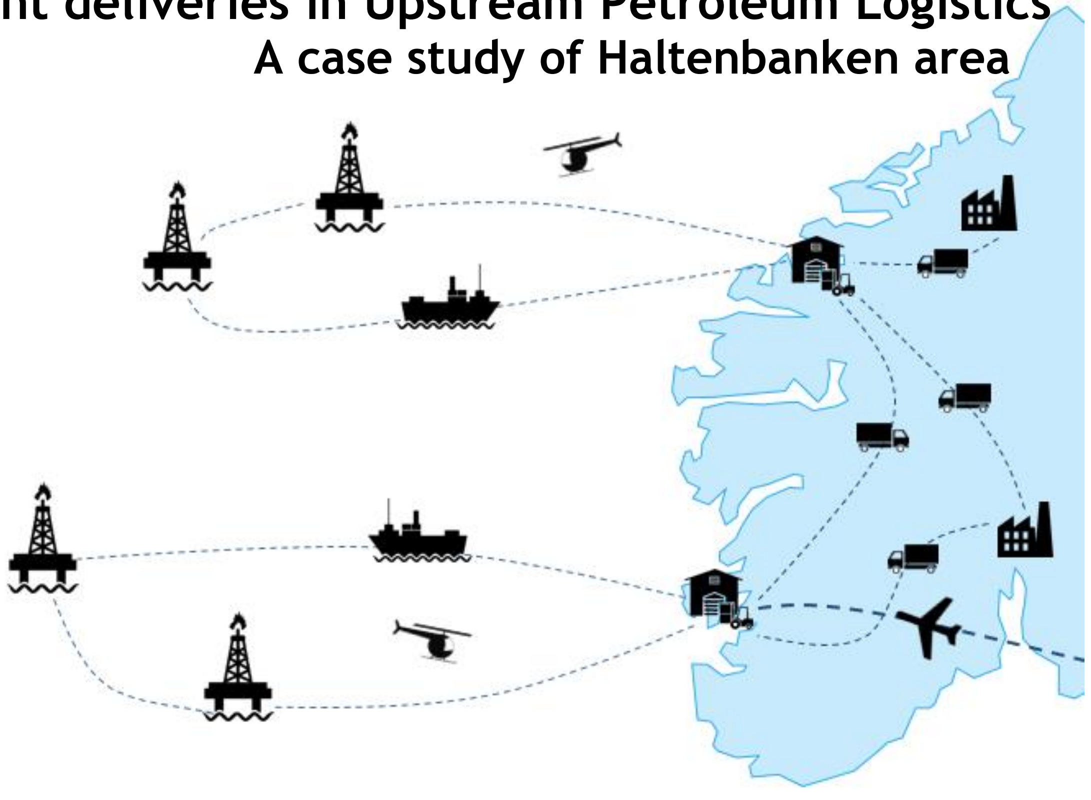
Master’s degree thesis

LOG950 Logistics

Analysis of urgent deliveries in Upstream Petroleum Logistics
A case study of Haltenbanken area



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Number of pages including this page: 198

Molde, 24.05.2016

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Foreword and Acknowledgements

This master thesis is the final mandatory part of the Master of Science in Logistics program at Molde University College - Specialized University in Logistics. The research work was carried out between December 2015 and May 2016 and has been conducted in order to obtain an MSc degree in Logistics.

We would like to thank our supervisor, Bjørnar Aas. Your knowledge, experience and honest feedback have been an extremely useful resource during this spring, and for that we are truly grateful. We would also like to thank Per Engelseth for introducing us to this topic. More thank you is in order to our contact points and interviewees Erik Gjul, Marit Tomelthy, Monica Bjerkelund, Kurt Monge, Kathrine Sørvik, Gunnar Settemsdal, Runar Olsen, Marius Nordli, Kurt Arve Trang, Ole Kristian Blindheim, Rolf Flatset, Lill Anita Lervag, Florian Zihlm Aresvik, Wenche Hild Sandnes, Eivind Gjøstøl, Kjell Arne Rød, Ola Heggem, Rune Andre Bjørkevoll, Inge Edverd Krohn, Geir Morten and Trond Crilly for their open-minded acceptance of two master students. This master's thesis could not have been possible without the valuable information, experience and thoughts they have shared with us during our interviews. We would also like to thank all the other contacts that have helped forward our email in the right direction or directed us to the right person during our phone conversations.

And last but not least, we would like to thank Jim for the lasagna.

Molde, May 2016
Kristanna Anderson and Luiza Oancea

Abstract

This master's thesis analyses urgent deliveries in the upstream oil and gas industry in the Haltenbanken area of the Norwegian continental shelf. More specifically, it seeks to discuss how different companies perceive and handle urgent deliveries and what can be done to improve the situation. This is done through answering six research questions: (1) how companies handle urgent deliveries and how suitable the supply network is for the task; (2) what the causes and consequences are; (3) how the information flow and use of information systems impact urgent deliveries and what can be done to improve the situation; (4) how purchasing strategy impacts urgent deliveries; (5) how planning impacts urgent deliveries and what represents better planning; and (6) what can be done to handle urgent deliveries more efficiently.

This thesis is an explorative study where the objective is to provide a better understanding of the urgent delivery concept in UPL and the factors that can have an impact, since research in this field is scarce. To help with this task, three theoretical concepts are discussed: information flow and information systems, planning, and purchasing strategy. Moreover, additional literature in the field of emergency logistics, express deliveries and spare parts is analyzed. Accordingly, an empirical study is conducted using an embedded single-case study through applying a general interview guide to 15 different companies.

The thesis proposes a definition of urgent deliveries in UPL context and finds that urgent deliveries are usually generated from the operator side, but their efficient handling is a supply network effort, in which the information flow and physical flow are equally important. Urgent deliveries can be caused by uncertainty, but there are preventable causes as well, so there is room for improvement. The main consequence of urgent deliveries is represented by higher costs for the operators, but it can mean good business for some suppliers or even a chance to gain competitive advantage. Moreover, the study finds that the efficiency of handling urgent deliveries is derived from the strategic and tactical decisions taken at a higher level in regards to workflow procedures, purchasing strategy, information systems, planning strategy and supply chain strategy.

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List of Abbreviations

3PL	Third-Party Logistics provider
CCU	Cargo Container Unit
CSF	Critical Success Factor
DN	Delivery Note
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FA	Frame Agreement
GDP	Gross Domestic Product
GPS	Global Positioning System
HSE	Health, Safety and Environment
ICT	Information and Communication Technology
IO	Integrated Operation
IPL	Integrated Planning and Logistics
IS	Information System
ISS	Insulation, Scaffolding and Surface Treatment
IT	Information Technology
KPI	Key Performance Indicator
MMO	Modifications, Maintenance and Operations
NCS	Norwegian Continental Shelf
NDT	Non-destructive Testing
NPD	Norwegian Petroleum Directorate
OCTG	Oil Country Tubular Goods
PO	Purchase Order
RFID	Radio-Frequency IDentification
SDFI	State's Direct Financial Interest
sm^3 o.e.	Standard cubic meters of oil equivalent
UPL	Upstream Petroleum Logistics
VAN	Value-Added Network

PART I: INTRODUCTION AND RESEARCH METHODOLOGY

1 Introduction

1.1 Background of the research

The oil and natural gas industry is one of the world's biggest industries. Its revenues are large, as are the costs of providing consumers with the energy they need. Norway is in the top ten exporters of oil, so the petroleum industry is vital for the country (reference see 7.4)

A challenge is that the costs in the petroleum industry are very high. Norway is a high-cost country and these costs are apparent in high salaries, high use of expensive consultants, coincidental purchasing, high transportation costs, high maintenance costs, etc. The culture in the oil and gas industry has been "it doesn't matter what it costs, I need it!" (Engelseth, Løkås, et al. 2014). This was not a problem before, but right now, because of the low oil prices (see 7.5), the high costs represent a big problem. So the question is how can the petroleum industry reduce the costs and increase operational efficiency?

In his paper, Per Engelseth (2014) details a discussion he had with the logistics coordinator of Statoil's Melkøya LNG plant, in which they deliberated the different logistical challenges involved. One of the issues that stood out were the urgent deliveries. The employees felt that they need to use urgent deliveries in order to avoid disruption of production, and that is not desirable since the transport of such supplies is significantly more expensive than shipments that may follow the normal transport route.

So it seems that a challenge in the logistics of the offshore petroleum industry might be waste associated with being responsive to highly uncertain demand. It is a very special case in petroleum logistics, since you cannot find the peculiarities of this situation in many other industries. If an urgent product does not come as soon as possible, then the production stops, and that can represent a very high cost (at Melkøya the production stoppage is 50 million NOK/day (Engelseth, Løkås, et al. 2014)). Thus, the company is willing to spend a lot of money to get the missing equipment to the installations as soon as possible. Furthermore, any cost/benefit analysis will prove that it is much better to pay the price to get the urgent delivery. However, the price is not small. For instance, flights within Europe for big equipment are between two and three million NOK and transportation from the U.S. is up in nine million NOK. And these are definitely costs that would have been nice to save.

1.2 The importance of the research

A search on Oria or Google Scholar for a few keywords like “urgent deliveries”/“express deliveries” and “oil and gas industry”/“upstream petroleum logistics” reveals this topic as a relatively undeveloped research field. So a main motivating factor for us has been our wish to contribute to this research field by providing a better understanding of how urgent deliveries are handled by different companies in Norway, and connect these practices with some theoretical logistics concepts that could offer some sort of recommendation for how urgent deliveries should best be handled. Our hope is that this master’s thesis can be used by researchers as a starting point for further studies on this very interesting topic.

Moreover, because of the low oil price, there is a very big focus right now on reducing costs in the whole petroleum industry. Urgent deliveries generate extra costs, so by looking into why urgent deliveries exist and how they are handled we might uncover some potential savings that could benefit the whole industry.

1.3 Problem formulation

The purpose of our study is to provide a better understanding of the urgent delivery concept in UPL and the factors that can have an impact. Thus, the main research problem for this master’s thesis is:

How do different oil and oil service companies that operate in Haltenbanken area of NCS perceive and handle urgent deliveries and what can be done to improve the current situation?

The research questions are further detailed in the research methodology section (2.6)

1.4 Delimitations

Our study is limited to only include the upstream operations of oil and oil service companies, since this is the area where we believe urgent deliveries are used the most.

Our study is also limited to just one geographical area, and that is companies with local presence supplying the Haltenbanken area of the Norwegian Continental Shelf. We have chosen this area because of the close proximity to Molde University College. Kristiansund is only one hour away from Molde and that is where most of the companies operating in Haltenbanken area are located. It was important for us to have face-to-face interviews with representatives from the companies, since we believe we can have a more meaningful interview than if we had a telephone conversation. Moreover, after studying two years of mainly theory in Molde University College, we really wanted to go out there and see the different facilities (warehouse, supply base, workshop and offices) and thus gain a better understanding of the real world.

We believe that each geographic petroleum area has their particularities and if our study was done for companies operating in the North Sea area or the Barents Sea area then our findings might be quite different. The Barents Sea would face many challenges because of long distance for truck deliveries, still newly developed area and hard to locally source products. In addition, the weather in the Barents Sea would pose even more challenges than the area that we are analyzing in our study. The North Sea area, with a lot of activity happening around Stavanger and Bergen would also provide a different kind of study since there are a lot more installations out there, some of them quite old, but then again most of the oil and oil service companies have their main offices around there and they are in closer proximity to the source of most of their equipment.

2 Research Methodology

Research methodology refers to a discussion of the underlying reasoning why particular methods are used. By methods we refer to the technical steps taken to do research (F. Schneider 2014). This chapter will describe the research methodology used in the research of our thesis.

2.1 Research objective

According to Wacker (1998), there are two main objectives of research, depending on the purpose: (1) fact finding, which includes the building of a lexicon of facts gathered under specified conditions, stressing descriptive differences in data; or (2) theory building, which concerns itself with the search for subtle systematic similarities between data and aims at building an integrated body of knowledge. Theory building research makes predictions before evidence is gathered through data gathering. Fact finding research, on the other hand, does not give explanations beforehand, and uses data evidence to make theoretical predictions.

Our master thesis is based on certain theoretical predictions, and we took them into consideration when we built our interview guide. But, as we went through the results of our interviews, we could use some of the facts found in order to make theoretical predictions that we did not consider beforehand. In conclusion, the objective of our research fits the characteristics of both theory building and fact finding.

2.2 Research strategy

There are two main research strategies: (1) quantitative research, that includes quantification in the collection and analysis of data; and (2) qualitative research, that is more concerned with descriptive detail and explanation. (Bryman and Bell 2015)

Also, there are two main approaches to the relationship between theory and research: (1) deductive, where the researcher deduces one or more theoretical hypotheses and subjects them to empirical study; and (2) inductive, where the researcher’s empirical findings and observations build new theory into the certain theoretical domain. (Bryman and Bell 2015)

Our thesis uses qualitative and deductive research strategy. Our initial plan back in December was to start with a qualitative study to gain a better understanding of how different companies in the oil supply chain in Haltenbanken area handle urgent deliveries, and based on our findings we wanted to continue with a quantitative single-case study in one of the companies interviewed. Our proposal was to get hold of raw data and by analyzing it gain better insight into why urgent deliveries happen and offer some focus areas for further research. Since there is a whole bureaucratic process around getting raw data from companies for research, we could not follow up on our initial plan. Instead, we expanded our qualitative study to include more companies in our analysis. Also, our thesis starts from the premise that some theoretical concepts (reviewed in part 2) could be used to explain how efficiently companies handle urgent deliveries, thus we use the deductive research strategy.

2.3 Research design

A research design can be defined as a plan that helps the researcher in the process of collecting, analyzing and interpreting observations (Nachmias and Nachmias 1993, 77-78).

It is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions. (Yin 2003, 20)

There are a few different types of research design and Bryman and Bell (2015, 53) discuss five of them that are frequently used in social research: experimental design, cross-sectional design, longitudinal design, case study design and comparative design. For the purpose of choosing the best research design for our thesis, we would like to discuss two of them. This is following Piekkari, Welch and Plakoyannaki (2009) conclusion that researchers need to be more aware of the type of research design approach they are adopting and should justify their choices more explicitly.

2.3.1 Cross-sectional design

Cross-sectional research design requires the collection of data on more than one case and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables which are then examined to detect patterns of association (Bryman and Bell 2015). In our study we use fifteen cases and data is collected in a period of 3 months, but we can consider the data to be collected at a single point in time since we are interviewing each respondent one time and we don't go back to ask the same questions and analyze the evolution in time of some variables. We do collect a body of quantitative data, but we don't really use this data directly to establish variation between the cases, nor detect patterns of association between variables.

2.3.2 Case study

Case studies are typically used to understand complex social phenomena and they are suitable when the question has not been thoroughly researched (McCutcheon and Meredith 1993). There are several challenges when conducting case research: it is time consuming, it needs skilled interviewers and one needs to be careful when generalizing the findings from a limited set of cases and in ensuring rigorous research. But, if conducted properly, case study research can lead to new and creative insight, development of new theory and have high validity with practitioners (Voss, Tsikriktsis and Frohlich 2002). Through conducting field case research, like the one we have planned, the researcher will personally benefit from the process, by being exposed to real problems and the opinions/insight of people at all levels of the organizations that form the unit of analysis of the case.

A primary distinction when designing case studies is between single- and multiple-case designs.

2.3.2.1 Single-case study

The single-case study entails the detailed and intensive analysis of a single case. A case can be a single organization, a single location, a single person or a single event (Bryman and Bell 2015). If the case study examines only the global nature of an organization or of a program, it would be called a *holistic case study*. In contrast, if the same case study involves more than one unit of analysis and attention is given to subunits, then the resulting design would be called *embedded case study*. Within embedded case study a major pitfall occurs when the case study focuses only on the subunit level and falls to return to the larger unit of analysis.

2.3.2.2 Multiple-case study

A multiple-case study contains more than a single case. Multiple-case designs have distinct advantages and disadvantages compared to single-case studies. The evidence from multiple cases is often considered more compelling and the overall study is regarded as being more robust. But, the conduct of such a case requires extensive resources and time beyond the means of a single student. One important way of defining multiple-case studies is to consider them as multiple experiments that follow a *replication* logic (after uncovering a significant finding from a single experiment, the immediate research goal is to replicate the finding by conducting more experiments that follow the same pattern). Once the data collection of the multiple cases has been finalized, an individual report is written for each case and based on these reports the conclusions across all the cases can be drawn. (Yin 2003)

2.3.3 Our choice of research design

What distinguishes a case study is that the researcher has an *idiographic* approach where he is concerned with elucidating the unique features of the case. Cross-sectional design on the other hand, has a *nomothetic* approach where researchers are concerned with generating statements that apply regardless of time and place. A simple rule of thumb to use when deciding between cross-sectional design and multiple-case study is to identify the focus. Multiple-case studies focus on the cases and their unique contexts, whereas cross-sectional design is focused on producing general findings with little regard for the unique contexts of each case. (Bryman and Bell 2015)

We would be inclined to believe that the suitable research design for our master's thesis would be a multiple-case design. But is it? We are indeed replicating the same interview guide across the 15 different companies. But it is not just a simple replication among the companies, since all the companies studied are interconnected (see **Figure 38**) and thus we are also interested in the relations between the companies and how this affects urgent deliveries. Besides, because of the different scope of the companies, we are not actually asking the exact same questions to the respondents, but we are carefully selecting the relevant ones depending on the setting and on the development of the interview.

Thus we can conclude that in our master's thesis, the most suitable research design is the *embedded single-case study*. The unit of analysis for our case is represented by the Haltenbanken area, the subunits are represented by the different groups of companies interviewed (oil companies, 3PL companies, MMO companies, etc) and the sub-subunits are represented by the individual companies. First we analyze the urgent deliveries at subunit level and then we go back to the main unit level and take into consideration the network that exists among the companies when we draw our conclusions. This provides us with the opportunity to map out trends and consider the factors that are common for the entire industry, but also consider individual good practices that other companies could adopt.

2.4 Research method

A research method is a technique for gathering data through for example documentation, archival records, interviews, observations or physical artifacts (Yin 2003). In our master's thesis we use interviews as the main method for data collection. This might pose some data triangulation problems. Triangulation strengthens the confidence in the research and findings by combining the different sources of data and counteracts the threat to validity associated with each. Patton (1990) discusses four types of triangulation in doing evaluations: (1) data triangulation (using multiple data sources to support a conclusion), (2) investigator triangulation, (3) theory triangulation and (4) methodological triangulation. Through triangulation, the potential problems of construct validity (see 2.8.1) are also addressed. As we discuss in 2.8.1, our main source of evidence is represented by the interviews, and by asking the same questions across different companies we draw our conclusions only if we see the same evidence repeating itself across companies. Whenever possible we also use external sources of evidence, represented by articles, reports or studies.

We were unable to get any internal documents from the companies interviewed in order to support their affirmations, but in some cases they did share with us such documents during the interviews (but because of the confidentiality nature of these documents, we couldn't get a copy). So we believe that we manage to address the data triangulation issue.

2.4.1 Interview design

One of the most important sources of case study information is the interview. Most commonly, case study interviews are of an open-ended nature, in which you can ask respondents about the facts as well as their opinions and even insight.

According to Gall, Gall and Borg (2003), there are four formats for interview design:

- informal conversational interview – the researcher does not ask any specific type of questions, but rather relies on the spontaneous generation of questions and the interaction with the participant to guide the interview process.
- semi-structured interview / general interview – is more structured but there is still quite a bit of flexibility since the researcher can ask questions or change questions based on participant response to previous questions. The strength of this type of interview is that it ensures that the same general areas of information are collected from each interviewee – it provides more focus than the conversational approach but still allows a degree of freedom and adaptability in getting information. (McNamara 2009)
- standardized open-ended interview – participants are always asked identical questions, but the questions are worded so that responses are open-ended. They are the most popular form of interviewing utilized in research studies because of the nature of the open ended questions that allow participants to fully express their viewpoints and experiences. But there is difficulty in coding data.
- closed fixed-response interview – where all interviewees are asked the same questions and asked to choose answers from among the same set of alternatives. (McNamara 2009)

Based on this information, we think that the most appropriate type of interview in our case is the semi-structured interview. Since we are talking to professionals working in different oil and gas companies that perform in different areas of the supply chain, we need to have some flexibility in wording the questions to be able to make them relevant for the company and to be able to gain better insight.

A standard open-ended interview would have offered an easier to define structure to our insights, but the main difficulty we would have faced with this would be creating an interview guide that can be applied to all of the companies interviewed. And if we would have created such a rigid interview guide, we will surely miss out on a lot of valuable insight.

By using semi-structured interview we have more flexibility in asking the questions and we can let the flow of the conversation take us in the areas that the interviewee considers to be relevant to our research and might uncover problems we haven't really considered beforehand.

2.5 Research process

When it comes to our research process, we will adopt the linear but iterative process described by Yin (2013) and illustrated in **Figure 1**.

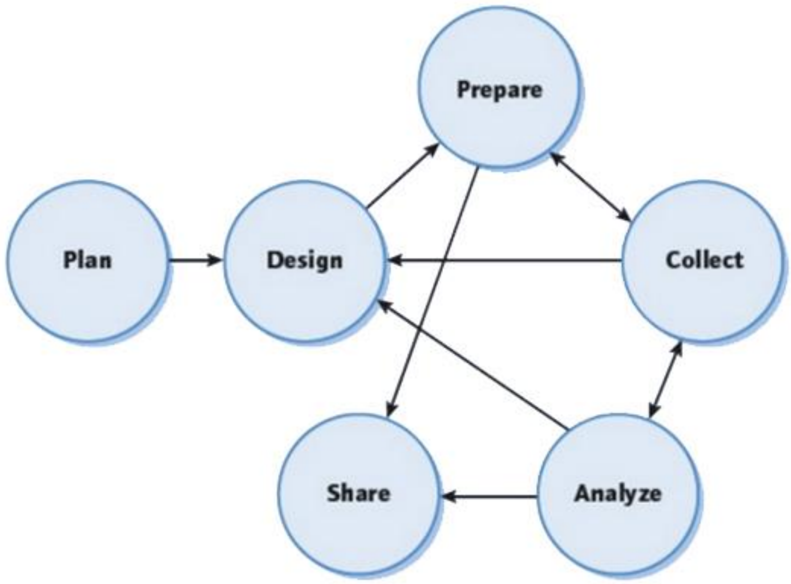


Figure 1 *Case study research process [Source: (Yin 2013)]*

Firstly, the researcher starts by planning the research, and this is done through identifying the research problem and research questions and deciding if case study is the appropriate research design method. After that, the researcher moves on to the design phase, where the unit of analysis and the case is defined and theory is developed. Theory development stage is quite important, since the data collection stage depends on understanding the theory. Afterwards, the research prepares for the data collection phase, and we have done this through the preparation of the interview guide. The last two steps are analysis and sharing and this is done in the form of a report. The flexible research allows for the iteration of some of the steps in case, for example, new information is discovered during data collection phase.

