifying the cost for the rental of the tool. The requisition number was 1003442397/180 and the corresponding purchase order number for the rental was 4503249970. There was no service number or material number in SAP for this purchase order as it was outside the agreed price list for the framework agreement.

Cost estimation

Statoil received a quote specifying the cost for the rental of the tool. This is confidential information and not revealed in this paper.

Transport of goods from supplier to the supply base

There was a dialogue between the DSR and the supplier in advance. The first e-mail in relation to the transport of the equipment was from 2 June 2015. Correspondence from the DSR to the supplier dated 2 June requested the equipment to be available at CCB 3 June 10.00 AM. The intention was that the equipment should depart on a supply boat from CCB the same day 18.00 PM. The subject equipment

was on rental, and this was not within the deadline for routine transportation. The DSR communicated by phone with CCB and raised a B-priority (number 45159) on CCB to ensure a smooth reception and loading on the supply boat the same afternoon. The equipment was prepared at the supplier premises during 3 June and was scheduled to be shipped in CCUs with ID's: CBQB001 (14 meter basket), S-81476 (14 meter basket) and CBXN026 (16 meter basket). After the work shop had finished the preparations and the CCUs were ready to be shipped, the supplier logistics department was informed. The logistics department prepared the shipping documents 3 June and booked Bring to transport the equipment from Tananger to CCB as an express transport.

The supplier booked through an e-mail Bring to transport the CCU from Tananger to Central Coast Base (CCB) at Ågotnes where the equipment was supposed to be delivered at the supply base. The CCUs were scheduled to be shipped further from CCB to the installation Statfjord A with a supply boat departing from CCB Wednesday 3 June 18.00 PM. The DSR also received a copy of this e-mail to Bring.

Comments:

Tracking: The telephone number to the driver was available for the involved parties

The shipping details:

Destination: Statoil, Statfjord A, A-8C   *CCU ID*: CBQB001 - 14 meter basket, 8 500 kg

                                               S-81476   - 14 meter basket, 8 000 kg

                                               CBXN026 - 16 meter basket, 10 000 kg

Tracking number: 2015/1589   *To be delivered*: CCB 3 June 2015 17.00 PM

The hydraulic pulling tool consists of several parts, and the supplier delivery ticket for the hydraulic pulling tool lists each of the individuals which are identified through unique serial numbers. No material numbers are listed in the delivery note. It is not common to identify serial numbers for parts and components for D&W agreements in SAP. The free text description in the purchase order in combination with the CCU id numbers was for this reason used to track the tool during the transportation from supplier to Statfjord A and back to the supplier again.

The DSR received an e-mail from the supplier containing the shipment documents at 13.14 PM and entered the shipping documents as an attachment to the correct line in the LPS. The red light on the right hand side in Figure 10.2.1 indicates that the shipment has not been received at the supply base.

Figure 10.2.1 Line in LPS illustrating the attached shipping documents and status of shipment

Source: Statoil internal, LPS

Bring picked up the CCUs and departed from Tananger about 14.00 PM. The mobile telephone number to the driver of the Bring lorry was available for the involved parties if required – for ad hoc monitoring if required. A revised scheduled arrival to CCB given a delayed departure was now 19.00.

Delivery at the supply base

The CCUs were delivered at Bergen Base at Ågotnes before 19.00 PM 03 June. The 3 CCUs were scheduled (Figure 10.2.2) to be loaded on the supply boat Skandi Mongstad (voyage 82718 in VTMIS) with original scheduled departure 18.00 PM.

Figure 10.2.2 Scheduled route for voyage 83718 – Skandi Mongstad

Source: Statoil internal, VTMIS

The boat had to wait for the lorry with the prioritized hydraulic pulling tool. At 19.28 PM I registered in VTMIS that the CCUs had been registered on the regarded voyage.

The receipts of the CCUs were not reflected in the LPS until the next morning. The CCUs were however manifested from CCB to Statfjord A on voyage 83718 with the supply boat Skandi Mongstad as scheduled. The boat departed 3 June 20.05 PM.