2.6 Research problem and research questions

One of the most important parts of research study is to define the research questions. The development of the research questions requires patience and time and they need to have both substance (what the study is about) and form ("who", "where", "how" or "why") (Yin 2003). Altogether, the research questions provide an answer to the research problem statement.

Bryman and Bell (2015, 11) mention that during the different stages of the research study and as we move through the literature review we might go back to our research questions and revise them or we might even suggest new ones. The research questions below are our final research questions and they differ quite a bit from the research questions we initially outlined during our proposal paper.

The final overall problem statement for this master's thesis is:

How do different oil and oil service companies that operate in Haltenbanken area of NCS perceive and handle urgent deliveries and what can be done to improve the current situation?

Six research questions are used to answer the overall problem statement:

Research Question 1 (RQ1) How do companies in Haltenbanken handle urgent deliveries and how suitable is the supply network for this task?

Research Question 2 (RQ2) What are the causes and consequences of urgent deliveries?

Research Question 3 (RQ3) How does the information flow and use of information systems impact urgent deliveries and what can be done to improve the situation?

Research Question 4 (RQ4) How does the purchasing strategy impact urgent deliveries?

Research Question 5 (RQ5) How does planning impact urgent deliveries and what represents better planning?

Research Question 6 (RQ6) What can be done to handle urgent deliveries in a more efficient way?

2.7 Collection of empirical data

2.7.1 Sampling of companies and respondents

In order to conduct our in-depth, expert interviews we required contact with people who were involved in the process of handling urgent deliveries. And it was important for us to talk to employees performing different functions in the companies so we can gain a broad understanding on the topic. The first respondents were mainly recruited through *purposeful sampling* (Patton 1990) based on our best knowledge of companies that might be suitable for the study and limited to Kristiansund and Molde area. Further, our list of respondents grew through *snowball sampling* (our initial respondents gave us suggestions of other companies or colleagues we could interview) and through *convenience sampling* (the category of our sample was somehow determined by the availability of the respondents). But through our sampling we did try to include companies of different sizes, with different positions in the supply chain and doing different activities.

2.7.2 Phone and email contact

Since at the beginning of our research we did not have any contacts in any of the companies we were planning to interview, we conducted a field visit on 11th of December 2015 to Kristiansund. During this visit we went directly to the offices of six companies (see Appendix B) and we presented ourselves and our case to the reception and we asked for the names and contact information of relevant employees. This provided us with an initial list to start from. We preferred our first contact of those persons to be via phone and then we followed up with an email where we attached a short presentation of our master's thesis (see Appendix A) and the purpose of the interview. We avoided sending direct emails whenever possible, because of high-rates of those emails being unanswered. Based on this information, we were directed to the most relevant person to answer our questions and we then scheduled our face-to-face interview.

Moreover, on 21st of January we took part in the Petropolen monthly meeting in order to try and make new contacts and be inspired by new companies we could research into. This was quite successful and it allowed us to further expand our list of potential companies.

2.7.3 Company visits and interviews

At the company visits, semi-structured interviews were performed. Most of the interviews were individual, but we did have a group interview as well. We used eight different days for performing the interviews, six of them were in Kristiansund and two of them were in Molde. The interview guide used can be found in Appendix C and it includes general questions about the respondent and for an initial understanding of the situation, questions about frequency and costs, about products, suppliers, consequences, proactivity, potential causes, questions related to information flow and use of information system, questions related to purchasing and relations with suppliers, and questions for further references. As mentioned before, the interview guide was not used in its entirety during the interview. We only asked the questions we thought were relevant to that specific company.

In **Table 1** we give an overview of the different companies visited and when the visit took place, the position of the person interviewed and the duration of the interview. We omitted the name of the person interviewed because we did not get permission to do this from each respondent, and we do not believe it is essential to the study to have this piece of information included here.

No.	Date	Company	Position	Duration
1	11.12.2015	CHC Helicopter	Cargo Handler	15 minutes
2	12.01.2016	Aker Solutions	Procurement Manager Procurement	90 minutes
3	12.01.2016	Shell	Logistics Manager	45 minutes
4	12.01.2016	Shell	Purchaser	10 minutes
5	12.01.2016	Shell	Warehouse Manager	30 minutes
6	20.01.2016	Aibel	Purchaser	60 minutes
7	20.01.2016	Axess	Warehouse Manager	80 minutes

8	9.02.2016	Vestbase	Operations Manager	60 minutes
9	9.02.2016	Bring	Transport Coordinator	45 minutes
10	9.02.2016	Haliburton	Warehouse Manager	60 minutes
11	9.02.2016	Benor	Head of Department	60 minutes
12	12.02.2016	Linjebygg	Purchasing Manager	45 minutes
13	29.02.2016	Statoil	SCM Senior Consultant	60 minutes
14	29.02.2016	Statoil	Purchaser	60 minutes
15	29.02.2016	Statoil	Planner	45 minutes
16	29.02.2016	Statoil	Discipline Responsible Automation	45 minutes
17	29.03.2016	SR Group	Import/Export Supervisor	40 minutes
18	29.03.2016	Kuehne Nagel	Oil & Gas FX-XO	90 minutes
19	29.03.2016	Swire	Base Manager	80 minutes
20	30.03.2016	Alpa	SCM Manager	60 minutes

Table 1 *Summary of companies and persons interviewed*

2.7.4 Recording and transcribing

By recording the interviews through the 'Voice Memos' app in our phones, we were able to focus more thoroughly on the answers and on follow-up questions. We asked for permission to record the interviews from all of our interviewees and they all agreed on this. Moreover, since we wanted our master's thesis to be open, we asked all our respondents to refrain from disclosing information of sensitive nature.

There are several advantages to recording and transcribing the interviews, for example it reduces the need to remember everything that the respondents say and it allows for a more thorough examination of what people have responded (Bryman and Bell 2015). We also felt that the conversations were more relaxed and the flow was more natural, and by not having to take notes frantically we were able to pay closer attention to the answer given and thus able to conduct the interview in a more satisfactory manner. Also, the attention of the interviewee was not distracted by us taking notes, like we have seen it happen in other circumstances.

Since this was the first time writing transcripts of interviews, we underestimated how much time and energy this would take. This is in line with the first time interview challenges uncovered by Roulston, Lewis and deMarrais (2003) in their research. Moreover, ¼ of the interviews were conducted in Norwegian because our respondents were not that comfortable with an interview in English. This posed even greater challenges since we not only had to transcribe the interview, but also translate it. And considering that Norwegian is not the first language for either of us, this became very time consuming.

Bryman and Bell (2015, 495) recommend allowing five to six hours for transcription for every hour of speech. We believe that this is in line with what we have experienced, although the interviews in Norwegian took 3 to 4 times longer to transcribe and translate. For some of the interviews, we used an online tool (transcribe.wreally) to aid us in transcribing and both of us noticed significant transcribing time improvement.

2.7.5 Statistics about the extent of the study

Throughout the study, we contacted 30 companies, out of which 15 agreed to participate in the research. Our interviews with these 15 companies resulted in 18 hours of interview and 132 pages of interview transcript (that's more than 70 000 words transcribed). Moreover, 27% of our interviews (in hours) were conducted in Norwegian because our respondents were not that comfortable with an interview in English. All these statistics are summarized in the figure below (**Figure 2**)

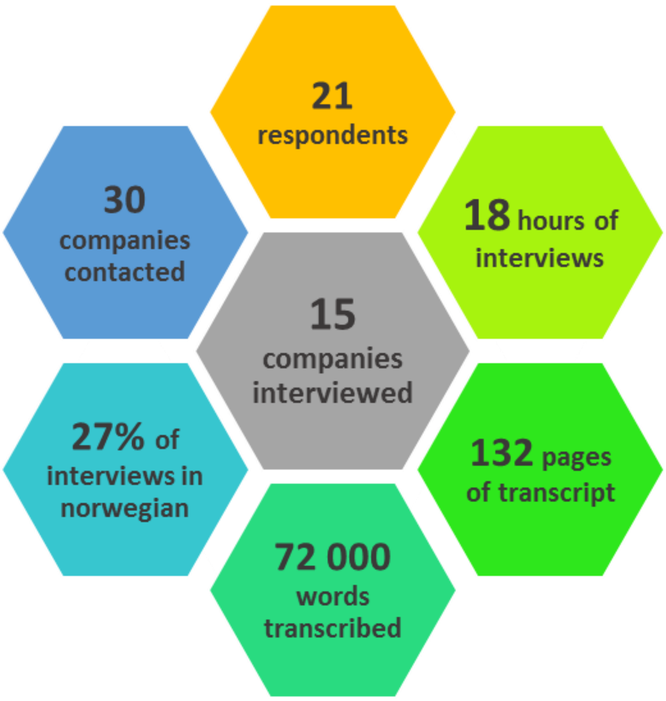


***Figure 2** Statistics of data collection phase*

2.7.6 Limitations

Since this was the first proper series of research interviews for both of us, the interview process was far from perfect. Roulstan, Lewis and deMarrais (2003) suggest five challenges when approaching the first interview(s), and we specifically had difficulties with maintaining focus in asking questions. Sometimes, our follow-up questions were a bit outside the scope of the study, even though at the time of asking the questions, we believed it would give us better insight into our research problem, or at least provide us with a better understanding of the industry.

Another issue encountered during the interviews is that of asking leading questions. Even though we have tried to avoid this in our interview guide, when we were actually asking the questions we were rephrasing them and sometimes transforming them into leading questions.

As with questionnaires, case research protocols need piloting either in a pilot case or in initial interview within an organization (Voss, Tsikriktsis and Frohlich 2002). We skipped this step, and this might have affected the quality of the first interviews. But in order to assure ourselves of the quality of the interview guide and interview process, we asked our co-supervisor to be present and observe our first interview and based on his feedback we were able to make slight improvements.

It is important to note that informants are prone to subjectivity and biases (Voss, Tsikriktsis and Frohlich 2002). Sometimes the things they are saying and situations they are describing might not be true, especially if they point at someone else being responsible for a certain problem. We have tried to keep this in mind when selecting the information to present in our master's thesis. If the person is directly involved in the situation they are describing, then the credibility increases. But if they describe a situation that they were not directly involved in, then we need to be more careful with using this information.

There might also be some limitations when it comes to the transcribing phase. As noted in 2.7.4, ¼ of the interviews were in Norwegian and since none of us are native speakers, the transcription and translation process of these interviews might lead to misinterpretation of facts.

2.8 Quality evaluation

When conducting research, one important aspect that needs to be taken into consideration is the degree of quality of the paper. In order to be able to ensure the scientific value of our study, we will use the research design criteria summarized by Yin (2003, 33-39) in his book.

2.8.1 Construct validity

The role of this criterion is to establish the correct operational measures for the concepts being studied, and this can be quite problematic in case study research. Critique of case studies is often based on the fact that the investigators fail to develop a sufficiently operational set of measures and that subjective judgment is used to collect the data (Yin 2003).

Yin (2003) proposes three tactics to increase construct validity. First of all, he recommends (1) the use of multiple sources of evidence. Our main source of evidence is represented by the interviews, and by asking the same questions across different companies we draw our conclusions only if we see the same evidence repeating itself across companies. Whenever possible we also use external sources of evidence, represented by articles, reports or studies. We were unable to get any internal documents from the companies interviewed in order to support their affirmations, but in some cases they did share with us such documents during the interviews (but because of the confidentiality nature of these documents, we couldn't get a copy). Secondly, (2) a chain of evidence should be established. There should be a progression of the research that should be easily traced by an external observer, and we hope to achieve this through the clear structure of our thesis. However, most of the empirical data gathered from the interviews is summarized, so it is then difficult to trace back to the person that made the statement. Thirdly, he recommends (3) having a key informant review the case study report. For this we are using our supervisor's feedback and expertise whenever possible. Also, our thesis could be sent for review to all of the respondents before publishing it, but because of time limitations, we are unable to do this. We will however send a copy of our master's thesis to them after we have submitted it, but this will be mainly so they can explore the findings of our study and not for construct validity purposes.

2.8.2 Internal validity

This criterion seeks to establish a causal relationship, whereby certain conditions are believed to lead to other conditions. This can be achieved through the general analysis strategy of examining conflicting explanations, through pattern matching, explanation building and logic models (Yin 2003). We have examined conflicting explanations by asking several interviewees the same question and by sometimes coming back to the same question later in the interview and rephrasing it.

2.8.3 External validity

This criterion is concerned with the generalization of the study's findings. Are the results of our study of urgent deliveries in Haltenbanken applicable to other areas of the NCS or other petroleum countries? Our study is quite broad, and we are hoping it can say something about the industry as a whole. But we are not sure if our findings can be generalized, and that is because different petroleum areas have their particularities and we believe that these particularities might impact the way deliveries are handled on an area specific basis. As mentioned before, Barents Sea might face more challenges because of more unpredictable weather, longer distance for deliveries, novelty of operations in this area and difficulty to locally source products. Whereas North Sea area might provide a different kind of study because of the high number and age of installations, short distance to suppliers and multitude of oil and oil service companies headquarters. However, if replications of this case study are conducted in the other areas of NCS and it would lead to the same results, then we could conclude that the findings can be generalized.

2.8.4 Reliability

The objective of this test is to make sure that if a later investigator followed the same procedures and conducted the same case study (but exactly the same) described in this master's thesis, they will arrive at the same findings and conclusions (Yin 2003). The goal of this criterion is to minimize the errors and biases in this study. There are two specific tactics for this, one is to follow a case study protocol and the other is to develop a case study database.

We have created a simplified version of a case study protocol through our proposal paper. Over there we covered the title, problem description, research questions and problem statement. Plus we included a timeline of our master thesis plan and a course of action for the first company visits. Since there was a lot of uncertainty in regards to the company representatives that will agree to have an interview with us, we could not be very precise in defining our plans. A lot of the company interviews were arranged throughout the spring semester and the list of potential companies to interview has grown as well since the moment we submitted our proposal.

When it comes to the case study database, this tool is used to organize and document the empirical data so that other investigators can review it directly. For this purpose the interview audio files and transcripts are stored digitally and they can be made available on request. We have not signed any confidentiality agreement with any of the companies interviewed, and we have specifically asked them not to mention any sensitive information during the interviews. It was important for us that the results of our study can be used immediately for further research and most importantly they can create value for the companies interviewed.

2.9 Summary

Table 2 gives an overview of the research methodology decisions made for the execution of our master's thesis work.

Methodology considerations	Decisions
Objective	Combination of theory building and fact finding
Strategy	Qualitative and deductive
Design	Single-case study, embedded
Process	Linear but iterative process
Method	General interview guide
Quality	
Construct validity	Few sources of evidence, empirical data is summarized (chain of evidence), one key informant reviews the report
Internal validity	Examined conflicting explanations
External validity	Findings could be generalized if similar case study is conducted in other areas (with same results)
Reliability	Case study protocol, audio files and transcripts are available

Table 2 *Summary of our research methodology decisions*

PART II: LITERATURE REVIEW

3 Urgent Deliveries

As described in the importance of the research (see 1.2), the topic of urgent deliveries in the upstream petroleum logistics has not been researched before. Searches on Oria or Google Scholar for keywords such as “urgent delivery” or “urgent deliveries” give results related to health topics (but not health logistics). When we also add “logistics” or “supply chain” to the keyword, the term “urgent delivery” appears in a few research papers that discuss performance measurements (Gunasekaran, Patel and McGauhey 2004) (Shepherd and Gunter 2010) (Sharma and Bhagwat 2007) or supply chain flexibility (Pujawan 2004), but the term is not clearly defined.

Urgent delivery synonyms or related keywords can be “express delivery”, “rush order”, “urgent order”, “urgent procurement”, “urgent logistics”, “delivery of urgent goods” or “emergency logistics”. *Rush order* appears in some research papers related to flexible logistics (Tönshoff, et al. 2001) (Abrahamsson, Aldin and Stahre 2003), but the concept is just used as a variable in models, and very little clarification is given to the term. Similarly, *urgent order* is mentioned in relation to lead time (Piroird and Dale 1998) or supply chain risk (Lin and Zhou 2011), but very little depth is given to the term.

For *urgent procurement*, one article (Alarcón, et al. 2011) that analyzed lean practices in Chile noticed a reduction of urgent procurement requests because of lean. *Emergency procurement* and *urgent logistics* gives results related to emergency logistics and humanitarian aid. For *delivery of urgent goods*, search results are related to vehicle routing problems e.g. newspaper distribution (Ferrucci, Bock and Gendreau 2013) or inventory slack routing problems e.g. medication delivery (Montjoy and Herrmann 2012). *Emergency logistics* and *express deliveries* are two keywords that provide relevant search results, so they are further detailed below. *Spare parts* are also discussed, since their characteristics make them prone to urgent deliveries. *Lead time*, *uncertainty* and *flexibility* are also reviewed since they can represent important factors in the understanding of urgent deliveries.

3.1 Emergency logistics

Sheu (2007) is the first to propose a definition for emergency logistics as the "process of planning, managing and controlling the efficient flows of relief, information and services from the points of origin to the points of destination to meet the urgent needs of the affected people under emergency conditions". Emergency logistics mainly refer to response to natural disasters by alleviation of disaster impact in the immediate aftermath.

The challenges of emergency logistics, compared to business logistics are (Balcik and Beamon 2008):

- Additional uncertainties like unusable routes, safety issues, changing facility capacities or demand uncertainties
- Complex communication and coordination like damage to communication lines, involvement of many third parties, government involvement, inaccessibility to accurate real-time demand information
- Harder to achieve timely and efficient delivery
- Limited resources often overwhelmed by the scale of the situation

Research answers these challenges mainly through the use of quantitative methods: optimization models, with focus either on facility location (Balcik and Beamon 2008) or relief distribution and casualty transportation (Sheu 2007) or emergency preparedness (Lämmel, et al. 2010), statistical and probabilistic models (Colles and Pericchi 2003), simulation (Hu, et al. 2008), decision theory (Tamura, et al. 2000) or fuzzy methods. Caunhye, et al. (2011) conduct a literature review of the optimization research papers in emergency logistics.

Emergency logistics response models is another area of research, and it is discussed by Pettit and Beresford (2005). These type of models are developed and used by numerous agencies and governments around the world, but their efficiency is usually tested when the disaster hits. So Banomyoung and Sopadang (2010) propose Monte Carlo simulation to test the effectiveness of the response models.

3.1.1 Critical success factors

Pettit and Beresford (2009) discuss 10 critical success factors (CSF) in the context of humanitarian aid supply chains. Critical success factors are a limited number of areas in which satisfactory results ensure successful competitive performance of the organization. These 10 CSFs are relevant for the implementation of successful supply chains and they are summarized in **Figure 3**.

Critical success factor	Alternate descriptor	Key aspects
Strategic planning	Long-term decision making, planning, management and leadership	Nature/size of the business, location, outsourcing, budgets, relationships, customer focus, setting of standards and performance monitoring, management and support, organisational infrastructure, and processes and activities
Resource management	Inventory management	Planning and coordinating materials flows, volumes, timings, and consolidation
Transport planning	Transport availability and constraints	Transport mode, capacity, scheduling, maintenance, and intermodality
Capacity planning	Storage, processing and transport capacity	Long- and short-term demand, number of warehouses/capacity, number of vehicles, and material handling equipment capacity
Information management	Strategic information management and enterprise resource planning	Data on performance and utilisation, system type, and level of integration
Technology utilisation	Implementation of new technology	Innovation and adaptation, technology leader/follower, interfacing, and training
HRM	Participative management	Number of employees in relation to capacity, training and education, motivational aids, culture, and human factor management
Continuous improvement	Benchmarking, key performance indicators	Reliability, flexibility, lead time, cost effectiveness, value-added, and measurement
Supplier relations	Collaboration	Management of competition amongst suppliers and service/price negotiation
Supply chain strategy	Just-in-time, agility, and lean supply	Management of base and surge, hub and spoke systems, inbound and outbound, and in-house/third party strategies

Figure 3 *Critical Success Factors for successful humanitarian aid supply chains [Source: (Pettit and Beresford 2009)]*

- *Strategic planning* – corporate strategy regarding transportation and warehousing, location of distribution centers, outsourcing of non-core activities, the size of the business and budgets, acquiring capital, deployment of resources and the effective use of the organization's skills.
- *Inventory management* – in emergency circumstances, inventory should first be "pushed" into strategic storage locations, and from there it can be "pulled" into the areas where it is needed (Whybark 2007). The time value of commodities is much

greater than the inventory carrying costs in emergency situations (Long and Wood 1995).

- *Transport planning* – activities such as consolidation, contract services, payment, local tendering and brokering, outsourcing of transport and strategic alliances (Gunasekaren and Ngai 2003). Transport and distribution are critical in disaster relief (D. Long 1997).
- *Capacity planning* – four key areas that affect capacity are warehousing, transport, material handling and human resources, so maximization of use of capacity is key (Gunasekaren and Ngai 2003). Increasing the capacity can also be achieved through collaboration with other organizations (Cottrill 2004).
- *Information management* – is crucial in disaster management and the speed with which it is used can have a critical impact on the effectiveness of the response. Management of information during a crisis is seen as "the single greatest determinant of success" (Long and Wood 1995). Real time communication can be the most important method for reacting quickly for effective coordination (D. Long 1997), and during the Asian tsunami (2004), almost all communication was done via phones.
- *Technology utilization* - the use of IT is an indicator of supply chain best practice, especially when it connects customers, suppliers and value adding activities (Power, Sohal and Rahman 2001) and assists in integrating activity and providing information to allow the supply chain to operate more effectively. Moreover, it allows for provision and continuity of accurate information, performance measurement and control (Gunasekaren and Ngai 2003). Although new technologies are often seen as a way to improve supply chains, appropriate and more effective use of existing technology should not be overlooked (Power, Sohal and Rahman 2001).
- *Human resource management* – in a disaster situation it's very important to get the right people at the right place as soon as possible. Effective response can be endangered by the lack of trained people in key locations closest to the crisis, so focus should be given to improving their skills.
- *Continuous improvement* – metrics and tools can be used to manage and improve performance, tracking key factors in supply chain performance and benchmarking the activities of an organization against KPIs. No such measures exist that measure the effectiveness of humanitarian supply chains.

- *Supplier relations* – it is widely acknowledged that it's important to have close supplier relations. Poor collaboration can have an impact on other CSF like inventory management, capacity planning and transport. Collaboration is more than just sharing information and resources, trust must also be built, and a relationship where both partners have an interest in sharing benefits and costs through process integration should be established.
- *Supply chain strategy* – Lean, agile and leagile are relevant strategies for humanitarian aid supply chains, where the value relates to ensuring the correct products are distributed to the right people at the right time and providing the correct form of aid to meet the immediate needs is critical.

3.2 Express deliveries

Express delivery is seen as a special service in the transportation industry. Sage (2001) defines express deliveries as a "collective term comprising the following: courier services, express delivery services in its narrowest sense and parcel delivery services". Barnhart and Schneur (1996) define express shipment as a service that involves the pick-up and delivery of shipments in a specified time interval (e.g. 24 hours, 48 hours or 3-5 days) in exchange for a premium.