Outbound delivery number 139417483 and shipment number 519041 was displayed in the LPS the following morning. The DSR was in contact with the base in the morning 4 June and the supply base updated the lines in LPS with a green light (Figure 10.2.3) confirming that the equipment was received at CCB in the evening of 3 June.

Figure 10.2.3 Green light indicating the equipment has been received at the supply base

Source: Statoil internal, LPS

The estimated shipment delivery date and time at Statfjord A was in LPS registered to be 4 June 16.06 PM (Figure 10.2.4). The estimated delivery time was later in the day postponed several times and the latest registered estimate was 19.16 PM.

Figure 10.2.4 Estimated delivery date and time for the equipment at Statfjord A

Source: Statoil internal, LPS

Shipment from supply base to offshore installation and receipt at offshore installation

Figure 10.2.5 gives an overview of the different voyages in VTMIS per 04 June 13.00 PM. Voyage number 83718 was the one I followed as the supply boat Skandi Mongstad had Statfjord A as one of the destinations on the route. Statfjord A as a destination had been moved forward as an early destination on the route due to the urgency for the regarded equipment.

Figure 10.2.5 Voyages in VTMIS per 4 June 13.00 PM

Source: Statoil internal, VTMIS

Figure 10.2.6 is another print screen from VTMIS 05 June at 07.06 AM where shipment 519041 has been received at Statfjord A 5 June 00.06 AM.

Figure 10.2.6 Delivery details for the voyage from CCB to Statfjord A

Source: Statoil internal, VTMIS

It was possible to track the CCUs in SAP and it was possible to check that the CCUs had been received at Statfjord A per 05 June. The date and time for the last line in Figure 10.2.7 indicate that the regarded CCU was received at that time.

Figure 10.2.7 Transaction history in SAP for CCU ID S-81476

Offshore logsitics container history

Container S-81476 - S-81476

C	Container ID	Name	Key date	Start date	Start time	End date	End time	Shipment
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		05.06.2014	00:00:00	26.06.2014	08:14:00	468253
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		26.06.2014	08:14:00	01.07.2014	07:09:00	474037
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		01.07.2014	07:09:00	15.07.2014	17:34:00	474137
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		15.07.2014	17:34:00	17.07.2014	06:21:00	475461
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		17.07.2014	06:21:00	16.10.2014	06:21:00	475948
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		16.10.2014	06:21:00	14.11.2014	06:21:00	475948
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		14.11.2014	06:21:00	18.03.2015	17:48:00	475948
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		18.03.2015	17:48:00	24.03.2015	07:52:00	508334
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		24.03.2015	07:52:00	05.06.2015	00:05:00	509166
1	S-81476	14.1mtr/46ft Offsho@BAKER HUGHES BUSINESS SUP.SERV		05.06.2015	00:05:00	05.06.2015	23:59:59	519041

Source: Statoil internal, VTMIS

The arrival of the tool was confirmed by the offshore crew in the following morning meeting.

A supplier employee on the offshore installation in need of the equipment should make a transfer of the equipment in the supplier ERP-system to reflect the location of their equipment. This should give the supplier a confirmation that the equipment was located on Statfjord A.

Return shipment from offshore installation to the supply base

This equipment was decided to be returned 05 June. The equipment was prepared for shipment by the offshore material coordinator. Return document 500667278 was created (Figure 10.2.8).

Figure 10.2.8 Return document 500667278 for the CCUs
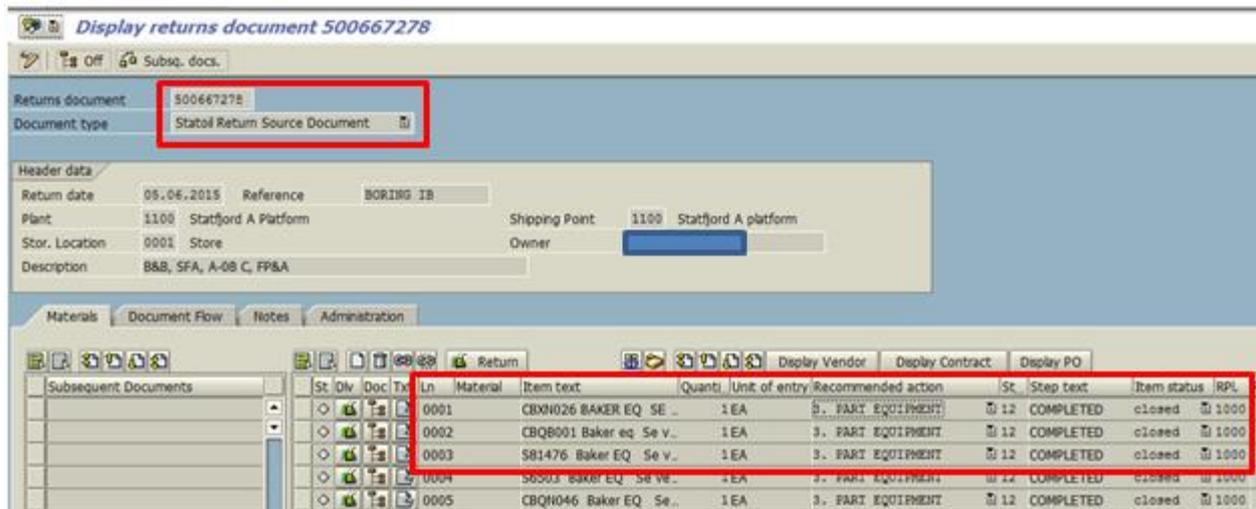
Source: Statoil internal, VTMIS

The material coordinator registered the shipment for the supply boat Blue Queen on voyage 83712 which should arrive at Statfjord A for loading 05 June in the evening.

Figure 10.2.9 Actual departure times from Statfjord A for the supply boat Blue Queen on voyage 83712
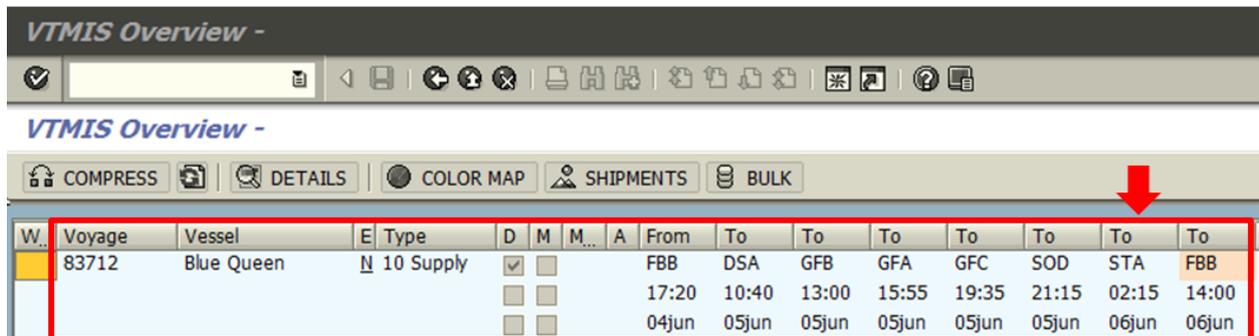
Source: Statoil internal, VTMIS

Blue Queen departed from Statfjord A 06 June 02.15 AM (Figure 10.2.9) as depicted in VTMIS. The 3 CCUs containing the equipment to be followed was registered on this shipment (Figure 10.2.10).