Tseng, Yue and Taylor (2005) identify express deliveries as a form of logistics operation that has emerged as a Just-In-Time (JIT) delivery principle, which involves more frequent delivery of materials at the right time and the right place in the production process. They also mention that express deliveries are seen as a way to reduce costs when it comes to high-value items where the interest costs bound in stock and inventories can be quite high.

Bertelsen and Nielsen (1997) analyzed the supply of building materials in the Danish industry and found that express delivery is the most common form of delivery, and that it generates unnecessary extra costs and is caused by lack of order and control where unforeseen events happen quite often. In their paper they also use JIT principles.

Quite a few papers (Li and Jiao 2010) (Ru-la and Xiu-ping 2010) (Zhao and Zhuang 2011) analyze the privately-run express delivery companies in China, mainly focusing on the opportunities and challenges of this market.

Other papers focus on the service network design problem: for an express delivery company (Barnhart, Krishnan, et al. 2002) or in air industry (Barnhart and Schneur 1996) that optimize route in order to guarantee delivery in the promised time frame.

The express deliveries industry offers a lot of value to companies and plays a critical role in international trade. They are increasingly important to ensuring the continued competitiveness of companies operations including sales, logistics and storage, production and customer support functions. Express services also enable companies to maximize the efficiency of their operations by reducing shutdowns. According to a survey of German companies, one third of firms using express services are able to reduce their production costs because of cutting down idle periods and production shutdowns. A survey of companies in India showed a similar thing - without next day delivery, production would on average be interrupted for more than 10 days per year (in some cases even more than 16) because of missing spare parts. Another example is from the airline industry, where they demand delivery of spare parts within 24 hours to avoid costs resulting from the aircraft being grounded. (Oxford Economics 2009) This is probably the main reason why oil companies use express services.

Surveys of companies and case study interviews suggest that the majority of firms either frequently or occasionally require their suppliers to deliver spare parts by express services. Many also use it for delivery of sub-components to their production facilities. From a survey covering nine countries, 50% of companies say that next-day delivery of sub-components is important because they operate a just-in-time inventory system while two-thirds require urgent delivery of spare parts for machinery in case of breakdown. (Oxford Economics 2009)

Four companies are the leaders of the global express industry – DHL, FedEx, TNT and UPS, which are vertically integrated companies that are capable of offering door-to-door services. Besides these big four, there are of course many other smaller companies. The express industry relies on overnight transport to achieve their promises and they use different transportation modes. Air express services are used only when there are no other options available to meet the customer requirements. (Oxford Economics 2009) The Air Transport Action Group estimates that the value of goods transported by air represents about 35% of all international trade, however by weight, the share is around 0.5%, reflecting the high unit value of goods transported by air (Air Transport Action Group n.d.) . Express services represent a big proportion of this international trade – almost half of the intra-European air cargo market. (European Express n.d.)

3.3 Spare parts

Spare parts are very slow moving parts with highly stochastic and hectic demands. Spare part inventory is different from other inventories because it consists of critical components that are necessary and must be available at the right time and the right place to keep equipment in operating condition. The parts are interchangeable and used for the repair or replacement of failed parts.

Effective inventory management of spare parts is very important for many companies, from capital-intensive manufacturers to service organizations such as chemical plants, telecom companies, car manufacturers or airlines. Different from work-in-process or finished product inventories, which are driven by production processes and customer demands, spare parts are kept in stock to support maintenance operations and protect against equipment failures (Porras and Dekker 2008). Spare parts inventory can exert significant influence on the operation. Since spare parts are connected to the operations, insufficient stocks can lead to extended equipment downtime. Effects of spare parts delay and spare parts inventory optimization are one of the most important maintenance issues in offshore production operation (Martorell, Guedes Soares and Barnett 2014).

The main objective of any inventory management system is to achieve sufficient service level with minimum inventory investment and administrative costs. Spare part inventory management is often considered as a special case of general inventory management with some special characteristics. Planning the logistics of spare parts differ from those of other material in several ways (Huiskonen 2001):

- Service requirements are higher and responsiveness has to be high, since a stockout can have a big financial impact
- Very slow moving parts with highly stochastic and hectic demands
- Usually the demand volumes are very low
- Prices of individual parts can be very high
- The number of parts managed is usually very big (Cohen and Agrawal 2006)
- High risk of stock obsolence (Cohen and Agrawal 2006)

The primary function of spare part inventory is to act as a buffer or reservoir between the uncertainties of the supply from companies or the repairing workshop - external or internal - and the inherent variability of the maintenance demand (Anthony 2006). Thus, for holding spare part inventory effectively, one might have the following functions:

- Inventory policy: A set of rules for deciding how the number of spare parts held in the inventory and to be controlled. For example, determining a maximum number of parts to hold and a minimum level of spare parts that should be re-ordered.
- Inventory control: A function for monitoring the usage and delivery of each spare part in the inventory. It uses the inventory policy to control part replenishment and to decide when the part should be re-ordered.
- Identification: All items in the inventory should be coded by type, size and classified and given a description with name and an inventory locator.

In practice, managing the inventory system and controlling the cost is much more challenging and complicated (Anthony 2006).

3.3.1 Spare parts classification

As indicated by Boylan and Syntetos (2007), spare parts for consumer products are highly varied, with different costs, service requirements and demand patterns. A classification of spare parts is therefore helpful to determine service requirements for different spare part classes and for stock control decision and forecasting.

“A part is not a part” argued Cohen and Lee (1990) when discussing service management of maintenance inventory. Not all parts should be treated equal, because of differences in the relative frequency of demand and essentialness in keeping a product operating. They suggest that parts should be grouped based on demand, supply and cost parameters, and based on their groups, service targets and stocking policies can be created.

Huiskonen (2001) suggest four different control characteristics that are specific to maintenance spare parts. See **Figure 4**. He argues that there is a need for a categorization of items based on their different effects on the characteristics of the logistics system.

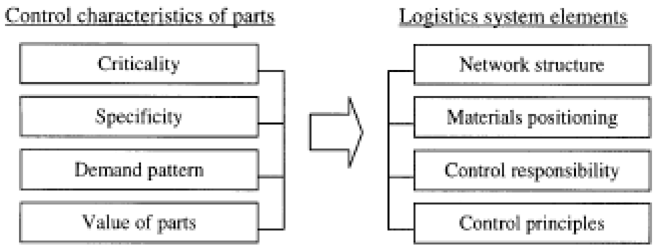


Figure 4 Relevant control characteristics and logistics system elements [Source: (Huiskonen 2001, 129)]

- Criticality
    - Process criticality – the consequence caused by the failure of a part on the actual process, in case a replacement is not readily available. It can be evaluated based on the downtime cost of the process. Or, a few different degrees of process criticality can be determined based on the time in which the failure has to be corrected:
        - Urgent – the failure has to be corrected and the spare should be supplied immediately → local safety stock is the only way of provisioning.
        - Moderate – the failure can be tolerated for a short period of time, during which the spare can be fixed.
        - Low – the failure is not critical for the process, it can be managed, so the spare can be supplied after a longer period of time.
    - Control criticality – what are the possibilities that the process failure can be controlled? This includes the predictability of failure, availability of spare part supplier and lead times.
- Demand pattern
    - Volume – large amount of spare parts have very low and irregular demand
    - Predictability - possibility to estimate failure patterns and rates by statistical mean. Can be divided into 2 parts:
        - Parts with random failures
        - Parts with a predictable wear – easier to implement period control and changes
- Value of parts – high priced spare parts makes stocking a non-attractive solution for any party in the logistics chain. On the other hand, low priced items have to be efficiently administrated so that the administrative costs do not increase

unreasonably in proportion to the value of the items themselves. In theory, a high value part favors positioning the material backward in the supply chain.

- Specificity
  - standard parts – good availability, a lot of available suppliers
  - specifically tailored parts – can cause a lot of problems, suppliers are unwilling to stock the special, low volume parts, and the responsibility and control remain with the user

From the four control characteristics specific to spare parts, Huiskonen (2001) chooses three of them (criticality, specificity and value) to categorize spare parts, and identifies five different strategies that can be applied at a paper and pulp mill factory.

Bacchetti and Saccani (2012) do a very thorough analysis of spare part classification literature. The most popular criteria refer to part value (unit or inventory cost) and part criticality. Other popular types of criteria are: demand volume or value, supply characteristics (such as replenishment lead time, supplier availability and risk of non-supply), demand variability, part life cycle phase, specificity and reliability. Their critique is that although several criteria have been proposed, very little attention has been dedicated to identifying in which case one criterion is preferable to another, and there is a strong need for case studies describing real implementation of classification methods and focused on their practical applicability problems.

3.4 Lead time

From a business logistics perspective, lead time is defined as the time it takes from the moment a customer places an order to the moment the customer receives the product (Harrison and Van Hoek 2011). From an emergency logistics perspective, it can be defined as “the delay between when the relief demand is actuated and when the corresponding relief is assigned” (Sheu 2007). In manufacturing, lead time can be further broken down into order handling time, manufacturing lead time, production lead time and delivery lead time (Rajaniemi 2012). Shorter lead times can be a definite source of competitive advantage for a company and philosophies such as Just-In-Time (JIT), lean and agile, total quality management (TQM) and theory of constraints (TOC) emphasize the importance of time management (Tersine and Hummingbird 1995).

How can lead time be reduced? First, the flow of material and information must be identified and lead time should be separated into its various components. Any activity that consumes time but does not add value to the product is an initial target for reduction or elimination of waste. And the value-added activities should be continually improved so they require less time, thus adding more value (Tersine and Hummingbird 1995). But lead time reduction should not be considered only from a manufacturing perspective, but also on the supply side (procurement lead times) and demand-side (distribution lead times) (O'Neal and Bertrand 1991). Proactively reducing lead time may be achieved through redesigning procurement processes, changing supplier selection criteria from cost focus to speed focus or developing suppliers for better lead time management. (Angkiriwang, Pujawan and Santosa 2014)

3.5 Uncertainty and Flexibility

With the rise in product varieties and the increased volatility of global marketplaces, uncertainty is now an important part of the business environment (Yi, Ngai and Moon 2011). Improving supply chain efficiency requires uncertainty to be reduced, minimized or even eliminated, but in many business cases such a thing may not be completely doable due to the product involved (Christopher and Towill 2001). In such cases, supply chains are faced with the situation where they have to accept uncertainty and thus develop a strategy that enables them to match the supply and demand (Mason-Jones and Towill 2000).

There can be three types of uncertainty (Angkiriwang, Pujawan and Santosa 2014):

- Supply uncertainty – uncertainty regarding material availability, supply capacity, material price, alternative sourcing availability and supply lead time.
- Internal process uncertainty – uncertainty related to machine availability, yield, quality, processing times, labor issues, availability of working capital and problems with information technology.
- Demand uncertainty – uncertainty regarding product mix that customers will order, errors in demand forecast, changes in customer orders and competitor actions regarding marketing promotion.

Much uncertainty evident in supply chains systems is induced and magnified by the “Bullwhip effect” as opposed to being present in the marketplace. The supply chain dynamics wave propagation observed by Forrester (1961) is called “demand amplification” (Lee, Padmanabhan and Whang 1997). System induced uncertainty is inherent within many supply chains due to the strategies and relationships involved and is therefore within the direct control of the companies involved (Towill and McCullen 1999).

A typical response to uncertainty is to build flexibility into the supply chain. Flexibility in the supply chain is defined as the ability of a system to respond to unexpected and unpredictable changes due to uncertain environment to meet a variety of customer needs or requirements, while still maintaining customer satisfaction and without adding significant cost (Angkiriwang, Pujawan and Santosa 2014). Strategies for increasing flexibility in the supply chain can be either reactive or proactive (Koste and Malhotra 1999).

Through *reactive strategies*, companies make no attempt to influence the level of uncertainty, instead reacting to it in an attempt to maintain their service level to customers or to maintain efficiency. Reactive strategies include increasing the safety stock (thus reducing inventory shortage), increasing the capacity buffer (maintain stand-by capacity), having supplier backups and adding a safety lead time. (Angkiriwang, Pujawan and Santosa 2014)

Proactive strategies on the other hand revolve around redesigning the supply chain, the products and the processes. Proactive strategies include component commonality, postponement, risk pooling (centralizing stock to fewer facilities), subcontracting/ outsourcing (reduce the risk of capacity utilization), flexible procurement contract, lead time reduction (discussed in 3.3), setup time reduction (increases ability to create volume and mix flexibility) and alternative routing (Angkiriwang, Pujawan and Santosa 2014).

4 Purchasing

Purchasing is a vital function in petroleum logistics, and thereby indirectly supports offshore production of petroleum raw materials. The oil and gas market represents the economic context of offshore production. Petroleum logistics denotes a wide range of services associated with supporting the production of oil and gas. This production process involves a network of integrated companies such as supply bases, specialized shipping, engineering services, drilling services, catering, helicopter transport and waste management.

Recently, the growing importance of supply chain management (SCM) has led to an increasing recognition of the strategic role of purchasing (Anderson and Rask 2003).

Purchasing has evolved from a simple buying function into a strategic function, and became a critical driving force in the strategic management of supply chain (Paulraj, Chen Injazz and Flynn 2006). Furthermore, the purchasing function's contribution to a company is high and its strategic importance is not debated, this transformation is progressing slowly (Cousins, Handfield, et al. 2006). Schneider and Wallenburg (2013) state that the purchasing strategy and purchasing organization need to be aligned with a company´s overall strategy for purchasing to fulfill both functional and corporate objectives.

According to Cousins and Speckman (2003), purchasing is often viewed rather as "procurement". This encompasses an increasingly inter-functional view that also encompasses sourcing strategy that is working on the supplier portfolio as well as relationships with single suppliers in a supplier network. Paulraj, et al. (2006) suggest based on empirical findings that to achieve better integration of cross-organizational teams, the purchasing function needs to be included at the highest strategic level. This is in contradiction with reality in many firms where the purchasing department included in the process at a very late stage, usually when purchase orders are being cut.

According to Gadde et al. (2010), developing business relationships develops trust and thereby reduces uncertainty and transactions costs associated with purchasing.

4.1 Purchasing strategy

One of the main advances in purchasing literature was the portfolio analysis where different vendors required different strategies in relation to procurement (Kraljic 1983).

Kraljic's purchasing portfolio matrix (1983) states that in cases of simpler leverage-type products, the business relationship administering flows of repeated and simple service provision should seek to design an automated solution, which incrementally and continuously improves. In cases of routine products, information supports relatively routine manual decision-making by a key-account manager and some degree of automation. In cases of bottleneck and strategic purchasing, the information flow is largely manual and information systems must support relatively complex decision-making. This information flow is complex and dynamic with information gradually unfolding over time that is highly path-dependent; one decision affects the next, as the purchasing process unfolds overtime. This implies more challenging purchasing planning. Agility is therefore a key feature of strategic bottleneck purchasing meaning the information system should represent a flexible resource in these cases.

Kraljic (1983) describes two factors that set the importance of a particular supply strategy. The first factor is used to determine what the strategic importance of a given procured item is (e.g. volume purchased, percentage of total purchase cost). And the second factor relates to the supply risk based on the complexity of the supply market (e.g. number of suppliers, availability, competitive demand, make-or-buy opportunities). Based on these two factors, procured items can be classified into four categories: strategic, bottleneck, leverage and noncritical.

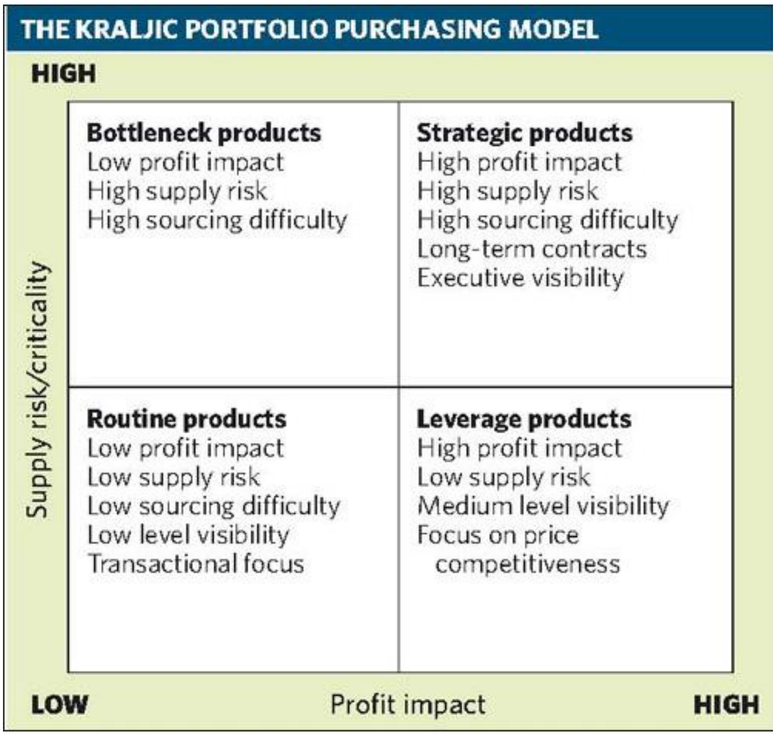


Figure 5 *Kraljic Portofolio Purchasing Model [Source: (Kraljic 1983)]*

However, Van Weele (2009) points out that one has to consider another aspect that can hinder the opportunities of the Kraljic approach. A strategic product for the buyer does not imply that the same product is of strategic relevance to the supplier involved. One has to find a proper fit for the product between the supplier's customer portofolio and the buyer's portfolio. A good fit between them stimulates the possibilities for an effective future collaboration between the buyer and the seller. This has led to the development of the Dutch Windmill approach, which is used in combination to the Kraljic portofoilio. The Dutch

Windmill leads to 16 different business-to-business relationships where each relationship requires a different sourcing strategy, as illustrated in **Figure 6**.

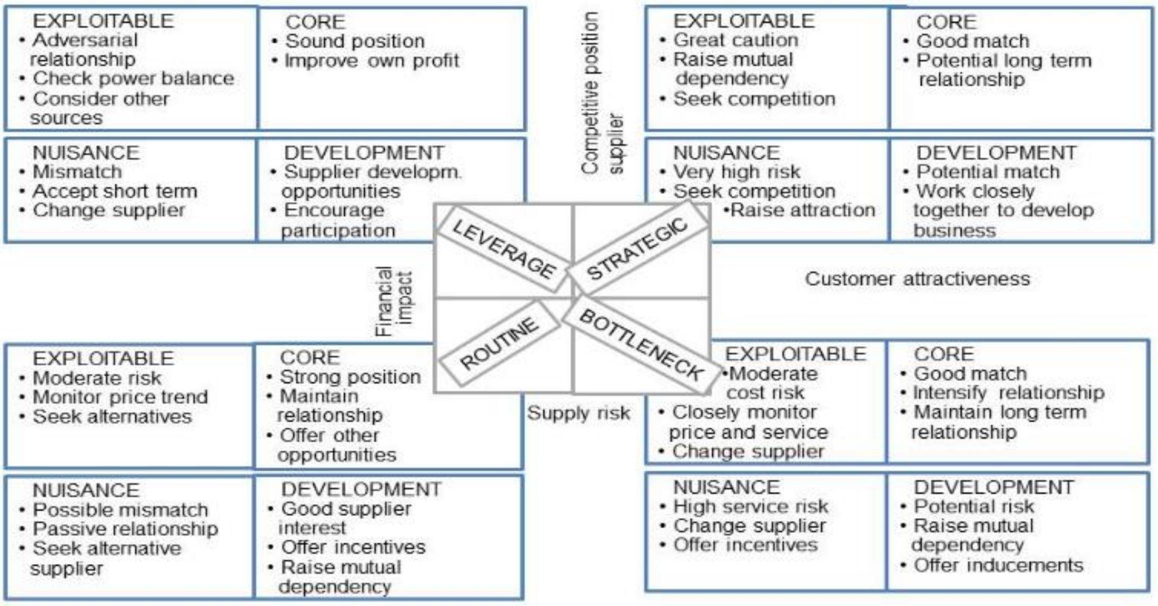


***Figure 6** The Dutch Windmill [Source: (Van Weele 2009)]*

Normally, a firm's purchasing function covers all these kind of purchasing, and thus the information systems should be developed accordingly, taking into account the complexity involved with variation in types of purchasing.

Another important issue to consider when deciding on the purchasing strategy, is the issue of local vs global sourcing. Benefits of local sourcing include production flexibility that comes from the ability to have an agile local supply chain during periods of demand fluctuation (Jin 2004), stronger social relationships and trust (Sorenson and Baum 2003), higher knowledge exchange in the innovation process and access to a safe source of qualified labor (Tunisini, Bocconcelli and Pagano 2011).

4.2 Power dependence theory

This theory is based on Emerson's (1962) power-dependence article. The resource-dependency theory states that companies cannot produce everything inside the organization (Ford, in the 30s was an exception) and must go to the market to buy what it needs. Because of the market transactions it will become dependent on the resources of other companies. Thus, the suppliers will have some degree of power over this company.

The power of actor A over actor B is the amount of resistance on the part of B which can be potentially overcome by A. The notion of reciprocity in power-dependency relations raises the question of equality or inequality of power in the relations. Power relations can be balanced or unbalanced.

$$\begin{array}{ccc} Pab & = & Dba \\ \parallel & & \parallel \\ Pba & = & Dab \end{array} \qquad\qquad \begin{array}{ccc} Pab & = & Dba \\ \vee & & \vee \\ Pba & = & Dab \end{array}$$

Figure 7 Balanced(left) and unbalanced(right) relations [Source: (Emerson 1962)]

An unbalanced relation is unstable and it encourages the use of power, so they will try to balance themselves out through balancing operations or cost-advantages (only short-term). There are four types of balancing operations (**Figure 8**):

- (1) Reduce the buyer’s interest in the resources possessed by the supplier – this can be done through changes in technology, substituting materials or developing new products
- (2) Increase the buyer’s availability of alternative sources – this can be done through multiple sourcing, producing internally, in-sourcing or supplier development
- (3) Increase the supplier’s interest in resources possessed by the buyer – this can be done through long-term contracts and developing the relationship. Alternatively, it can be done by establishing a coalition with other smaller/dependent buyers.
- (4) Reduce the supplier’s availability of alternative resources – this can be done by increasing control over the supplier’s customers.