Figure 10.2.10 Monitored CCUs listed as part of shipment to voyage 83712 on its way from Statfjord A to CCB

Load/unload	HU	Company	Material	HU Contents	HU Gr1	HU Gr2	Length	Width Σ	Footprint Σ	Total weight of HU
LOAD	KA925	Swire Oilfield Services AS, Tananger	00005095	Halliburton swages og Setting tool	DRILL		2,991	2,438	7,292	3,400
	NSK-1081			Chiksan Kontainer Halliburton	DRILL		2,990	2,435	7,281	5,800
	CBR140	Swire Oilfield Services AS, Tananger	00103049	Tom	PROD		6,268	1,198	7,509	2,000
	CBS212	Swire Oilfield Services AS, Tananger	00103050	Klemme + Ventil C-Seksjon SFA	DRILL		8,268	1,198	9,905	3,400
	40-074	Swire Oilfield Services AS, Tananger	00103108	Tom (SI4142)	DRILL		2,300	2,300	5,290	2,500
	THSA131	Swire Oilfield Services AS, Tananger		Tom Meg	DRILL		2,750	1,850	5,088	2,700
	THSA305	Swire Oilfield Services AS, Tananger		Tom WT-1099	PROD		2,750	1,850	5,088	2,700
	THSA451	Swire Oilfield Services AS, Tananger		Tom (Sodium Chloride Brine)	DRILL		2,750	1,850	5,088	2,700
	THSA652	Swire Oilfield Services AS, Tananger		Tom (SI4142)	DRILL		2,750	1,850	5,088	2,700
	THSA880	Swire Oilfield Services AS, Tananger		Tom(SI-4142)	DRILL		2,750	1,850	5,088	2,700
	THSA947	Swire Oilfield Services AS, Tananger		Tom (SI4142)	DRILL		2,750	1,850	5,088	2,700
	AMD3538	Swire Oilfield Services AS, Tananger	00155686	Rut's retur	PROD		1,595	1,868	2,979	2,100
	AMN196	Swire Oilfield Services AS, Tananger		Dagens Varer	PROD		1,590	1,856	2,951	2,400
	CBXN026	Swire Oilfield Services AS, Tananger	00196444	BAKER TUBULARS	DRILL		16,260	1,190	19,349	9,000
	CBQB001	Swire Oilfield Services AS, Tananger	00250254	BAKER TUBULARS	DRILL		14,190	1,160	16,460	9,300
	S-81476	Swire Oilfield Services AS, Tananger		BAKER TUBULARS	DRILL		14,190	1,160	16,460	8,300
	THSA1508	Swire Oilfield Services AS, Tananger	00384083	Tom_SI4142	DRILL		2,750	1,850	5,088	2,700
	THSA278	Swire Oilfield Services AS, Tananger		Tom (Sodium Chloride Brine)	DRILL		2,750	1,850	5,088	2,700
	THSA380	Swire Oilfield Services AS, Tananger		Tom (SI4142)	DRILL		2,750	1,850	5,088	2,700
	F535	Swire Oilfield Services AS, Tananger	00390331	tom	PROD		2,718	1,798	4,887	2,500
	FR238	Swire Oilfield Services AS, Tananger		tom	PROD		3,038	2,096	6,368	3,100
	S-6503	Swire Oilfield Services AS, Tananger	00487514	BAKER CUTTING EQ	DRILL		5,300	0,815	4,320	1,800
LOAD									▪ 156,843 ▪	79,900
									▪▪ 156,84... ▪▪	79,900

Source: Statoil internal, VTMIS

Receipt and handling at the supply base

Blue Queen arrived CCB 06 June 14.00 PM, and the CCUs should be unloaded and placed in the back-load area. According to the supply base person on duty the unloading from the supply boat started immediately after. The persons working with back-loads at CCB should verify the equipment on Sunday 07 June and prepare for Bring to collect and transport back to the supplier. Figure 10.2.11 illustrates that all 3 CCUs have been fully received at the supply base.

Figure 10.2.11 The shipment status report for the regarded CCUs

Source: Statoil internal, VTMIS

Through the return document number 500667278 for the regarded CCUs I was able to identify that the CCUs were registered in SAP as collected by Bring at 14:52 PM 8 June 2015 (Figure 10.2.12). The number for the bill of lading was 70713750113656525.