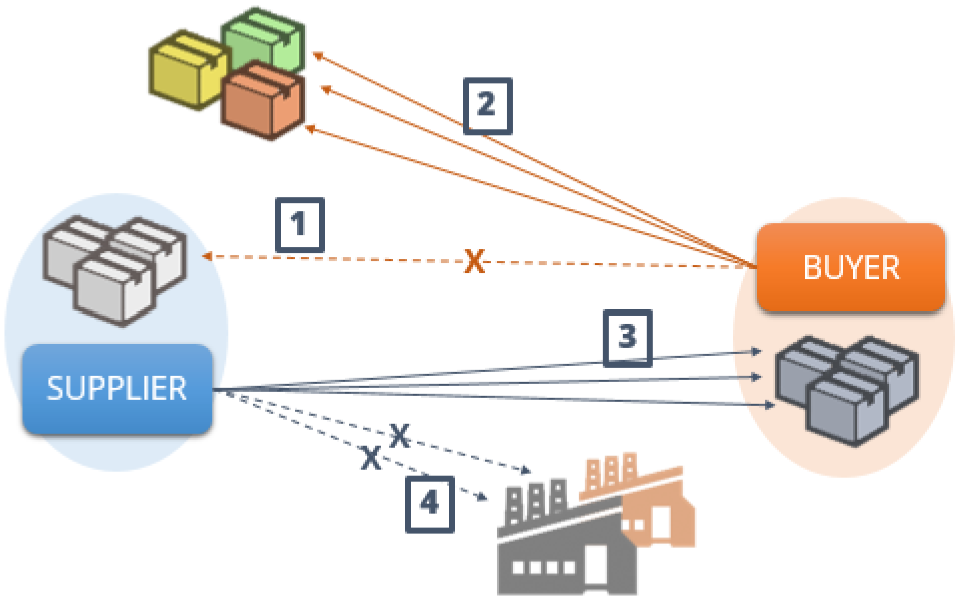


Figure 8 Power relations – the four types of balancing operations

5 Planning

5.1 Operational Planning

The scope of this part is limited to operational planning, which means the planning processes for operational, work order and works permit planning for offshore activities including production, operation, and maintenance.

5.1.1 Operational Planning Decision-making

According to Sarshar et al., (2014), the operators control the production, maintenance, crane operation and offshore transport as helicopter and supply vessel. Besides, they are making the planning process for all offshore activities. Thus, the quality of the plans and the quality of the execution of works and controls are crucial. When it comes to plan and planning, there must be some decisions that are made. The definition of decision making is described by Flin et al., (2008) that a course of action or a process of reaching a judgment or choosing an opinion to meet needs of a given situation.

Following organization and decision theory, there are two terms of decision-making such as strategic and operational, which are used to differentiate the levels of decision-making in an organization (Marakas 2003). Regarding operational planning, the operational decision-making is a focus in this part. Thus, an operational planning decision defined as "*a choice of action to be implemented within a short time interval in the operational phase of an existing plant. The time lag is relatively short from the need to make a decision arises until the decision is made, but long enough that alternative actions can be considered*" (Yang and Haugen 2016).

Furthermore, Yang and Haugen (2016) mentioned that following four dimensions might clarify the definition of operational planning decisions:

- *Available time,* which is including the degree of emergency (Orasanu 1995). There is a relatively short time like from days to weeks from a need arises until the decisions have taken. But the time for some emergency decisions that have to be taken immediately is not considered in the operational planning.
- *Available knowledge*. Available knowledge. There should be gathered enough detailed information about relevant factors that may influence risks, and knowledge needed. Theoretically, information about technical conditions about safety barriers,

who is going to perform the work, the competence of workers, available resource, and weather conditions as well.

- *Decision maker*, which is the level of decision-making in an organization. In theory, the middle-level managers or project managers, engineers (designer), operational managers and front-line operators have to take a decision in operational planning.
- *Consequences*, which is the effects of the decision. Decisions for operational planning mainly consider the activities that have relatively short durations. Thus the focus primarily on the short term effects. However, the decisions might have long term as years, medium as months to weeks or short term as day effects.

5.1.2 Operational Planning Process

In general, the planning can be defined as making a decision in advance for coming activities, to achieving a goal. According to managerial language (MSO u.d.), *the planning* is termed as a forward-looking process, which means an organization creates a forecasting of future activities so that, the organization may have more confidence regarding the accuracy of future events.

Incidentally, the planning process, which is used on the NCS, is a standardized process based on the concept of Integrated Operations (IO), which is defined in part 5.3**.**

In addition, Sarshar et al. (2015) have pointed out that the planning is performed with different time horizons as several years, one year, three months, two weeks and the 24 hours as well. *An operational plan* is a three months forward-looking process for operation. Thus, the operation plan contains the primary information about operations and maintenance and modifications. Thus, the operation plan contains the primary information about operations and maintenance and modifications. Mainly the operation plan includes tasks as following:

- The main tasks within Health, Safety, and the Environment (HSE)
- The production related tasks that require shut-down
- Additional tasks that are requiring external resources
- Bed capacity, which is a crucial constraint for performing work offshore due the capacity of the installation to accommodate people
- The tasks requiring coordinated actions (e.g. heavy lift operations)
- Monitoring.

Furthermore, Sarshar et al. (2015) described that the companies have operational plan meetings that are held in every two weeks, and in the meeting participate people both from onshore and offshore to evaluate simultaneous activities and the total activity level with a focus on production and risk. Thus, the purpose of the operational plan is to assure that the decisions and activities from the primary plan are performed and to set the framework for activities on underlying levels like top-down planning.

Furthermore, the operational plan is followed by *the work order plan*. Thus, the work order plan contains all activities that are planned and prepared in deeply in coordination with logistics and contractors, and the involvement of people both onshore and offshore.

The purpose of *the work order plan* is to assure that the execution of work is coordinated between the different actors and to plan for safe, effective and reliable execution of work on the offshore installations. By following this, a work order is a formal request for work, which means it is a need for work. Thus, the work order contains a description of a job package, and usually, it is describing subtasks that might be particular in sequence. Then, personnel must apply for a work permit to perform the particular work. Therefore, a work permit describes as a work permission for a particular work.

The point of *the work permit* is to maintain control over which activities execute on the installations, and it applies mostly to maintenance work (corrective or preventive) on the process equipment, pipes, and structure of the platforms. The corrective maintenance corrects when failures have occurred while the preventive maintenance prevents failures to occur. Moreover, considering the risks for work, then the work permit can be differentiated as for high-risk jobs that are classified as level 1, and for low-risk jobs that are classified as level 2, and there are some jobs that not require a work permit at all (Sarshar, Haugen and Skjerve 2015).

Figure 9 illustrates the planning processes from an operational plan (steps from A to H) to a work order (steps from I to P) and a work permit (steps from Q to T) to perform the work (U) in offshore.

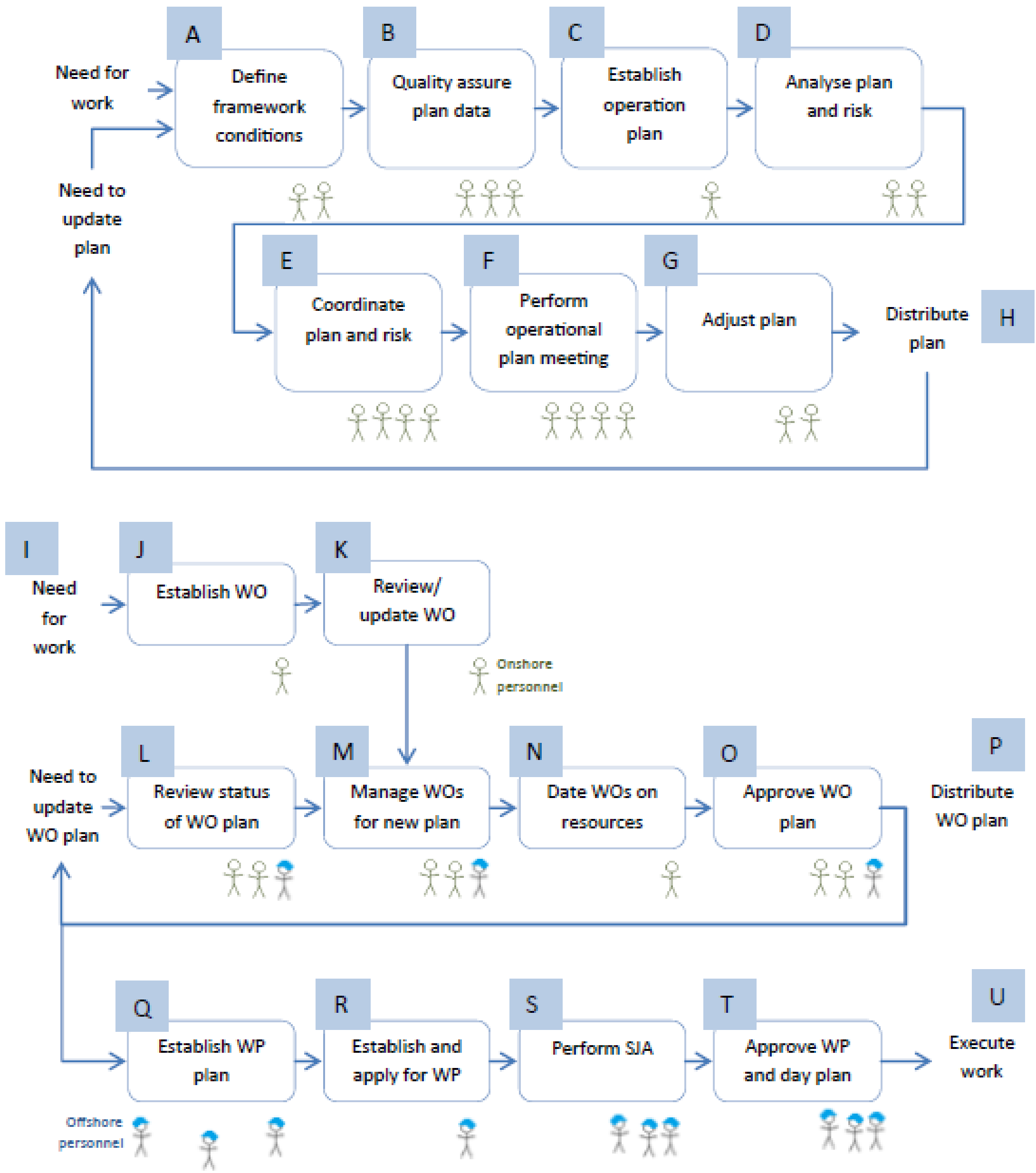


Figure 9 The complete operational planning process to execute work offshore [Source: (Sarshar, Haugen and Skjerve 2016)]

5.2 Logistics Planning

The term logistics planning is mostly used in quantitative logistics management literature, which contain topics as production planning, inventory management, distribution planning, vehicle routing, etc. (Aas 2008). In the UPL, the logistics planning often is connected to vehicle routing problem (Toth and Vigo 2014), which is the limitation in this part. On the other hand, Aas and Wallace (2008) defined logistics planning as an activity, and its purpose is to find an efficient way to coordinate and guide the resources for logistics operations. Thus, in the UPL, one important thing is supporting the offshore activities so that they can be executed as planned and in cost efficient manner (Aas, Halskau and Wallace 2009). Furthermore, the main objective of logistics planning is to substitute low customer service levels, waste and the use of buffers and slacks in the execution of logistics activities. Consequently, the poor logistics plans can result in inefficient use of logistics resources, and it should be considered to avoid of, and sometimes the logistics planning most likely needs some changes concerning the logistics resources used for executing the logistics (Aas and Wallace 2008).

5.2.1 Emergency Logistics Planning

Research on the topic “emergency logistics planning” resulted in some research articles that is limited to quantities work. For instance, Haghani and Oh (1996) presented a single objective linear programming model on a time-space network with detailed routing and scheduling of available transportation modes, and the aim was to minimize the sum of total costs over all time periods while Fiedlich et al. (2000) proposed a dynamic combinatorial optimization model and a heuristic to determine an optimized resource schedule for assigning resources in space and time to the affected areas after strong earthquakes, where the aim is to minimize the total number of facilities during the search.and –rescue period.

The Emergency Logistics planning is an action where the goal is forwarding deliveries (e.g., medical materials, personnel, specific materials, specialized rescue equipment and rescue team, food, etc.) to the joints in affected areas as quick as possible (Özdamar, Ekinci and Kucukyazici 2004) Thus, the aid operations are speeded up. Furthermore, Sheu (2007) mentioned that a critical issue for emergency logistics is the quick response to the urgent need. Furthermore, the emergency logistics can be obtained by repetitively solving the dynamic time-dependent transportation problem with an aim to minimize unsatisfied demands of all commodities throughout the planning horizon (Özdamar, Ekinci and Kucukyazici 2004). Thus, the emergency logistics plan contains optimal pick-up and delivery schedules for transport modes within the scheduled planning time the horizon, optimal quantities and the type of materials picked up and delivered on those routes (Chang, Tseng and Chen 2007).

In emergency logistics planning, a proposed three –layers emergency logistics co-distribution conceptual framework considered by (Sheu 2007). **Figure 10** illustrates a proposed conceptual framework of the specified emergency logistics network that involves two mechanisms such as relief supply channels and relief distribution channels with three main chain members as (1) relief suppliers, (2) urgent relief distribution centers, and (3) relief demanding areas, which is forming a specific three-lyers relief supply chain (Sheu 2007).

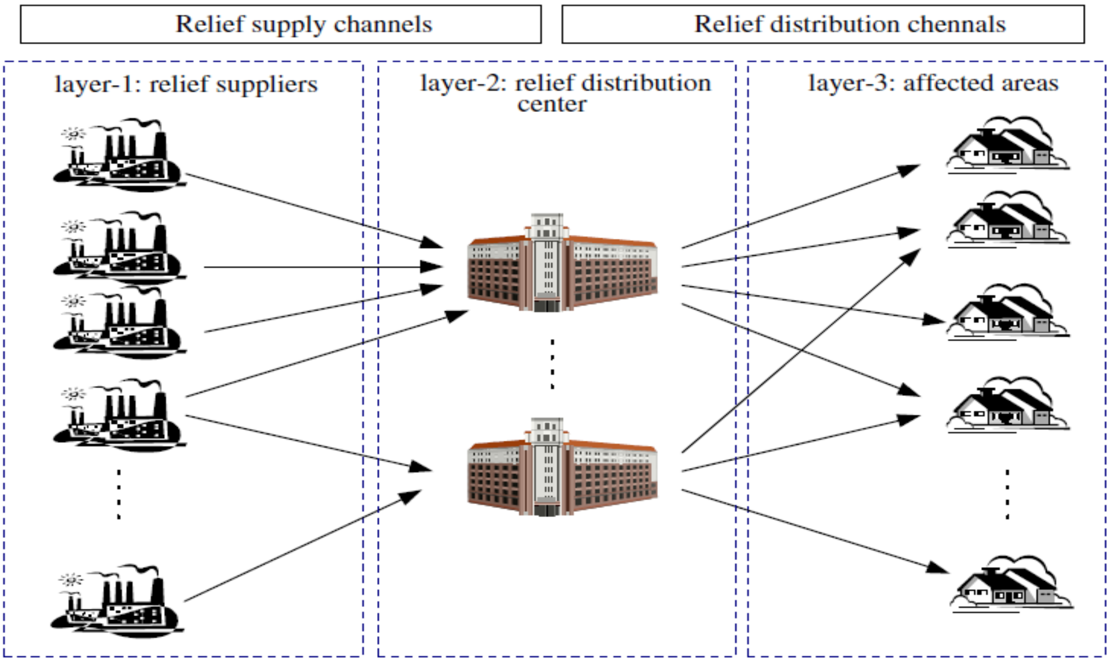


Figure 10 A specific three-layer supply chain in emergency logistics network [Source: Sheu, J. (2007)]

Incidentally, Chang et al. (2007) mentioned that improving the efficiency of emergency logistics might depend on circumspect preparation plans made in peacetime.

5.3 Integrated Operations

Within the Norwegian oil and gas industry, the term Integrated operations (IO) is defined as an integrated work process between onshore personnel and offshore fields using real-time data (OLF 2008). According to the Center for Integrated Operations in the Petroleum Industry (IO Center), within the petroleum industry it is a new way of optimizing the operation of offshore fields by using smart solutions and making smarter decisions through the integrations of professionals with different expertise, work processes, and information and communication systems from various domains (IO Center 2008). Furthermore, the real-time data sharing between onshore and offshore might be used to eliminate the physical distance between offshore installations and the support and the operating organization onshore, between professional groups, and internally in the company and its suppliers, and service companies (Skarholt, et al. 2009). Integrated operation shows how modern information and communications technology (ICT) provides possibilities for a remote operation by using high bandwich fiber optic networks that makes real-time data sharing (Rosendahl and Hepsø 2013) , and is a new and efficient manner of working (Statoil u.d.), and it builds on the capability to collaborate (Sarshar, Haugen and Skjerve 2016).

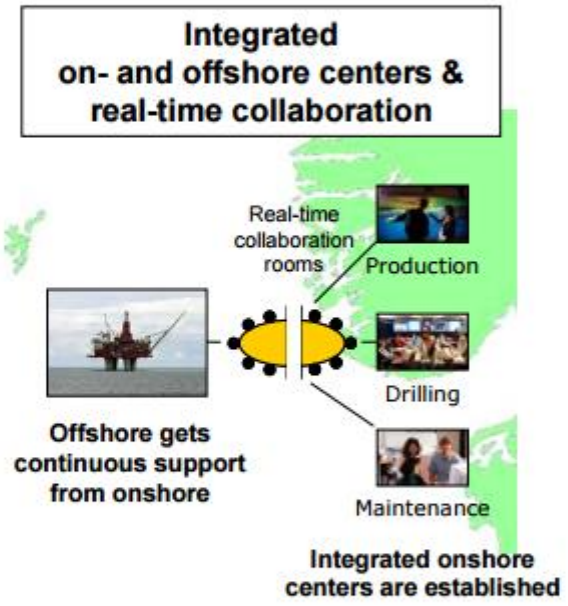


Figure 11 The concept of Integrated operations on the NCS, [Source: (OLF 2005)

Moreover, by putting all parts as the organization of people, processes, and information systems together in integrated operations can result in making smarter decisions to optimization of the whole value chain. Incidentally, people with different expertise from anywhere in the global networks of the oil companies and their suppliers will work together to solve local problems throughout assets worldwide (IO Center 2008). Thus, the purpose of IO, which is described in OLF (2005), is to achieve increased and accelerated production, increased recovery, increased safety in operations and reduced operational costs, as illustrated in **Figure 12**.

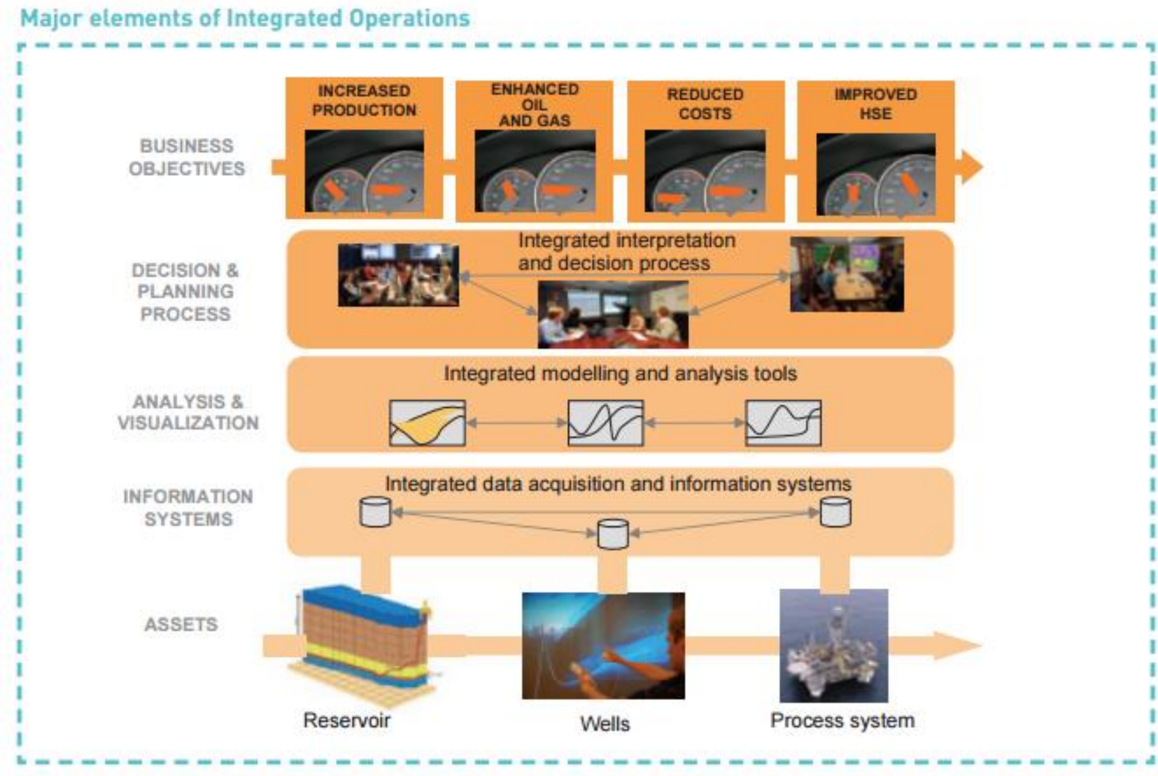


Figure 12 The major elements of Integrated Operations [Source: (IO Center 2008)]

5.3.1 Integrated Planning and Logistics

Within the oil and gas industry, the transferring of Integrated Operation (IO) projects into the planning domain created the concept of Integrated Planning (Rosendahl and Hepsø 2013). According to the Center for Integrated Operations in the Petroleum Industry (IO Center), Integrated Planning Logistics (IPL) is a cross-disciplinary planning activity that is required to establish the overall operational plan, especially focusing on the logistics role in the interface. Thus, it contains the identification of needs related to information exchange, communication, decision authorities and collaboration to obtain better and quick decisions considering coordination and prioritizing of operational activities. The purpose of the IPL is achieve improvements in planning across geographical, organizational, and professional boundaries to increase the efficiency of operation and reduce operational costs. IPL proposes an IPL-model that focuses on three key supporting factors as (1) *information and communication tools* (ICT), (2) *processes and roles* for describing best practice, (3) *arenas* for coordination of plans, and additionally four organizational capabilities

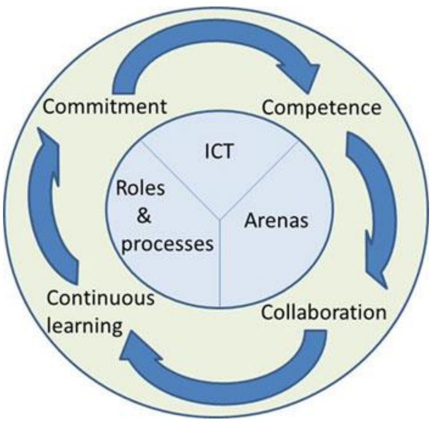


Figure 13 The IPL-model [Source: MARINTEK]

such as competence, collaboration, continuous learning and commitment as shown in **Figure 13** (MARINTEK n.d.). IPL concept is based on several theories, Network Centric Warfare, Agile Manufacturing and Agile Project Management. The IPL provides an organization with a better overview of the operation and more capable of understanding the constraints under which the operation is working thus better realizing the assets plans regarding productions and recovery (IO Center 2008)

5.4 Challenges in Offshore Planning

The primary challenge in offshore operations is the uncertainty associated with a plan (IO Center 2008). Regarding the definition of planning, which is described in part5.1, thus, the future is uncertain and risk oriented. Therefore, the plan usually has affected of the uncertainty of future (MSO u.d.).

Moreover, the causes of urgent delivery can be found not just in uncertainty, but also in the preparation for performing work activities in offshore and planning of the project. In PSA (2012), the preparation for work activities is crucial for acute incidents on offshore installations. For instance, many different factors and a long chain of events that have root causes such as misunderstanding of work, lack of information and communication flow among groups and individuals as well might affect the cause of dangerous situations and the accident (Sarshar, Haugen and Skjerve 2015).

Besides, there are some challenges in planning that may cause to occur an urgent situation in the execution of the work. Sarshar et al., (2016) have pointed out that the challenges in planning divides into four topics such as (1) inadequate plan, (2) inadequate planning, (3) inadequate shared overview and (4) understanding and late risk identification. Thus, earlier in the planning process identifying the possible risks might help to make the plan more adequate.

Furthermore, Sarshar et al. (2016) identified thirteen factors that might influence serious accidents and acute situations in the execution of work offshore. These factors are following:

- *Information flow*: If information is weak, unclear, inadequate or unsuitable between the different steps in the planning process.
- *Communication*: Lack of communication or inadequate communication channels between the different actors and roles.

- *Misunderstandings*: Misperceptions influence the quality of execution of work.
- Documentation: When the documentation is not fitting the reality in the system or missing.
- *Procedures*: Unclear and imprecise procedures or it is missing.
- *Planning quality*: It happens when the planning process is poor defined or inadequate.
- *Plan quality*: It happens when the plan and its content is inadequate.
- *Competence*: The required competence is not available or present.
- *Overview and situation awareness*: The overview of activities is not completely and the situations complexity.
- *Work practice*: When a work practice deviates of defined processes or procedures.
- *Workload*: Inadequate resource or time to execution of work.
- *Risk assessment*: It happens when an inadequate analysis or measures not followed up.
- *Learning*: It is related to the planning process in their study.

According to Yang and Haugen (2016), the maintenance work is including the planning and preparing equipment for repair and also latent failures (e.g. incorrect fitting of flanges or bolts, valves in incorrect position, etc.). Furthermore, Sarshar et al. (2016) pointed out that accidents not caused only by one factor, mostly a combination of factors, for example, “lack of maintenance due to the wrong classification of equipment” or “lack of maintenance failure with new hazard” (Okoh and Haugen 2013). Thus, it is important to focus on equipment criticality classification. The result of the wrong classification of equipment or wrong use of classification may be a critical equipment maintained insufficiently, or a less critical equipment maintained overly. Thus, it can increase the probability of maintenance induced accidents or failures (Øien, et al. 2010).

In addition to this, Okoh and Haugen (2013) explained the relationship between a given accident and its maintenance related causes, the consequences, the safety barriers, and the failure pathway in a bow-tie diagram, see **Figure 14**. For more technical explanation, see

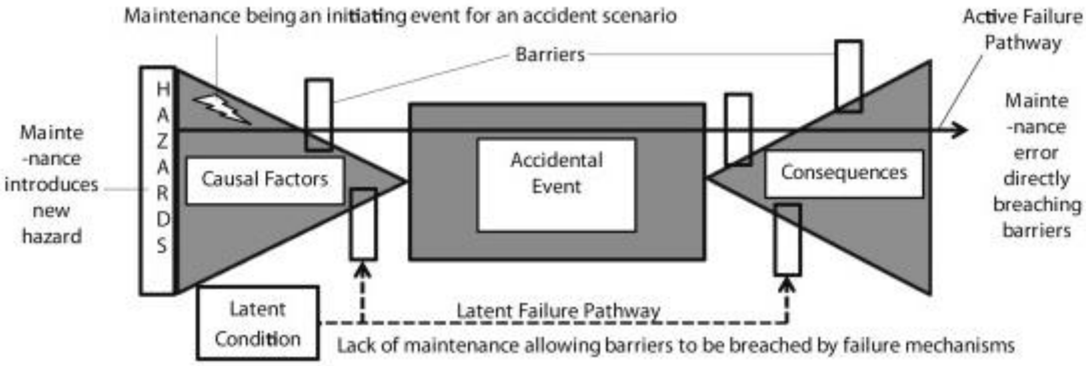


Figure 14 The maintenance related causes linked to an accident process [Source: (Okoh and Haugen 2013)]

Furthermore, Okoh and Haugen (2013) classified the work process for maintenance related causes into two situations. Thus, the maintenance failures can occur either in during turnaround or outage or in during normal operation. See **Figure 15**.

Deficient work process	Potential deficiencies	Deficient work process
Deficient Planning/Scheduling/Fault diagnosis	Wrong act planned, planning undone, omission in plan, unrequired in plan, unsafe conditions ignored/ Wrong timing, wrong overlap, timing undone, omitted steps, wrong sequence, use of wrong plan, omitted responsibility/ wrong test frequency, wrong test, test undone , low test coverage, unrequired in test, wrong procedure, wrong calibration etc.	**Deficient Planning/Scheduling/Fault diagnosis**
Deficient mobilization/shutdown (shutdown not always necessary, e.g. during unplanned outage)	Deficient supply, movement or assembly of resources/Incorrect shutdown, imperfect switching between units in redundant systems etc.	**Deficient mobilization/shutdown** (Shutdown is applicable to redundant systems repair, but not to activities such as hot tapping and hot bolting)
Deficient Preparation for maintenance	Deficient isolation, deficient inerting, deficient evacuation of hazardous materials, deficient bypassing of redundant safety systems etc.	**Deficient Preparation for maintenance**
Deficient performance of maintenance work	Wrong actions, omitted actions, unrequired actions, work undone, supervision lacking, other unsafe acts etc.	**Deficient performance of maintenance work**
Deficient startup	Deficient checking (e.g. pressure test), deficient de-isolation, deficient pre-startup safety review, imperfect switching between units in redundant systems etc.	**Deficient startup** (Startup is applicable to redundant systems repair, but not to activities such as hot tapping/bolting)
Deficient normal operation	Wrong operating conditions, etc.	**Deficient normal operation**

Figure 15 The classification of work process for maintenance-related causes [Source: (Okoh and Haugen 2013)]

From the upstream supply chain management, the maintenance resources are finite and some constraints must be considered in planning of maintenance of activities (Shafiee 2015).

6 Information Flow and Information Systems

6.1 Information flow

In any supply chain, materials flow and information flow both play an important role in order to meet customer requirements in an efficient manner. Information plays an important role in the supply chain, where sharing more information throughout the network can lead to making better decisions for every single part involved.

The oil and gas industry is known for its mega-projects characterized by high complexity involving a lot of contractors, sub-contractors and other actors and stakeholders in a series of very complex and inter-linked relationships. Thus, the management of interorganizational and intraorganizational relationships is very important. The information flow between the different users inside the firm and its vendors require a special focus through relationship management. (Engelseth, Wang, et al. 2015).

According to Pereira (2009), the management of information is a core element in a supply chain management context where missing, delayed, distorted or wrong information can cause inefficiencies in the supply chain and can represent a considerable challenge. Chopra and Meindl (2010) describe that the use of information affects deeply every part of the supply chain and having a good information flow on demand and supply will definitely improve the utilization and responsiveness of the whole supply chain.

According to Jæger and Hjelle (2015) from the perspective of business processes, a network’s operational complexity can be judged by the number of interconnected companies, the number of flows between these companies and the heterogeneity of the technology environment at each company. The more companies, each with their own information services to support their business, the higher the level of complexity, as illustrated in **Figure 16**.

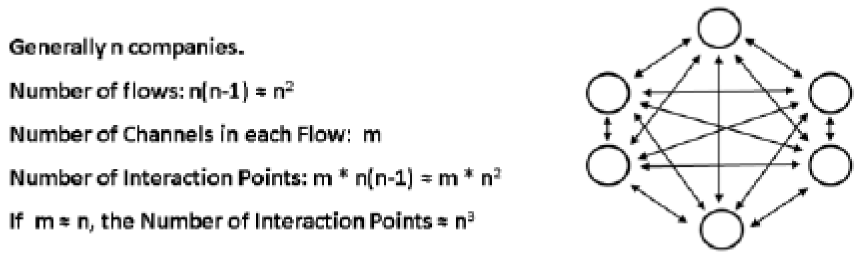


Figure 16 Connection complexity in a general supply network [Source: (Jæger and Hjelle 2015)]

Even in relationships that involve just two companies, one supplier and one buyer, there are a lot of other third party companies involved in the information handling related to this transaction. UNDA 7th tranche project (2013) illustrates in **Figure 17** a typical case for international trade flows, where there are 13 actors involved and a total of 49 necessary exchanges of information for the supplier and 50 for the customer.

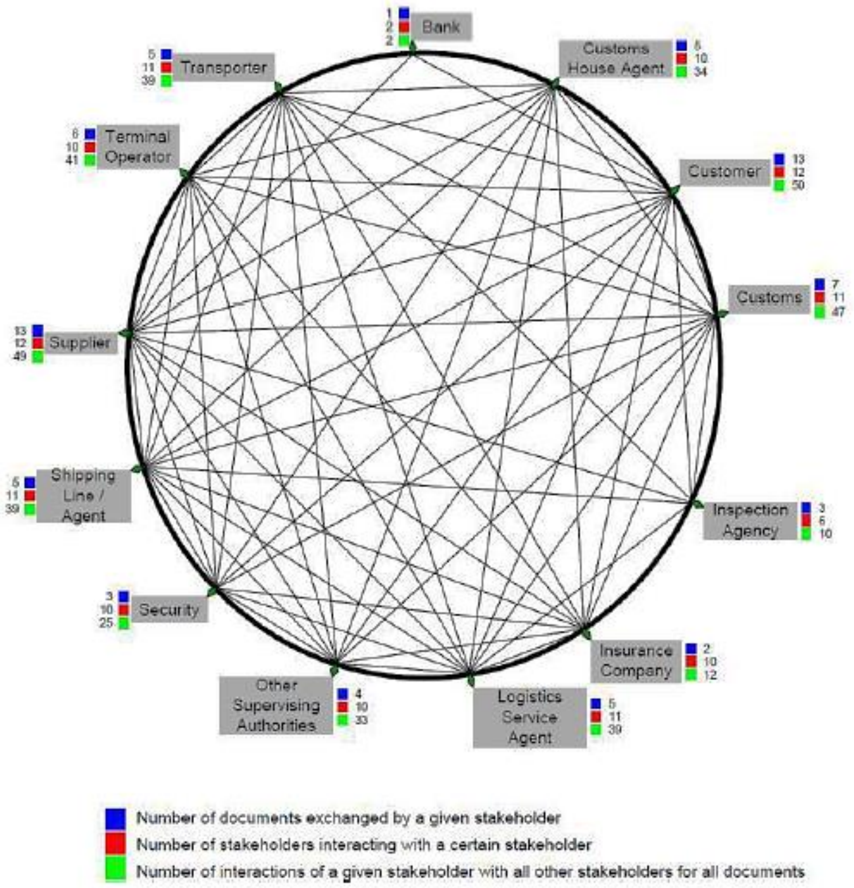


Figure 17 Information flow in international trade between two companies [Source: (UNDA 2013)]

6.2 *Information systems*

An information system is a computer system that provides management and other personnel within an organization with up-to-date information regarding the organization's performance, for example current inventory and sales. It is usually linked to a computer network and is designed to capture, transmit, store, retrieve, manipulate and display information used in one or more business processes. The different types of information that comes out of the system should be useable at all levels of an organization (strategic, tactical and operational) (Encyclopedia of Management 2013)

Information systems consist of three layers, visualized in **Figure 18**. (1) Operational support layer forms the basis of an information system and contains various transaction processing systems for designing, marketing, producing and delivering products and services. (2) The support of knowledge work contains subsystems for sharing information within an organization, and the (3) management support layer contains subsystems for managing and evaluating an organization's resources and goal.

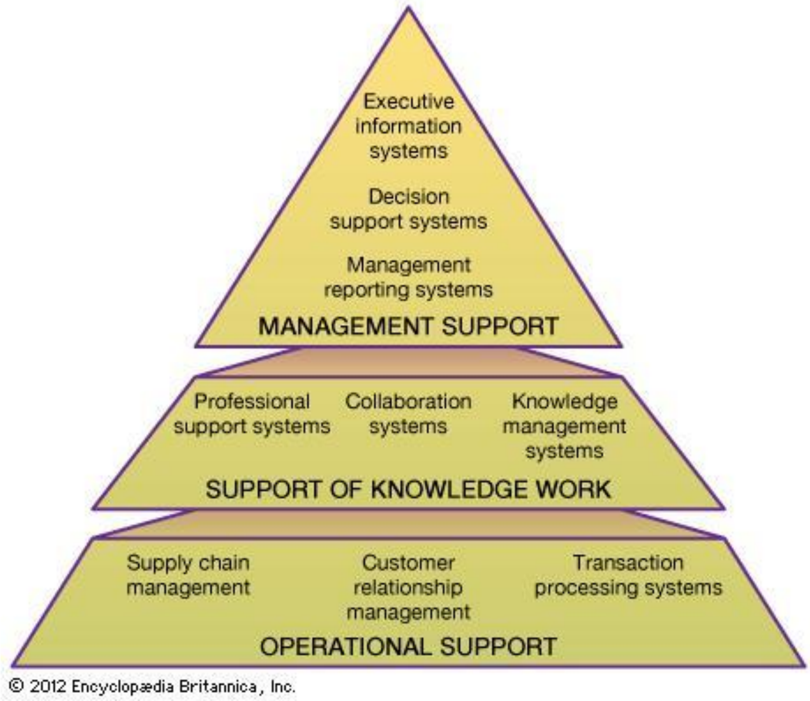


Figure 18 *Layers of an Information System [Source: (Encyclopedia Britannica 2016)]*

Throughout our research, the focus has mainly been on the operational support layer, so we further detail the three types of information systems. The *transaction processing system* supports the various functional units, such as sales and marketing, production, finance and human resources, which are integrated in an enterprise resource planning (ERP) system. The *supply chain management system (SCM)* manages the flow of products, data, money and information throughout the entire supply chain. The *customer relationship management system (CRM)* supports dealing with the company's customers in marketing, sales, service and new product development (Encyclopedia Britannica 2016). The most complex ERP systems integrate SCM and CRM as modules in their offering, as well as management support modules.

Blos, et al. (2009) stated that information systems are commonly accepted to be an effective approach to manage supply chains under disruptions. Moreover, Skipper and Hanna (2009) mentioned that information systems could contribute and improve flexibility of supply chains.

6.2.1 IS inside companies

Each company may have dozens or even hundreds of separate computer systems. Some large enterprises even have multiple ERPs resulting from mergers and acquisitions (Jæger and Hjelle 2015). Cecere (2014) reports an average of four ERP instances per company.

For any company, to achieve the strategic goal, the information flow must be shared equally from the managers at the top level to the workers at the bottom level. Thereby the whole team of company works for delivering the right product to the right customer at the right time, at the right place, in the right condition, in the right quantity and at the right cost (Hossain, Hasan and Ahmed 2015).

When it comes to the ERP software, there are a lot of options out there, as Panorama Consulting Services mention in their latest report (2016), "there has been no other time in history when organizations have had so many enterprise software options." According to Gartner (2015), the ERP market is dominated by a few big players like SAP, Oracle, Sage, Infor and Microsoft, but there are still a lot of small players out there, as illustrated in **Figure 19**.

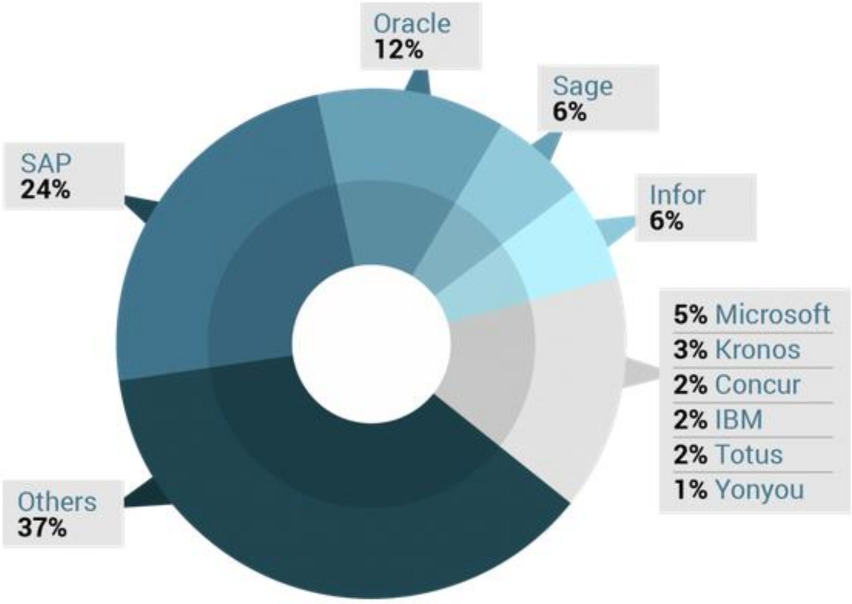


Figure 19 *ERP Providers [Source: (Gartner 2015)]*

6.2.2 IS between companies

The supply networks are complex and involve mutual dependencies with different trading partners like manufacturing companies, service providers, third-party logistics providers, freight forwarders and transportation providers. Although advanced new information systems are used by a variety of companies with a great success, technology that actually serves multi-party supply networks is still underdeveloped (Jæger and Hjelle 2015). While companies streamline their internal business processes by using integrated ERP-systems, doing the same to the operation of the extended supply chain is much more challenging since it involves a multitude of companies and information systems.

According to Sufian (2010), companies implement information technology in order to achieve effective supply chain integration. Through integration in the supply chain, a base for quick and precise exchange of information can be achieved. Integration is the driving force behind operationalizing, cooperation and exchanging information in the relationship with suppliers (Jespersen and Skjøtt-Larsen 2005). Using information technology allows data to be shared immediately with all stages of supply chain, for instance, it can significantly reduce the time and cost to process an order, capturing and sharing information of real time demand could lead to improvements in supply chain performance (Cachon and Fisher 2000).

The average company operates in a heterogeneous technology environment, where there is a widely requested need for visibility and synchronization across instances of ERP between companies (Cecere 2014). Nevertheless, visibility across companies has been made possible in recent years through new technologies and standards like improved labeling or track and trace systems (Sarma, Brock and Ashton 2000). This information can be made available across the supply chain through internet connectivity and more recently through cloud services.

Considering the extent of the information flow that goes on between companies (**Figure 17**), coordination and synchronization across supply chain becomes a challenge. According to Cecere (2014) the most common business-to-business communication channels include EDI, phone, email, spreadsheets and enterprise web portals, as illustrated in **Figure 20**.

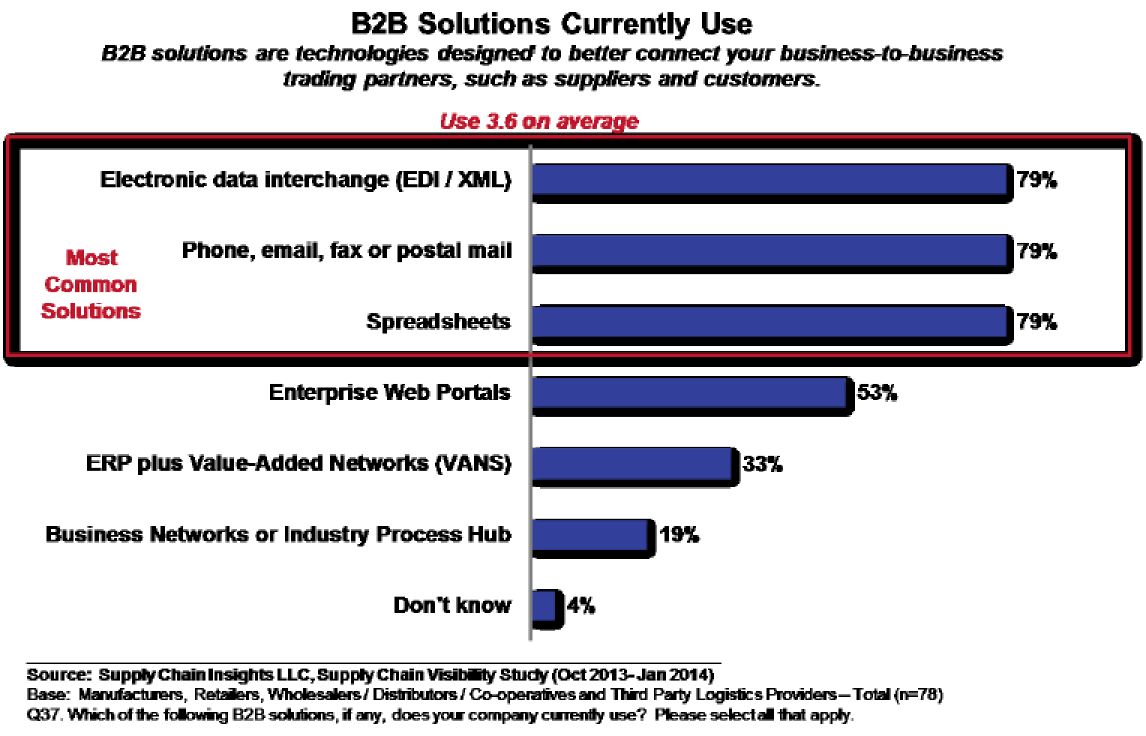


Figure 20 *B2B solutions used by companies [Source: (Cecere 2014)]*

Electronic Data Interchange (EDI) is the electronic transmission of information and documents such as invoices, sales orders and purchase orders between computer systems in different organizations based on a standard structure, machine-retrievable format (Sanchez and Perez 2003). The definition includes the direct transmission of data but also transmission using an intermediary such as value-added network (VAN), exchange of disks or other storage devices (Hill and Ferguson 1987). VAN is a service that provides a way of data transmission between businesses in the EDI industry. By moving from a paper based exchange of business documents to one that is electronic, businesses enjoy major benefits such as reduced cost, increased processing speed, reduced errors and improved relationships with business partners (Hsieh and Lin 2004). But there are drawbacks to EDI as well: it is expensive, especially for small and medium sized businesses, the initial setup is time consuming, business processes depend on standard formats that can change, it is vulnerable to viruses and hacking, requires staff training cost, requires proper backup and can limit the trading partners as some businesses partners require EDI (Sparrow 2015). Moreover, it is a unidirectional and fixed private network with fragile links that can easily break (Cecere 2014).

Simchi-Levi, et al. (2008) reason that the ability to track goods in supply chains is an asset that should be utilized, and the challenges linked to lack of visibility are counteracted with increased inventories and extra staff. But a better solution would be to establish a good cooperation with the transport companies and suppliers in the area of information sharing. In one of their reports, IBM (2011) argues that a good supply chain visibility can help resolve supply chain exceptions before they escalate into major problems and can improve the performance of the 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.