Figure 10.2.12 Pick up details at the supply base for CCUs on their way back to the supplier premises
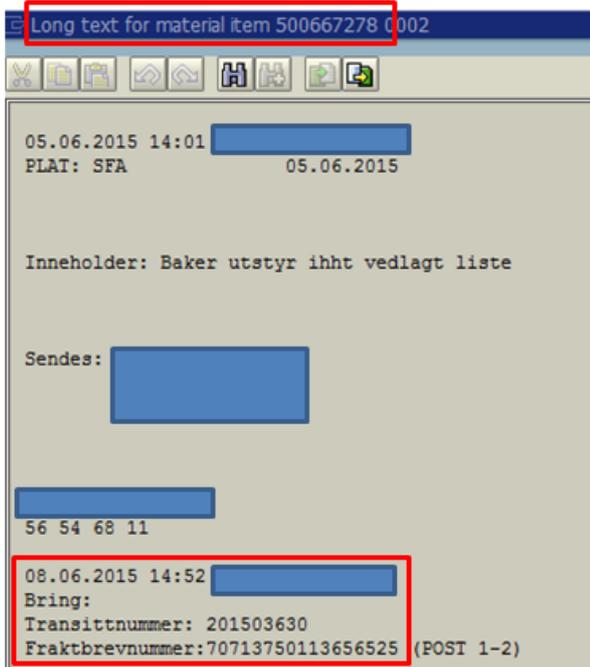
Source: Statoil internal, SAP

The spreadsheet in Figure 10.2.13 is available in SAP and shows the content of the regarded CCUs in different tabs.

Figure 10.2.13 Content of selected CCUs

Source: Statoil internal, SAP

Return transport of goods from supply base to supplier

When the CCUs were on their way from the supply base to the supplier, the available tracking should be available through the Bring MINe. I was unable to track the relevant bill of lading number 70713750113656525 with my Statoil MINe user profile, and the explanation was that the supplier was responsible for the transport from the supply base to the supplier premises. The default access to tracking information is limited to the company responsible for the transport.

Billing

The Service Entry was done in SAP 12 June 2015 with reference number 1007961521. The supplier invoice was dated 15 June 2015 and was in line with quotation received. A comment from an

attachment in the invoice mentions that it takes time to check the invoice against the different lines in the DSP. The comment refers to the fact that there is no alignment of master data identification numbers between the supplier and Statoil.

10.3. Appendix C Staple yourself to an order – Operations & Maintenance

Introduction

I have used the 10 steps adjusted to our scenario also for O&M.

For the close monitoring of the O&M OMC the intention was to staple myself to the order and tracking this from the perspective of a SCM coordinator. I did not follow the order physically but was monitoring it closely through SAP during the process. I used the standard means to follow the preparations and tracking through the supply chain.

I stapled myself to the O&M work order 23369294 and the shipment of a Hydraulic Valve - purchase order 4503252026

I decided to staple myself to the transportation of a hydraulic valve which was going to be shipped from the supplier premises at Sola to Statfjord A. The shipment should be picked up by Bring at Sola, and Bring should transport the equipment by road to the supply base Coast Center Base (CCB) at Ågotnes where it should be received and shipped to the Statoil platform Statfjord A.

Order planning

A hydraulic valve was requested for corrective maintenance to Statfjord A on work order 23369294 dated 05 April 2015.

Order generation

Purchase Requisition 1003453643 to source the valve was raised as a free text item 11 May 2015. A Request For Quotation (RFQ) was released by a purchaser 16 June 2015. No part was ordered at this stage. The work order status per 7 June is illustrated in Figure 10.3.1.

Figure 10.3.1 The work order status in SAP Sunday 7 June

Source: Statoil internal, Material Tracking – PM order

Purchase order 4503252026 was then released 08 June 2015 to source the hydraulic valve. The lead time was 2-3 weeks from order date.

Cost estimation

Statoil received a quote specifying the cost for the hydraulic valve. This is confidential information and not revealed in this paper.