In the oil and gas industry in Norway, the information challenge has motivated companies to establish a number of shared information handling services for all players in the supply chain. The Exploration and Production Information Management association (EPIM), an organization owned by all the operators on the NCS, has developed services in five different areas: joint venture management (JVM), quality, health, safety and environment (QHSE) services, exploration & production subsurface services, supply chain management services and infrastructure & technology services (EPIM 2016). Below, some of these solutions that are relevant for the research are detailed:

- LogisticsHub is a joint information hub containing real time tracking data of cargo containers units (CCU) as they are being loaded, shipped and unloaded by the companies in the offshore supply chain. RFID tags are installed on the containers and antennas are installed on premises. This allows real-time tracking information of CCUs of all the relevant stakeholders, as shown in **Figure 21**. The tracking informs the actors on when to expect the CCU to arrive, and the container company is able to locate units that are idle or in need of repair or that require recertification. This is still in project phase. EPIM's opinion is that the implementation of this project has a potential to increase the efficiency of the logistics in the industry with up to 25%, and thus lead to increased competitiveness of the companies. The objectives represent simplified management of the CCUs and goods, improved visibility and less waste of time and resources.

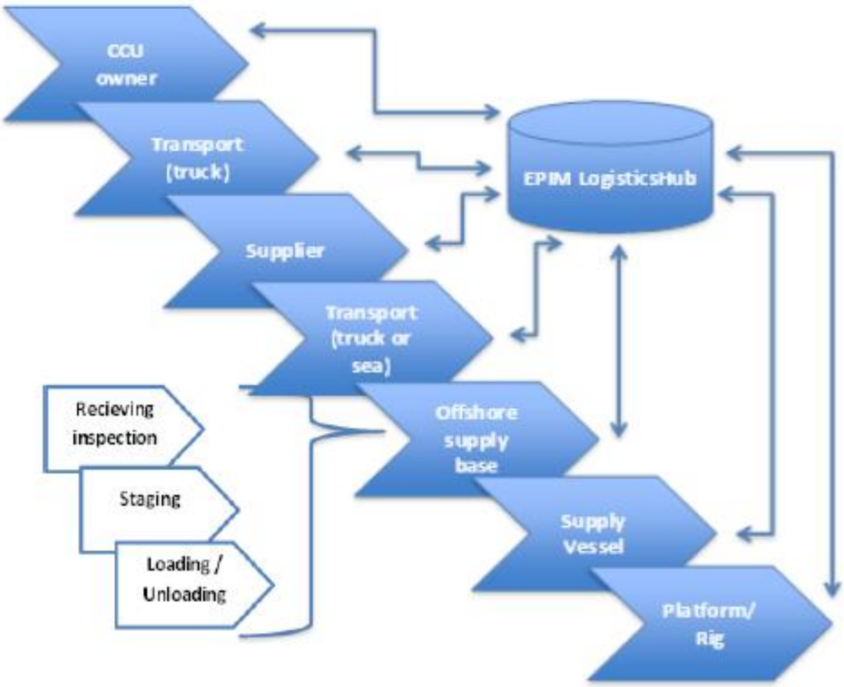


Figure 21 *Companies in the supply chain generate CCU events recorded into the LogisticsHub [Source: (Jæger and Hjelle 2015)]*

- EqHub is an online documentation platform that simplifies the documentation process of equipment for offshore installations. All the documentation information of standard equipment is found on the hub, in standard equipment information handling forms. This reduces the costs in regards to documentation processes and makes it easier for both operators and suppliers to find the right documentation when it's needed.
- Cassandra (Cassandra 2016) is an EU funded project that created a data pipeline to improve the supply chain visibility during the international container supply chain shipments. The information from the source becomes available to other actors in the supply chain during the shipment process and they can also add their own relevant data to the pipeline. Actors can access the necessary data from the pipeline for their

operations. The buyer is better informed about the shipment, thus making receiving the goods more predictable. Customs interactions is also simplified.

A main challenge with collecting the data in one information hub is the reluctance of companies to share their personal data. Not all the actors in a supply network would want to share all the data that could be actually shared. Even if the information hub would greatly improve the performance of the supply chain, it does not necessarily mean that the individual actor would also benefit from the data sharing. In some cases, such concerns are supported through a risk evaluation, but in other cases, fear of sharing data could just be a matter of culture. So solutions should be put in place that enable actors to maintain control over their data and who it is shared with (Jæger and Hjelle 2015).

Although information systems have the ability to reduce risks and remove uncertainty, these are standardized tools and cannot replace people completely (Zuboff 1988). In a complex supply chain, the human brain is still necessary to deal with changes that occur in the operations, problem solving, taking decisions or performing the necessary communication. But advances in technology, such as artificial intelligence, machine learning, big data management and cloud computing can definitely make it easier for humans to react to changes and take better decisions.

PART III: THE INDUSTRY AND THE SUPPLY NETWORK

Since we have chosen to base our case on the Norwegian petroleum industry, this part serves as background for better understanding of the industry, the area of our study and the different companies involved in the study and their supply chains. First, we start with a description of the Norwegian petroleum industry and the upstream petroleum logistics, and then we go into the specifics of the Haltenbanken area and the current activity. This part concludes with a short description of the 15 companies involved in the research study and a visualization of their interdependencies via a supply chain network.

7 Norwegian Petroleum Industry

7.1 Norwegian Continental Shelf (NCS)

The Norwegian Continental Shelf is gigantic and divided into three ocean areas: North Sea, Norwegian Sea and Barents Sea (**Figure 22**). When the NCS was discovered for oil and gas first time in 1969, everyone realized that the industry would have a big impact on Norwegian economy. The production activities started from the first field "Ekofisk" in 1971. Since then, the exploration activities have led to remarkable discoveries, and so far there have been discovered 100 oil and gas fields on the Norwegian Continental Shelf. Today, oil and gas are extracted from 82 fields (65 in the North Sea, 16 in the Norwegian Sea and 1 in the Barents Sea).

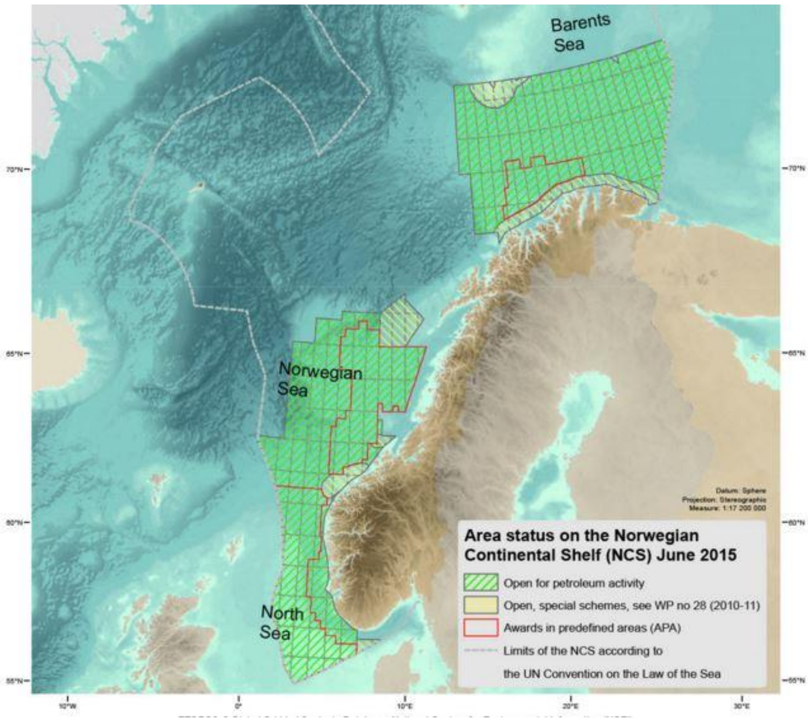


Figure 22 *Area status on the NCS [Source:Norwegian Petroleum Directorate (NPD)]*

7.2 The Norwegian Petroleum Adventure

The most beautiful memory of the Norwegian petroleum industry was the day before Christmas in 1969 when Norwegian petroleum authorities received news from Phillips about the discovery of Ekofisk field, which is one of the largest offshore oil fields ever discovered on the NCS, and this was just the beginning of Norway's petroleum story. In the next years, many of the significant discoveries such as Statfjord, Gullfaks, Oseberg, Troll, Åsgard and Snøhvit were found in the Norwegian Continental Shelf.

Currently, the industry has gotten a new North Sea giant oil field that is now under development and called Johan Sverdrup. This field has brought a big future and bright spot in the difficult time for Norwegian petroleum industry. Moreover, this giant oilfield is expected to produce 1.8-2.9 billion barrels of oil for seven decades when it comes on stream in 2019. **Figure 23** shows the historical timeline of the major fields on the NCS.

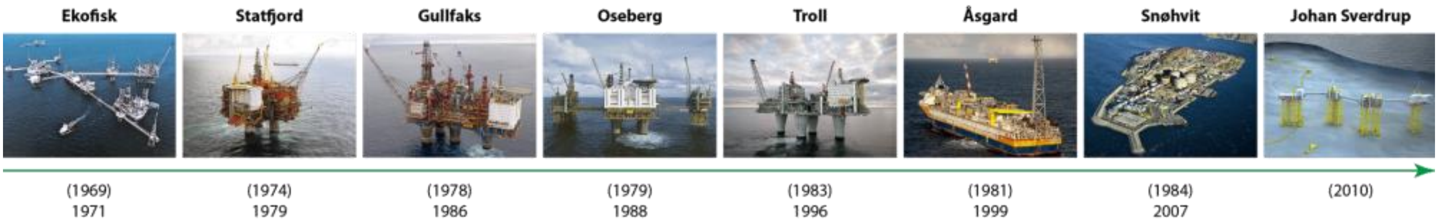


Figure 23 The major fields with the year of discovery and production start [Source: The Norwegian Petroleum Directorate]

Norwegian participation in developing the first oil and gas fields started with Norsk Hydro, and gradually increased as Saga Petroleum and Statoil entered the market. These companies were established in 1972, and Statoil was owned by Norwegian state.

Today, there are more than 50 companies involved in exploration, production, and infrastructure on the NCS. Currently, 34 companies are operators and 20 companies are pure partners in production on the Norwegian Continental Shelf, and this diversity of companies ensures competition, efficiency, use of various technology and broad competence in the industry.

Referring to NPD, Statoil is the largest company on the NCS, measured by the company`s production volume, and it is followed by the main international companies such as ExxonMobil, Total, Shell, ConocoPhillips, and Eni.

Table 3 shows total petroleum production on the Norwegian Continental Shelf divided into sea areas, at the end of 2015.

Sea Area	*Oil*	*Condensate*	*NGL*	*Gas*	*Total sum o.e*
North Sea	*3504.39*	*74.70*	*246.15*	*1626.00*	*5451.24*
Norwegian Sea	*570.97*	*33.08*	*96.09*	*414.96*	*1115.10*
Barents Sea	*0.00*	*5.93*	*3.32*	*35.27*	*44.52*

Table 3 *Total production per Sea area in 2015 [Source: The Norwegian Petroleum Directorate]*

Figure 24 shows the development of oil and gas production on the Norwegian Continental Shelf from its start in 1971 to 2015.

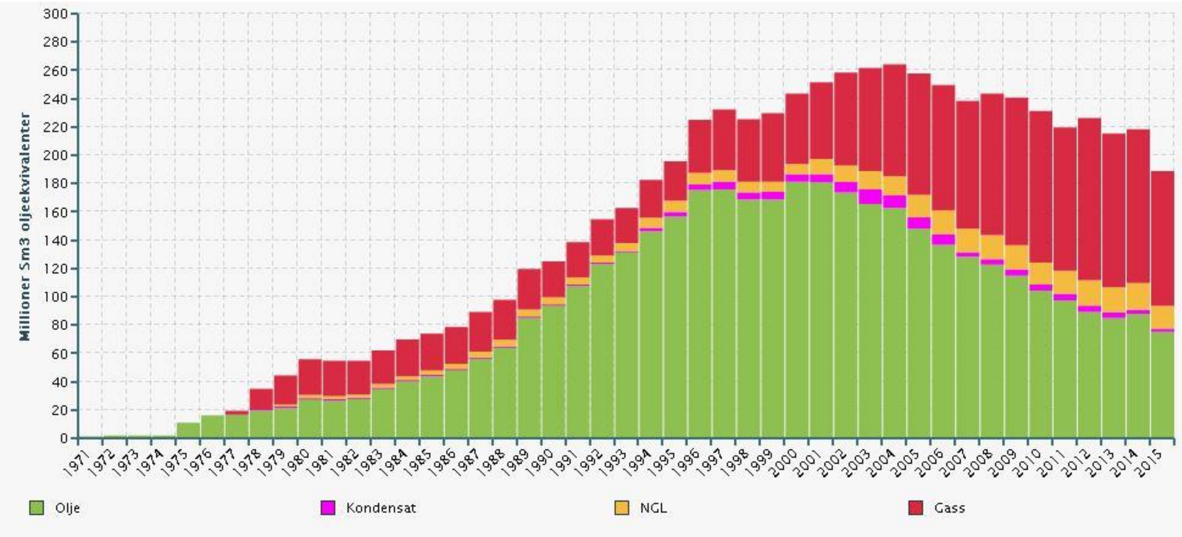


Figure 24 *Annual petroleum production, 1971-2015 [Source: The Norwegian Petroleum Directorate]*

According to NPD, the total production of marketable petroleum was 227.8 standard cubic meters of oil equivalents in 2015. It shows that the production in 2015 was 14% lower than in the peak year 2004, which was 264.2 million sm^3 o.e. 5% higher than in 2014 where 216.2 million sm^3 o.e. was produced. Most of the produced petroleum resources have been exported and sold to different countries. The revenues from sales of oil and gas have played a vital role in creating the modern Norwegian welfare state. Thus, today Norway is one of the leading and largest suppliers of oil and gas on the global market.

7.3 The Norwegian Petroleum resource

One of the most important tasks of Norwegian Petroleum Directorate is having an overview of all of the Norwegian petroleum resources on the Norwegian Continental Shelf. It helps to manage the petroleum activities in the best interests of the Norwegian society.

According to Norwegian Petroleum Directorate, the current estimated petroleum resources are about 14.2 billion standard cubic meters of oil equivalents. Approximately 47 % of this is measured as produced and sold.

The calculation of total petroleum resources on the Norwegian Continental Shelf in 2015 is following in **Table 4**.

Resource category	Oil	Gas	NGL	Condensate	Sum o.e
Production, sold and delivered	*4075.4*	*2100.4*	*179.5*	*113.7*	*6630.5*
Reserves	*1023.0*	*1856.5*	*116.2*	*28.1*	*3128.3*
Contingent resources in fields	*328.1*	*221.8*	*22.3*	*2.2*	*594.5*
Contingent resources in discoveries	*375.1*	*322.9*	*14.7*		*739.0*
Possible future measures	*155.0*	*60.0*			*215.0*
Undiscovered resources	*1315.0*	*1485.0*	*0.0*	*120.0*	*2920.0*
Total	*7271.6*	*6046.6*	*332.6*	*277.0*	*14227.3*

Table 4 *The total petroleum resources on the NCS, 2015 [Source: NPD]*

The North Sea is the engine of Norwegian petroleum activities. It is still the leading area, and that contains about 51% of the total remaining resources on the NCS (see **Figure 25**).

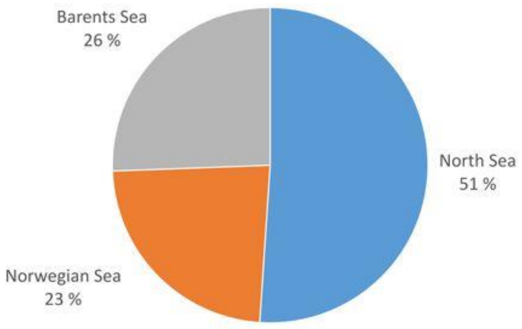


Figure 25 *The remaining oil and gas resources distributed by sea area, 2015 [Source: NPD]*

Figure 25 displays that the remaining resources in the Norwegian Sea and the Barents are almost the same, but the Barents Sea is estimated to contain more undiscovered petroleum resources.

7.4 *Norway`s petroleum wealth*

The Norwegian petroleum industry has led to a significant growth in the Norwegian economy. It might be one of the most important reasons that Norway has developed an exceptionally strong welfare state. According to NPD, the petroleum activities have added more than 12 000 billion NOK to Norway`s GDP since the production of oil and gas started on the Norwegian Continental Shelf. Thus, this industry has a vital role and is the leading and most influential sector of Norwegian economy, measured concerning value creation, state revenues, investments and export value. **Figure 26** shows the visualization of macroeconomic indicators for the petroleum industry in 2015.

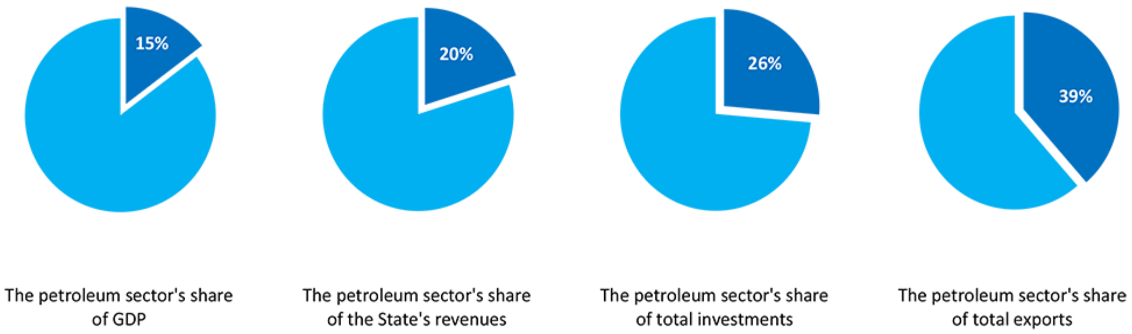


Figure 26 Macroeconomic indicators for the petroleum industry, 2015 [Source: National Budget 2016, NPD]

Figure 27 shows the development of macroeconomic indicators for petroleum industry from the production start in 1971 to 2015.

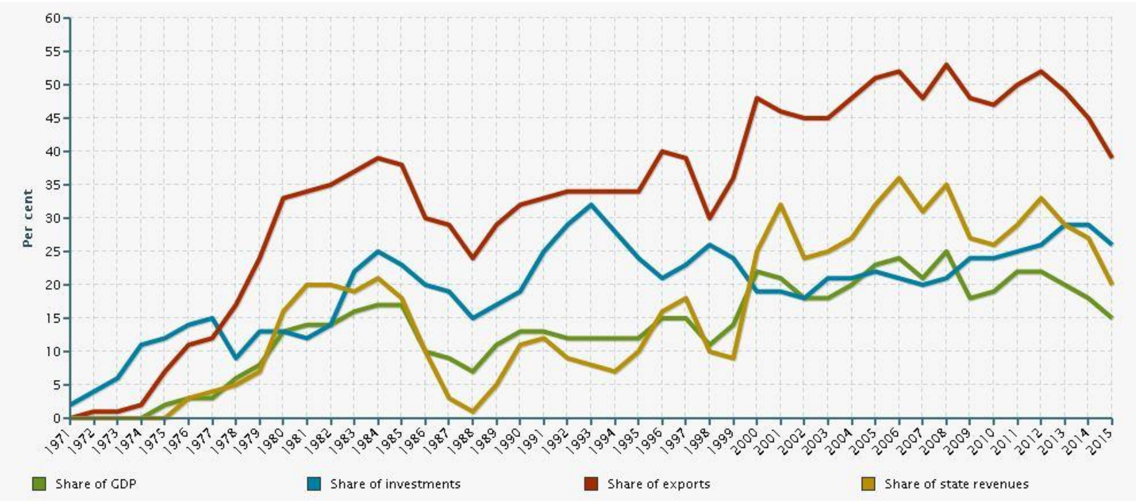


Figure 27 The importance of petroleum industry [Source: Statistics Norway, Ministry of Finance, National Budget 2016]

The most important principle of Norway's petroleum resource management is that all petroleum activities such as exploration, development and production, must result in creating maximum value for the society. Thus, the Norwegian State has a particular system for revenues from the petroleum activities, and this secures a significant share of value creation through the taxation and the ownership of the State's Direct Financial Interest (SDFI).

Table 5 shows the State's total net cash flow from petroleum activities in billion NOK in 2015. The environmental taxes, area fees and the dividend from Statoil represent approximately 10 % of total State's revenues.

The State's net cash flow	NOK
Taxes	103.7
Environmental taxes and area fees	6.8
Net cash flows from SDFI	93.6
Statoil dividend	15.4
The State's total net cash flow	219.5

Table 5 *The Norwegian State`s total net cash flow, 2015 [Source: The Ministry of Finance- Statistics Norway, NPD]*

Figure 28 shows the illustration of the statistics of the State`s net cash flow from petroleum activities from 1971 to 2015.

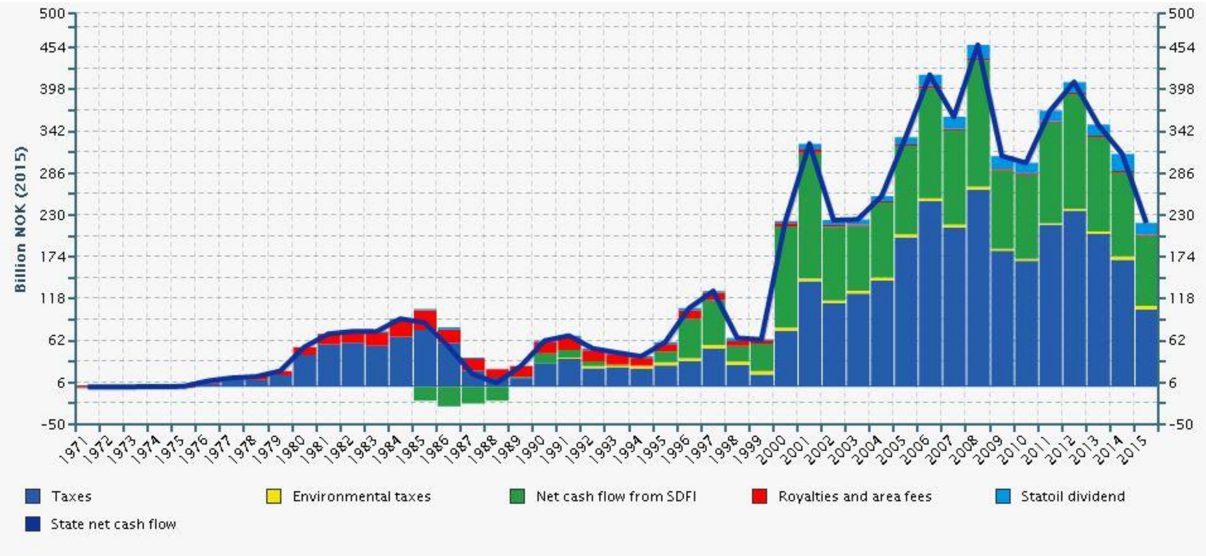


Figure 28 *State`s net cash flow from petroleum activities, 1971-2015 [Source: Ministry of Finance, Statistics Norway]*

As shown in **Figure 28** the State's total net cash flow reduced in 2015 by 30%, compared to the previous year. It is attributed to the low oil prices (discussed in 7.5) in the last year. Furthermore, the State's revenues from petroleum activities are transferred to Norwegian Government Pension Fund Global, which is known as the Oil Fund since 1990. The purpose of this fund is to build financial wealth from petroleum revenues for future generations and to support the government's long-term management of petroleum revenue. Thus, it is a national savings account. The Government has a fundamental principle for spending the fund, and it is called budgetary rule, and only maximum 4% of the expected real return on the fund might be used in the Norwegian national budget per year. In 2015, 179.6 billion NOK were transferred to the state budget. Today, the Fund`s market value is 6 998 billion NOK

7.5 Norwegian oil market

Today, the Norwegian oil industry is struggling due to low oil prices resulting in a lower need for new seismic exploration, decreased drilling activities, increased competition on the market, reduced demand, still high operation costs (although they have been reduced significantly), lower incomes and unemployment. Since the products of the petroleum industry are homogenous, they are traded on the stock market, and the price is decided there. Back in June 2014, the price of Brent crude oil was around 115 USD per barrel and today (24 May 2016) it is at 48 USD per barrel. In just six months, the price dropped by more than 50%, and it has not changed much since. In **Figure 29**, ever since 2010, the price of oil has always been above the 100 USD per barrel mark.

Figure 29 *Brent Crude price evolution up to 24th May 2016 [Source: Bloomberg[1]]*

The oil price reached its lowest point in January 2016, when a barrel of crude oil was traded on the stock market at 26.89 USD. Many Norwegian economists are critical about the current situation because oil investments on the Norwegian Continental Shelf are crucial for growth in Norwegian economy. Thus, they think that there will not be that much investment in the oil industry for the years to come, as long as the price stays around 40 USD per barrel.

[1] http://www.bloomberg.com/quote/CO1:COM

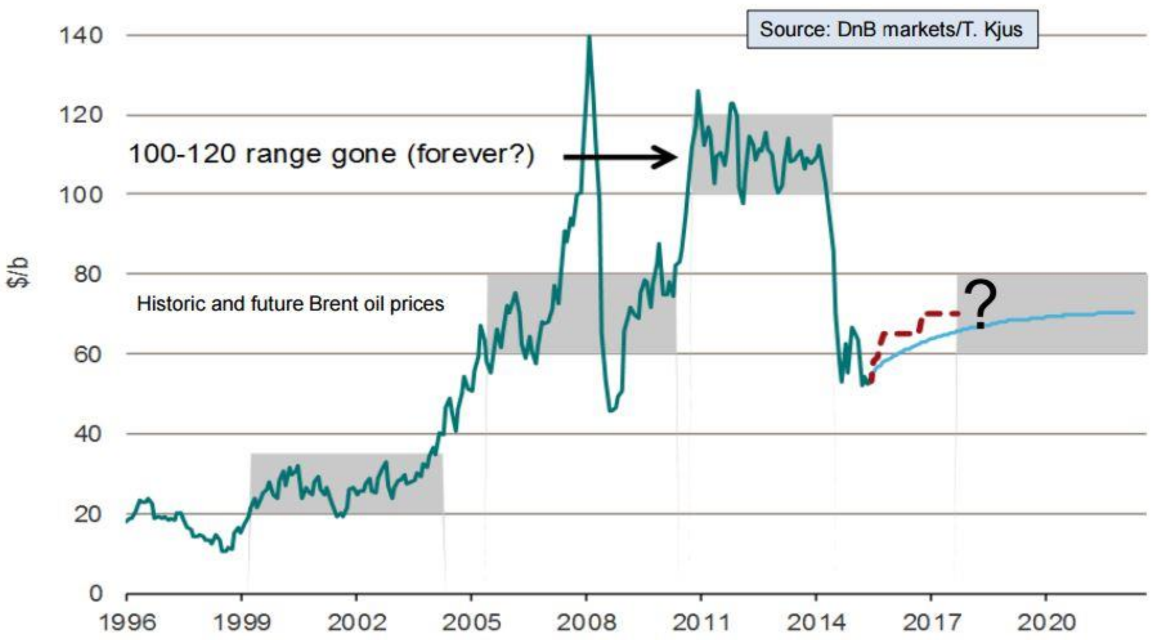


Figure 30 *Norwegian Oil price trend, 1996-2016 [Source: DNB Markets]*

According to Nordea Markets analysis, Norway`s oil investment in 2015 declined by 15%, and the prediction for the future reduction in oil investment is 10% in 2016 and 7% in 2017. If this trend continues over time, then there will be fewer companies investing in a certain field on the NCS due to a too low profitability.

Figure 31 shows the breakeven oil price for 24 planned projects that will start after 2019 on the NCS. According to NPD, the breakeven price is forward looking from 2016, and it is based on investments yielding 10 percent per year.

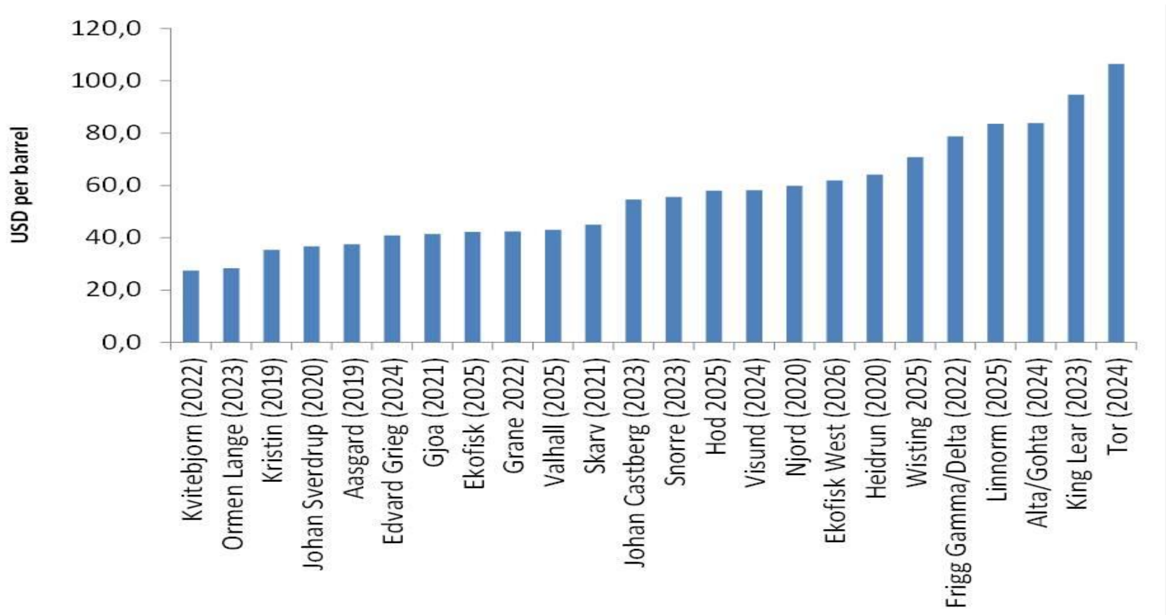


Figure 31 *Breakeven oil price for 24 coming projects on the NCS [Source: Rystad Energy and Nordea Markets]*

Despite low oil price, the new giant Johan Sverdrup oilfield ensures profitability for the operators and the Norwegian State in the future. In fact, this field has proven to contain a resource of 2460 million barrels of oil equivalents. Besides, the oil analysis of DNB Markets and EIA predict that oil prices will go up in 2017. Moreover, demand will gradually ascend towards summer 2016, and production might gradually decrease due to the reduced investment in the oil sector.

8 Upstream Petroleum Logistics

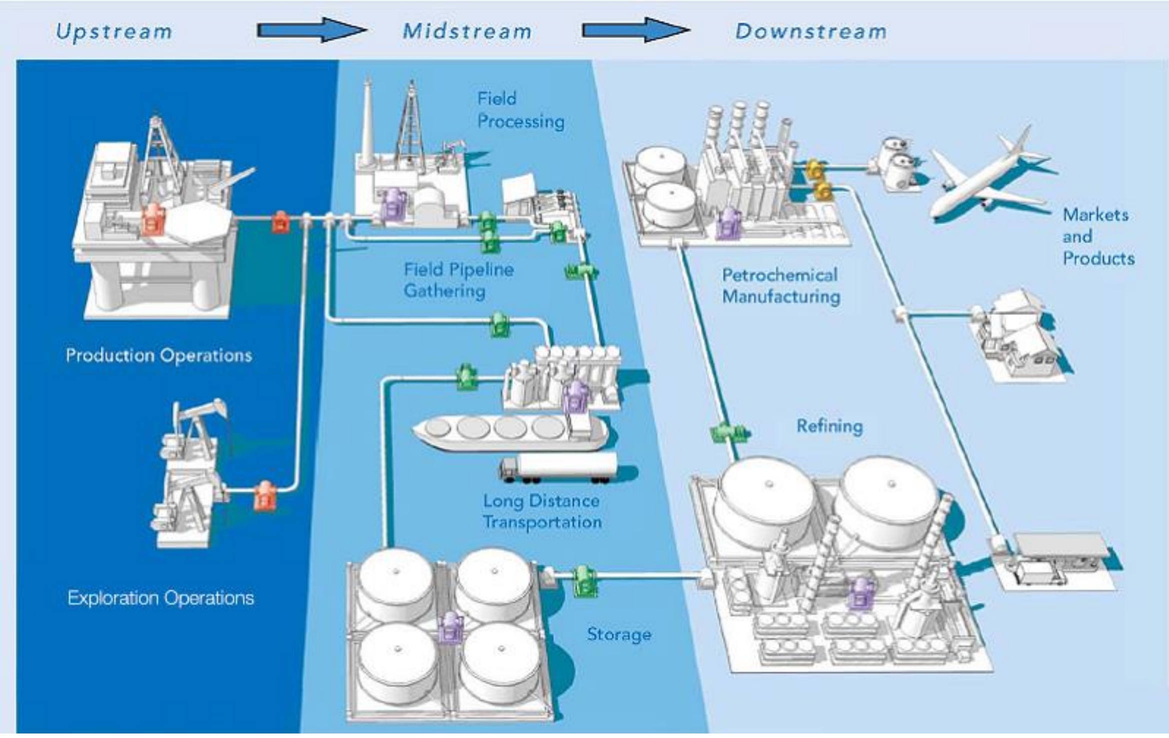


Figure 32 *Representation of the upstream, midstream and downstream activities [Source: Avata SCM]*

According to Briggs et al. (2012), the oil and gas industry can be broken down into three chronological sectors:

- *Upstream* – includes activities related to searching for, recovering and producing crude oil or natural gas from underground or underwater fields. It is sometimes known as the exploration and production (E&P) sector
- *Midstream* – the objective is to get the oil and natural gas from the wellhead to processor, and it covers transportation, processing, storage and distribution operations.
- *Downstream* – includes the refining and processing of oil and gas, and the further wholesale and marketing. Examples of companies that are part of the downstream

activity are oil refineries, petrochemical plants, petroleum products distributors, retail outlets and natural gas distribution companies.

During our thesis, we are only focusing on the upstream petroleum logistics, because that is where the urgent deliveries are most needed. We further detail this term.

8.1 Offshore Upstream Logistics

According to Aas (2008), the logistics activities that relate to supplying offshore facilities such as drilling and production are defined as upstream logistics. Thus, the purpose of upstream petroleum logistics is to provide the necessary supplies to offshore installations (exploration rigs, drilling and production platforms, and subsea installations) to support the upstream oil and gas industry. This logistics part is challenging due to its projects and activities (critical parts that need to be delivered quickly and cost-efficiently, and the cargo itself consist of mostly oversized and heavy loads).

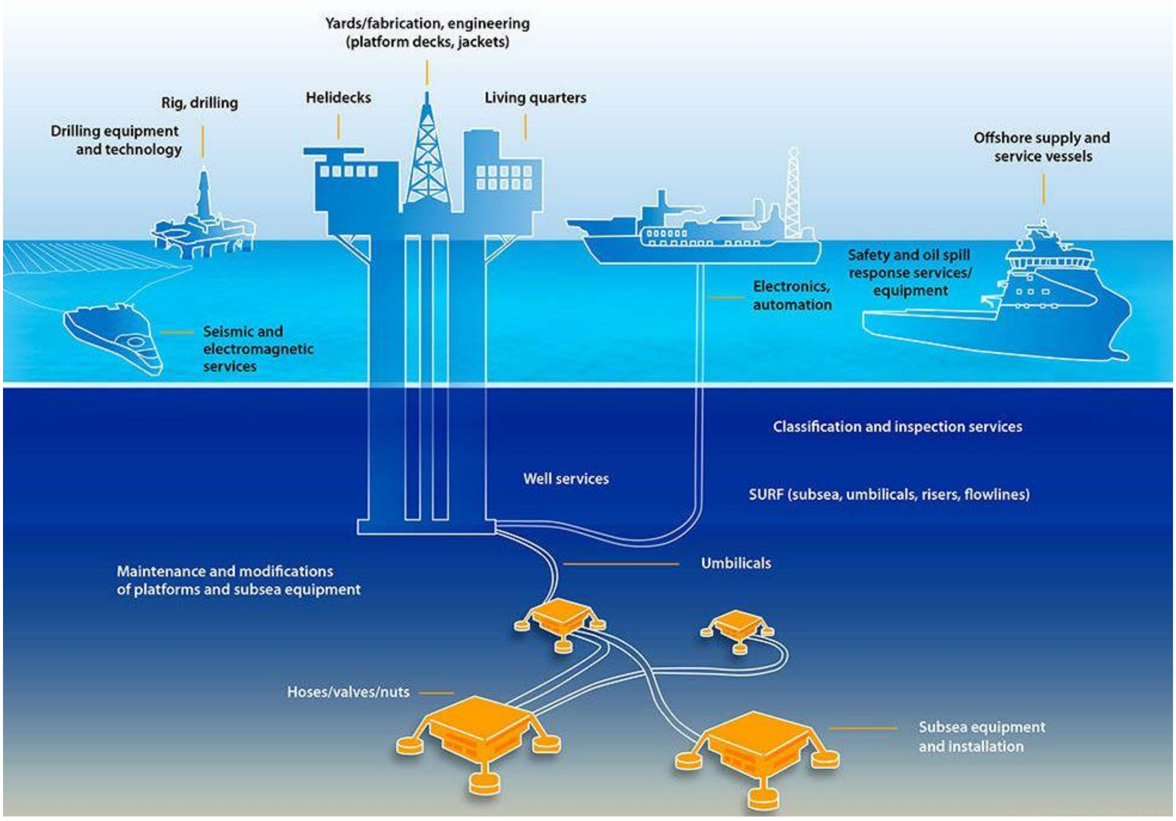


Figure 33 Offshore petroleum operations on NCS [Source: NPD]

Offshore installations on the NCS need to be supplied, and the return loads of used materials and equipment from platforms must be delivered to land.

Figure 34 shows the supply chain actors that are involved in the offshore upstream logistics operations.

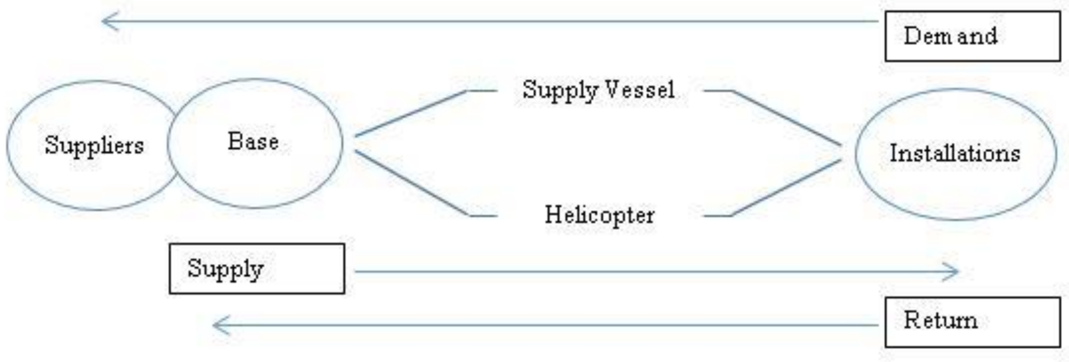


Figure 34 *Integration of the upstream logistics operation [Source: previous work done by Kristanna Anderson]*

Norwegian upstream logistics contains three key players: the operators, service companies, and the pure vendors. The suppliers are typically the oil service companies. The base is an onshore supply base. There are two types of transport modes from the supply base to the offshore installation, namely, supply vessel and helicopter. The helicopter is used as the only mean of transportation for personnel to installations because transporting people by boat is not allowed. In urgency cases, some possible deliveries will be carried by helicopter due to cost saving, because causes like shutting down on wells or production stop on the platform can represent high costs. Also, most of the cargo is not possible to send by helicopter due to size or weight limitations. Thus, the supply vessel is a primary transport in offshore upstream logistics. The supply vessel carries cargo to the offshore installations and returns such as empty load carriers, rented equipment, excess backup equipment, and leftover to the onshore supply base. The challenge here is that the many types of offshore drilling and production units need to be frequently provided to avoid a shortage and a buildup of returns due to small storage capacity offshore. In offshore, some installations have spare parts inventory some not due to lack of space on the installations.

From an upstream supply chain perspective, the offshore facilities are seen as end customers. The offshore drilling and production installations need a different type of supplies due to their operations. For instance, drilling operations have more uncertainty. Thus, the demand for its supplies is more fluctuating than for production units that have a more predictable and smooth demand. Moreover, the installations are designed differently due to the operations such as exploration and drilling-production. Thus, the sizes of offshore installations are different, and it varies from small subsea units to the large installations such as fixed production platforms with many hundreds of persons onboard, production ships and exploration rigs and ships. It affects both demand for supply and storage capacity of the installations.

From the offshore upstream supply chain aspect, the term of logistics is explained as support and a necessary part of the operations in the petroleum industry. Further, the integrated upstream petroleum logistics processes contain onshore transportation, supply vessels and helicopter, offshore storage facilities, warehousing, cargo handling, purchasing, information management, performance measurement and monitoring. Thus, the higher the degree of integration across the supply chain the better a company performs, clarified by Schøyen (2013). The result of integrated supply chain can be incorporated logistics that provides better planning and better customer service, and cost efficient supply operations.

Recently, all oil companies that are operating oil and gas fields on NCS are focusing on having cost efficient supplies due to the low oil price. The upstream logistics activities represent a significant cost for operators. In fact, according to NPD, the total logistics cost for operations in Norway in 2014 was almost four milliard NOK, which represents 5% reduction compared to 2013, and the corresponding annual cost saving was approximately 200 million NOK in 2014.

Therefore, if they have an integrated and efficient supply logistics, it can reduce the overall costs. Having an integrated supply chain and cost effective supply service is crucial for upstream petroleum logistics.

Also, the petroleum activities on the NCS are highly specialized. Thus, these activities require a supply base that must be integrated into the supply chain and can provide all the necessary support logistics activities. According to NCS each supply base mainly services its set of installations. For instance, the offshore facilities such as production platforms, drilling ship, rigs and other subsea installations in the Haltenbanken area, are supplied by supply vessels from the supply base named Vestbase in Kristiansund. Additionally, this area will be the case study of our thesis.

Figure 35 Vestbase, Photo: Harald M Valderhaug [Source: Norseagroup]

8.1.1 Complexity and uncertainty

According to Aas and Wallace (2008), upstream offshore logistics require proper planning because it is a complex operation, and their logistics often challenges the oil companies. In addition to the complexity, uncertainty plays a significant role also. Exploration and drilling activities have unusually high uncertainty compared to production. The uncertainty drivers for offshore logistics that relate to different activities can be multiple, but mostly it occurs with reserves, high risky operating environment, the complexity of the drilling and production equipment, new technologies, harsh weather condition, poor logistic planning, weak interaction and lack of communication in the system. For oil companies, it is important to be proactive. Increasing the competencies in knowledge related to uncertainties in connection with offshore upstream logistics activities will lead to better logistics planning in companies. Further, the main challenges for upstream logistics might be the uncertainty in supply and the cost of operating under uncertainty.

9 Supplies to the installations in Haltenbanken area

9.1 Norwegian Sea

The Norwegian Sea is covering an area of 287 000 square kilometers and is much larger than the North Sea. This area has largely proven petroleum resources, and the first oilfield was Draugen that started in 1993. According to NPD, the Norwegian Sea has vast gas reserves and is less mature and less explored, compared to the North Sea.

In 2013, several fields such as Skarv, Skuld, and Hymne started production, and at the moment, 16 fields are producing in The Norwegian Sea. Today, there are two fields, Maria the oil field and Aasta Hansteen the gas field, under development, and the estimated production for these fields is expected to start respectively in 2019 and 2018. In conjunction with the gas field Aasta Hansteen, it is about the Polarled gas pipeline that will extend the Norwegian gas transport system north of the Atlantic Circle for the first time.

Moreover, the produced gas in the Norwegian Sea is transported via different pipelines to various onshore facilities, for instance via the Åsgard transport pipeline to Kårstø and via Haltenpipe to Tjeldbergodden. Moreover, the gas from giant Ormen Lange is transported via pipeline to Nyhamna. Oiltankers transport all produced oil in the Norwegian Sea is

9.2 Haltenbanken area

Haltenbanken is a prime area in the Norwegian Sea, and the production of oil and gas started over 20 years ago. Haltenbanken is located west of Trøndelag in the Norwegian Sea.

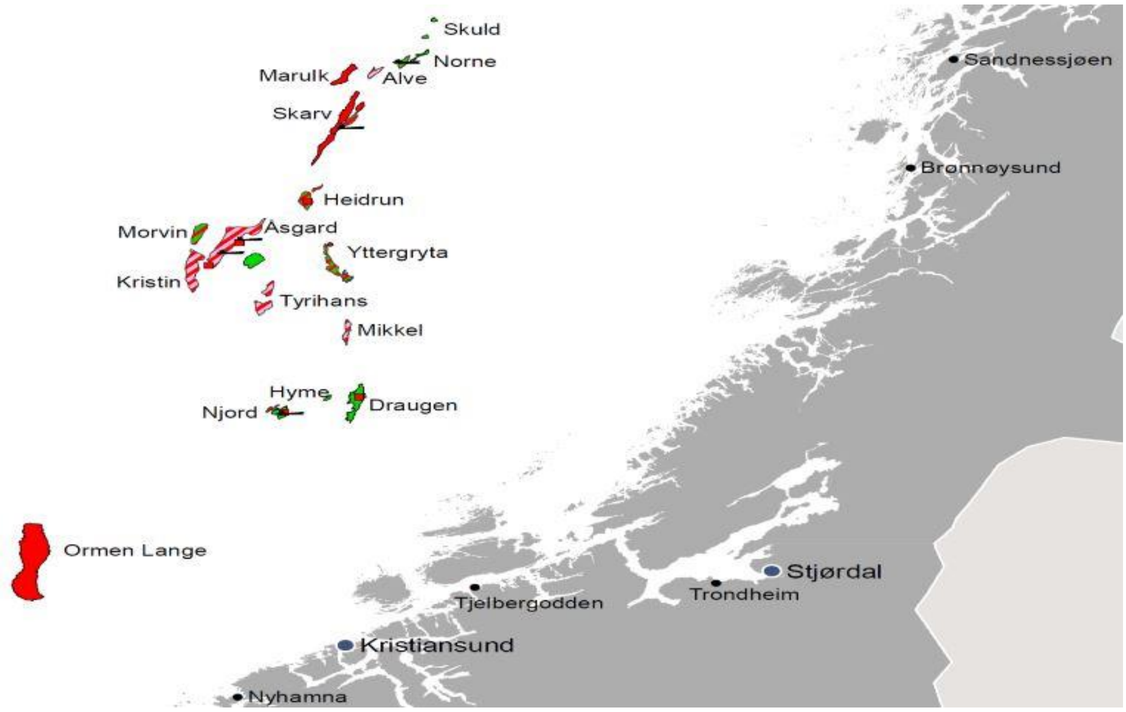


Figure 36 *Haltenbanken area in the Norwegian Sea [Source: cutoff from the petroleum map at NPD]*

Today's status in this particular area is that ten fields are in production, and two new fields are under development. Most of the installations are supplied from Vestbase, the supply base in Kristiansund while some of the fields are supplied from the supply base in Sandnessjøen. Statoil's operating organization for the oil and gas fields is located in Stjørdal, except Njord that is operated from Kristiansund. The offshore helicopter service is provided from the airports in Kristiansund and Sandnessjøen. Nyhamna is a gas processing plant for Ormen Lange field. Moreover, Ormen Lange is the second largest gas field developed on the Norwegian Continental Shelf.