Transport of goods from supplier to the supply base

The supplier was located in the Stavanger area, and the delivery address on the purchase order was the supply Coast Center Base (CCB) at Ågotnes. The order for the transport from the Stavanger area to the supply base at Ågotnes was the responsibility of the supplier according to the purchase order. The Incoterms on the purchase order was FCA Sola.

There was no requirement in the purchase order that Statoil should be informed about the transportation. Statoil did for this reason not get any information from the supplier up front about when the valve should be picked up by Bring and transported from the supplier facility to the supply base. The supplier confirmed that they did not give any information about shipping details to Statoil as this was not requested at this occasion.

To chase purchase orders not delivered in accordance with agreed delivery dates the purchaser normally runs a report in SAP on a weekly basis listing purchase orders with overdue delivery times. The overdue purchase orders are then chased. The purchasers generally have a more pro-active approach for follow-up on prioritized purchase orders.

Delivery at the supply base

The hydraulic valve was delivered at Ågotnes, and a Goods Receipt (GR) was created for the hydraulic valve in SAP 7 July 2015 (Figure 10.3.2).

Figure 10.3.2 Purchase order status per 10 July 2015
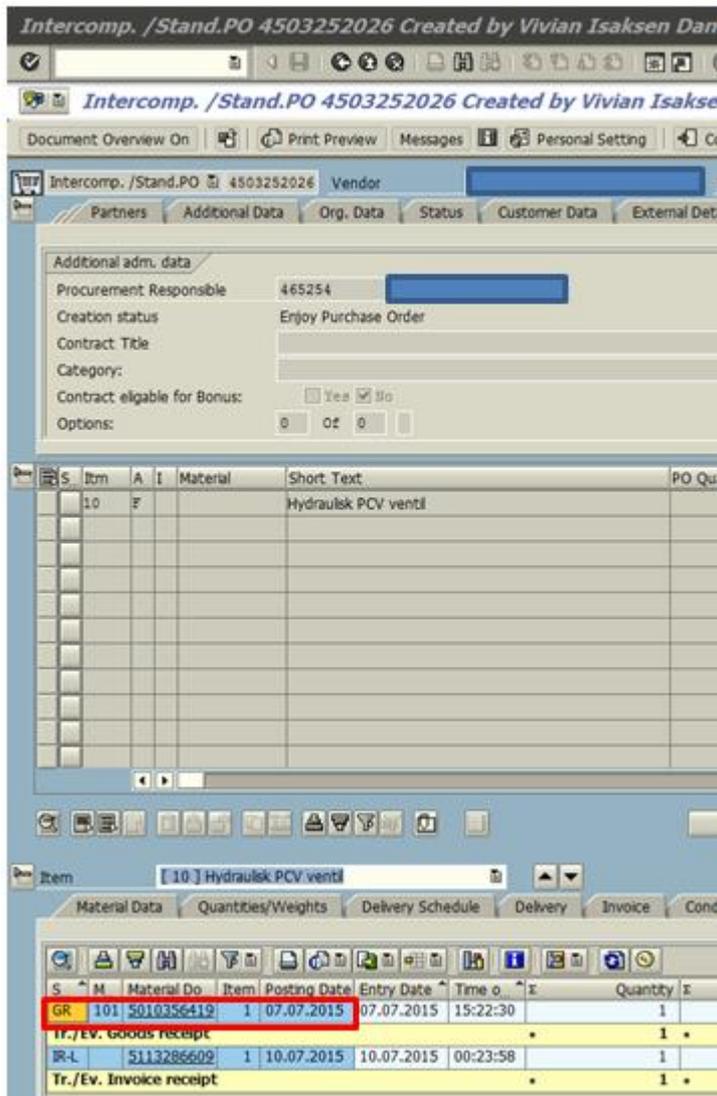
Source: Statoil internal, SAP - purchase order

After the Goods Receipt at Ågotnes the hydraulic valve was placed on a Hold area at the supply base to wait for further shipment to Statfjord A (Figure 10.3.3).

Figure 10.3.3 The Valve is still in the Holding area per 17 July 13.00 PM

Source: Statoil internal, Material Tracking – PM order

Shipment from supply base to offshore installation and receipt at offshore installation

The work order was scheduled to be started early August 2015, and the hydraulic valve was scheduled to be transported from Ågotnes to Statfjord A in due time. The valve was scheduled for shipment 525648 in CCU number AMD2990 which was registered departed from the supply base 29 July 15.18 PM. The Shipment is registered as ended in VTMIS 31 July 10.15 AM (Figure 10.3.4).

Figure 10.3.4 Status of the shipment in SAP per 31 July

Source: Statoil internal, VTMIS

The CCU number AMD2990 is listed in the shipment in VTMIS to have arrived at the installation 31 July 10.15 AM (Figure 10.3.5).

Figure 10.3.5 Offshore logistics container history in SAP

C	Container ID	Name	Key date	Start date	Start time	End date	End time	Shipment
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		08.10.2014	07:08:00	14.10.2014	08:14:00	488067
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		14.10.2014	08:14:00	15.10.2014	15:37:00	488445
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		15.10.2014	15:37:00	26.12.2014	11:41:00	489326
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		26.12.2014	11:41:00	30.12.2014	08:26:00	497128
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		30.12.2014	08:26:00	13.01.2015	12:42:00	498262
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		13.01.2015	12:42:00	18.01.2015	15:39:00	500103
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		18.01.2015	15:39:00	24.01.2015	12:18:00	500525
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		24.01.2015	12:18:00	01.02.2015	16:56:00	501047
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		01.02.2015	16:56:00	04.02.2015	11:43:00	501822
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		04.02.2015	11:43:00	25.03.2015	10:31:00	502913
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		25.03.2015	10:31:00	28.03.2015	08:14:00	508862
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		28.03.2015	08:14:00	02.04.2015	11:44:00	509440
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		02.04.2015	11:44:00	08.04.2015	07:05:00	510940
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		08.04.2015	07:05:00	12.04.2015	07:20:00	511328
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		12.04.2015	07:20:00	16.04.2015	08:48:00	511855
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		16.04.2015	08:48:00	22.04.2015	08:15:00	512641
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		22.04.2015	08:15:00	24.04.2015	07:00:00	512620
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		24.04.2015	07:00:00	02.05.2015	16:17:00	512738
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		02.05.2015	16:17:00	11.05.2015	07:38:00	514271
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		11.05.2015	07:38:00	15.05.2015	13:44:00	515616
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		15.05.2015	13:44:00	08.06.2015	12:55:00	515661
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		08.06.2015	12:55:00	09.07.2015	12:55:00	519402
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		09.07.2015	12:55:00	24.07.2015	14:51:00	519402
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		24.07.2015	14:51:00	27.07.2015	11:31:00	524869
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		27.07.2015	11:31:00	31.07.2015	10:15:00	525925
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		31.07.2015	10:15:00	06.08.2015	12:31:00	525648
1	AMD2990	Mini Offshore Container@STATOIL AGOTNES		06.08.2015	12:31:00	14.08.2015	23:59:59	526572

Source: Statoil internal, VTMIS

The hydraulic valve did arrive in due time for the scheduled start of 3 August for the job on work order 23369294. The work order status in SAP per 14 August illustrates the valve is delivered to the final destination through the green lights and status "Shipped, received offshore" (Figure 10.3.6).

Figure 10.3.6 The work order status in SAP per 14 August 2015

Source: Statoil internal, Material Tracking – PM order

This concludes the transportation as there is no return transportation linked to the work order and purchase order.

Return shipment from offshore installation to the supply base

No part was being returned – not possible to identify if a part was returned.

Receipt and handling at the supply base

No part was being returned – not possible to identify if a part was returned.

Return transport of goods from supply base to supplier

No part was being returned – not possible to identify if a part was returned.

Billing

The Goods Receipt was done in SAP 7 July 2015 with reference number 5010356419. The supplier invoice was dated 06 July 2015 and was in line with quotation received.