9.2.1 The oil and gas producing fields in Haltenbanken

Draugen was the first oil field that came on stream in 1993 in the Haltenbanken area. It is also the first oil-producing field for Shell as operator on the Norwegian Continental Shelf. When this field started to produce oil, the estimated lifetime was between 17 and 20 years. However, today, Draugen is still producing oil and gas, and there have been carried out several late-life field extension projects such as installing subsea completions and updating the structure of platform, to extend the lifetime of the existing installations on the field.

Heidrun has been producing oil and gas since 1995, and Conoco discovered it in 1985. Today, Statoil is responsible for the operations of this field. Moreover, the northern area of this field is developed with subsea installations to carry out more petroleum resources. Improving the utilization of this area, Statoil has a recovery strategy that is based on the pressure maintenance through water and gas injection. Tankers transport the produced oil, and the challenge is that the platform has no storage facilities. Thus, the tankers must be there ready to take the oil.

According to Statoil, the production on *Kristin* is critical due to decreasing reservoir pressure. However, this field is considered as the center for new discoveries in this area. Furthermore, *Njord*'s production has significantly declined in 2015 due to postponed drilling operations, and Njord A is going to be towed to land from 1st of June 2016 due to structural issues. The situation at Njord A is very critical right now. In addition, the entire *Åsgard* contains 63 production and injection wells drilled through 19 subsea templates, and the production facilities include an area of 20 by 60 kilometers. Thus, this field is ranked as world's largest subsea production system so far.

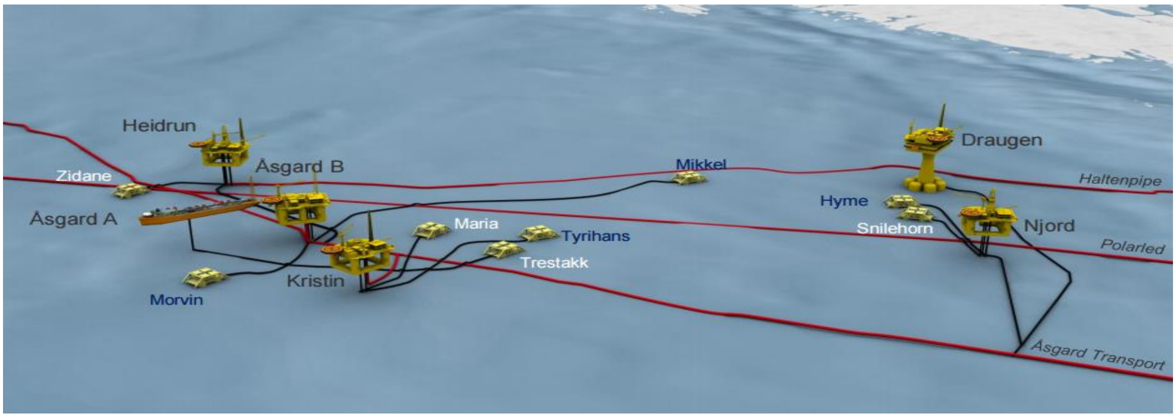


Figure 37 A snapshot of the activity in Haltenbanken area [Source: Statoil]

Table 6 shows a summary of the fields that produce oil, gas and condensate in Haltenbanken. In addition there are several subsea fields (Hyme,Tyrihans, Mikkel, Morvin), which connect to the other existing installations, producing actively per today. Recoverable and remaining reserves are given in million standard cubic meters oil equivalents (Sm^3 o.e).

Field Name	Production start	Installation type	Operator company	Recoverable reserves	Remaining reserves
Draugen (Oil)	1993	Concrete gravity platform	A/S Norske Shell	151.61	8.17
Heidrun (Oil and gas)	1995	Floating concrete tension leg platform	Statoil Petroleum AS	239.75	70.40
Njord (Oil)	1997	Floating semi-submersible platform	Statoil Petroleum AS	56.84	16.06
Åsgard (Oil and gas)	1999	Semi-submersible platform, Storage ship	Statoil Petroleum As	403.84	90.04
Kristin (gas and condensate)	2005	Semi-submersible platform	Statoil Petroleum AS	66.29	13.07
Ormen Lange (gas field)	2007	Subsea templates	A/S Norske Shell	315.30	146.60

***Table 6** Oil and gas producing fields in Haltenbanken [Source: NPD, Statoil]*

9.3 The operators and oil service companies in Haltenbanken area

This part presents only the companies, who operate and provide service to offshore installations in Haltenbanken area, which we interviewed. The information submitted here is mainly based on the introductory part of the interviews and supplemented with information found on the company's websites or in brochures we picked up from their offices during our visits. Even though some of the companies we present are global, we mainly focus on the activities that they do from their local offices in Kristiansund or Molde.

9.3.1 Supply chain network of the companies interviewed

All the companies interviewed are interconnected, some playing the role of customers and some playing the role of suppliers in relation to other companies. In order to better understand these connections, we visualized their supply chain network, see **Figure 38**. The companies were grouped depending on their activities and each group was assigned a color. Arrows are used to show that there is a connection between 2 companies, and the direction of the company points from the supplier to the customer. For example, the inspection companies Axess and Benor are suppliers to operator companies like Shell and Statoil, and also to MMO companies like Aibel and Aker Solutions. At the same time, the inspection companies are supplied by a transportation company like SR Group, Keuhne Nagel, Bring or CHC and they are also supplied by the supply base Vestbase. The relationship between the groups of companies is not inclusive, meaning that there is a connection between these boxes as long as at least one company in box A has a connection to at least one company in box B. For example, if the inspection box is connected to the operator box, it should not be understood that Benor supplies to both Statoil and Shell. Benor supplies to Statoil and Axess supplies to both Statoil and Shell.

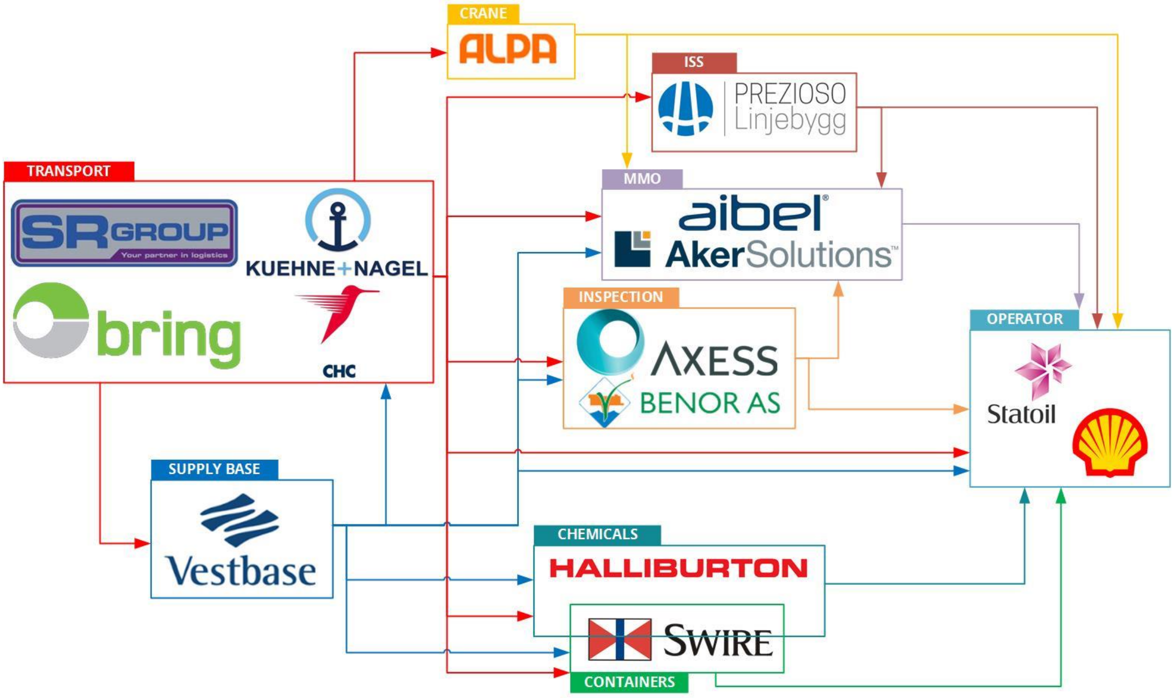


Figure 38 Supply chain network of the companies interviewed

As it can be noted from the visualization, using the word 'network' to describe the supply chain is very appropriate. For example, Vestbase is both a customer and a supplier for the transportation companies. On one hand, Vestbase can use a transportation company for its own deliveries of equipment and on the other hand, Vestbase supplies warehouse space and services to a transportation company. Also, note that the company Swire is a container company that is partially in the chemical category as well. This is intentional, because of the activities undertaken by the company (detailed in 9.3.3.6.1)

9.3.2 The operator companies

The operator companies are companies that are responsible for the extraction of oil and gas and in charge of daily operation management of the petroleum activity on the NCS. They are the strong players in the UPL, purchasing commodities and services from a wide variety of providers. A substantial part of their activity is outsourced to suppliers.

9.3.2.1 Statoil

Statoil was established in 1972, and the main office is in Stavanger. They are the leading operator company on the Norwegian Continental Shelf, with 60% of total production, and at a global level they are ranked twelfth. Regarding exploration and production activities on NCS, Statoil is operating 34 fields alone. Statoil`s Development and Production Norway (DPN) has the full responsibility for field development and operational activities on the NCS. In fact, Statoil is operating 14 fields (6 fields producing gas and condensate, five fields producing just oil and three fields producing oil and gas) in Haltenbanken area of Norwegian Sea. DPN`s Operations Mid-Norway is located in Stjørdal and responsible for all the producing field, except Njord (this is operated from Statoil Kristiansund). Today, Operations Mid-Norway is focusing on finding and developing fields using existing installations and infrastructure in Haltenbanken. Statoil Kristiansund is a part of Operations Mid-Norway and only responsible for Njord field`s operation and development.

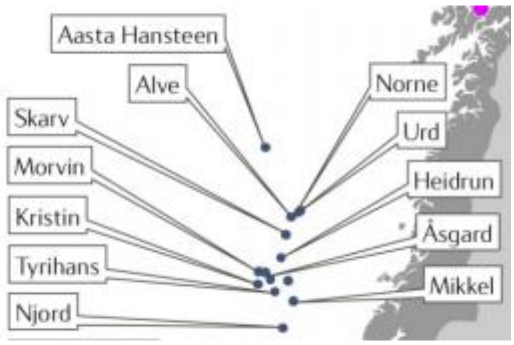


Figure 39 Operations Mid-Norway [Source: Statoil]

9.3.2.2 Norske Shell

Norske Shell is a Norwegian-registered company and subsidiary of Global Shell, and they have participated in the search for oil and gas on NCS since the first seismic explorations were conducted in 1960s. It has approximately 1500 employees and 3 offices in Norway: (1) Kristiansund, where they handle the upstream operations for the two fields they are operating, Draugen and Ormen Lange, (2) Oslo, where they handle the downstream operations and (3) Stavanger, which is the head office and where the project & technology operations are handled. The Kristiansund office employs around 130 people and is responsible for day-to-day operation and maintenance of both Draugen and Ormen Lange land plant, and in addition, the office handles whatever happens on NCS when it comes to drilling activities (no matter if it's in the southern part, middle part or even Barents Sea). However, since November 2015, for the first time, there is no drilling activity happening on NCS, but the team from Kristiansund supports the drilling activities in Gabon, Africa. One of the reasons for that is of course the low oil prices (see 7.5), because of which all the projects are kept on hold. Moreover, the other reason for lack of drilling activities is the fact that they just finished a 10-year drilling program at Ormen Lange. They have one warehouse in Kristiansund where they store equipment for Draugen (both for operations and for subsea) and they have their own warehouse at Ormen Lange to supply the onshore facility and the field.

9.3.3 The oil service companies

Oil service companies provide services to petroleum exploration and production industry but do not typically produce petroleum themselves.

9.3.3.1 Modifications, maintenance and operations (MMO)

The MMO companies handle the planned maintenance and planned modifications for the operators. Usually, that is characterized by long planning horizons before starting the actual execution.

9.3.3.1.1 Aker Solutions

Aker Solutions is a Norwegian global provider of products, systems and services to the oil and gas industry, present in over 20 countries. They provide support all throughout the lifecycle of the oil field, from exploration and development to production and decommissioning. In Norway, they have offices in 12 different locations, and from the office in Kristiansund they provide service to fields in Haltenbanken, and one of their biggest projects here is providing MMO services to Shell's Nyhamna onshore facility.

9.3.3.1.2 Aibel

Aibel is a Norwegian engineering company that plans, builds, upgrades and maintains platforms, vessels and production facilities in the oil and gas industry. They have offices in eight cities in Norway but also international offices in three other locations. Modifications are Aibel's core business and they have a market share of around 50% of the Norwegian modification projects. They provide a complete supplier of EPCIC services, which means that Aibel covers all engineering, procurement, construction, installation and commissioning and this is the preferred contract module for complex offshore and onshore projects.

9.3.3.2 Supply base

According to Offshore Norway, there are currently 17 supply bases in Norway, from Farsund in the south all the way to Vardø in the north and NorSea Group owns 10 of them.

9.3.3.2.1 Vestbase

Vestbase, as part of NorSea Group, is the main supply base that serves Haltenbanken area and other oilfields off the coast of Mid-Norway. Their terminal and quay facilities ensure accessibility and capacity for bulk handling as well as the handling of large individual jobs. They have an area of 600 000 sqm with 60 companies, workshops, offices, storages, subsea maintenance facilities and inspection plants. Moreover, they have 11 quays and are in close proximity of the airport and helipad. When it comes to their supply base operations, they offer indoor-outdoor storage (long term warehouse rental 10-15 years), handling equipment (e.g. crane hire, heavy machinery for cargo loading and discharge), tank farms for dry & wet bulk products and for gas & oil, planning management of cargo operations, trucking and internal transport. Moreover, they also offer supply chain management (procurement and sourcing strategies), marine services and project management. The supply base is open 24/7, but they do not have full capacity all the time, only during the normal operational hours from seven to 17.

9.3.3.3 Logistics

The logistics companies are crucial for the activity of the oil and gas industry since they provide the solutions for delivery of equipment but also people. In this section, we detail three 3PL companies that mainly provide truck base-to-base transportation, but also airfreight forwarding services. In addition, we cover a helicopter service provider.

9.3.3.3.1 Bring

Bring is a Norwegian logistics company that is a part of Posten Norge and targets corporate customers. They provide a wide range of services, from package distribution via truck, boat, plane or train, express deliveries, contract logistics, transport of temperature-sensitive products, 3PL services and distribution of post and commercials for a wide range of industries. From their Kristiansund office they mainly serve the oil and gas industry through their base-to-base service via the oil express (daily truck transportation service between Stavanger and Hammerfest and back with stops in the different bases along the way)

9.3.3.3.2 Kuehne+Nagel

Kuehne+Nagel is a German company with more than 1000 offices in over 100 countries, which has grown into one of the world's leading logistics providers. They provide seafreight forwarding services, air cargo forwarding, and overland transport capabilities with their dedicated and individual delivery services, contract logistics and integrated logistics with a worldwide network of warehouse and distribution facilities. From their Kristiansund (5 employees) office they mainly service the oil and gas industry (they are present in many other industries), and their core solutions for this industry are focused on road transport, air freight, ship agency, customs clearance and bonded warehouse. Their base-to-base logistics solution is their main activity in Kristiansund office - Kristiansund to Stavanger/Bergen and also Hammerfest or Sandnessjøen.

9.3.3.3.3 SR Group

SR Group is the largest privately owned Norwegian logistics company that serves only the oil and gas industry. They provide national and international road transport, sea freight and airfreight, but also tankers and bulk transport and terminal services. They have offices in eight cities across Norway, and their Kristiansund office is situated 1.5 km from Vestbase.

9.3.3.3.4 CHC Helicopter

CHC is a large helicopter service company that specializes in transportation to offshore oil and gas platforms, but also search-and-rescue missions and helicopter maintenance. It operates more than 250 aircrafts in 30 countries and in Norway; they have their offices in Stavanger, Bergen, Florø, Kristiansund and Brønnøysund airports. All the rigs in Haltenbanken area are served by CHC from heliports in Kristiansund and Brønnøysund.

9.3.3.4 Inspection

9.3.3.4.1 Axess

Axess delivers inspection programs and certification of products and equipment, which includes the critical elements of a structure, crane or piping system. They perform evaluation of maintenance strategies based on the design, usage and operational environment. In addition, they perform lifting operations on onshore and offshore energy plants. Their headquarters is situated in Molde and they have a warehouse in Kristiansund, close to Vestbase and a workshop. Even though they are mainly a service company that provides inspection, there is a need for them to have a warehouse to store their inspection kits, lifting equipment and rope access equipment. Big parts of their customers operate in the drilling segment, but they do deliver to the production segment as well. From Kristiansund, they do send some of their equipment to installations in Haltenbanken area (but right now, there is no exploration activities there). Most equipment is sent to Fløro, Stavanger and Bergen to be used on rigs in North Sea or in UK sector.

9.3.3.4.2 Benor

Benor is an inspection company located in Vestbase and they are part of Oss-Nor Group. Their mother company, Oss-Nor is mainly a mechanical company that specializes in repairing oil field tubulars, production pipes and casing pipes which go down in the oil well. Benor was founded in 2009 in order to avoid integrity problems within Oss-Nor. As an inspection company, Benor specializes in non-destructive testing (NDT) and oil country tubular goods (OCTG). The NDT department travel out in the field to different customers and check the integrity of different materials using techniques such as X-ray, ultrasonics and magnetic particle testing in order to check for faults in mainly steel. OCTG department does inspection of oil field tubulars before they are sent to the offshore installation. Their biggest customers are Oss-Nor and Statoil. In Kristiansund, we inspecting both the casing and production tubing and drill pipes.

9.3.3.5 Chemicals

9.3.3.5.1 Halliburton

Halliburton is one of the world's largest providers of products and services to the global energy industry, with offices in over 80 countries. They serve the upstream oil and gas industry throughout the life cycle of the reservoir, from locating hydrocarbons and managing geological data, to drilling and formation evaluation, well construction and completion and optimizing production throughout the life of the field. In Norway, they have offices in all the six supply bases: Bergen, Stavanger, Florø, Kristiansund, Sandnessjøen and Hammerfest. From Kristiansund office, they supply chemicals and solutions, fluids, dry chemicals and drilling mud mainly for the drilling operations. Their customers are the oil operators such as Shell and Statoil.

9.3.3.6 Container

9.3.3.6.1 Swire Oilfield Services

Swire Oilfield Services is a global company with offices in five continents and they are the world's largest supplier of specialist offshore cargo carrying units to the global energy industry. Swire's main business is rental of containers, tanks, skips and baskets, since everything that is sent offshore needs to be put in some sort of container. They also offer chemical handling for the oil platforms, and from their Kristiansund office, they are an agent for six different chemical companies (only production chemicals). As an agent, they store the chemicals and ship them out in their transportation tanks to the oilrigs. Moreover, a small part of their business is centered on offering special units (SMS) that are custom made for customers with a workshop, office or laboratory. For Kristiansund, 60% of their activity is on containers and around 40% is on the chemical business.

9.3.3.7 Crane

9.3.3.7.1 Alpa

The main focus of Alpa is lifting (cranes and winches) and material handling equipment. They could be considered a competitor to NOV, but they are smaller and they focus on smaller scale products. Their main job is to design, develop, produce and deliver the product. Service is another important part of their business, since the customer's focus right now is on upgrading and maintaining the old equipment instead of buying new one. Alpa was established in January 2015 as a daughter company of Axess and was formerly known as the crane department of Axess. Earlier, Axess was both making the cranes and providing the inspection, and since this represented a conflict of interests, the decision was taken to create Alpa. Axess can still provide the inspection and certification on Alpa's products.

9.3.3.8 Insulation, scaffolding and surface treatment (ISS)

9.3.3.8.1 Prezioso Linjebygg

Prezioso Linjebygg is a leading international provider of a range of multidisciplinary technical and engineering services for the oil and gas industry. Linjebygg has offices in 14 countries, and in Norway, they are present in Bergen, Stavanger, Molde and Trondheim. They have two main businesses. The one is ISS (Insulation, Scaffolding and Surface treatment) where they design and implement services for protective and insulation coatings and related access in order to extend the life of industrial facilities and infrastructure. The other one is IMD (Inspection, Modification and Decommissioning) where they engineer and implement solutions for the modification, inspection and repair of oil and gas assets that require special access resources and expertise. Their customers are oil operators - they won a large term contract with Statoil in the beginning of 2016 and they have a contract with BP as well.

PART IV: EMPIRICAL DATA AND ANALYSIS

The empirical content in this part is mainly based on the general understanding drawn from the interviews, so no references to sources of information will be included. Some real examples are incorporated to give a more clear understanding of the situation, but specific names of companies or people are omitted as much as possible. The following analysis is based on more than 70 000 words of transcribed interviews with 21 respondents from 15 different companies, and additional documents from within the Norwegian oil and gas industry.

10 Characteristics of urgent deliveries

10.1 Urgent deliveries – perception of the companies

The general perception of most of the companies is that there used to be more urgent deliveries earlier, when the oil price was higher and the activity was more intense. Some companies mention more urgent deliveries back in 2000s while other companies mention 2010-2011. The main reason for this is the recent cost-focus driven by the low oil price – companies are aware that urgent deliveries generate extra costs, so they are planning better, analyzing the situation better, making their operations more efficient or putting more pressure on the suppliers to deliver on time. The lower activity in the oil&gas industry allows them to focus on these improvements as well.

A few years back, some of the urgent deliveries were handled with the "it doesn't matter what it costs, I need it" attitude, like illustrated in Example 1.

> *This is an example from a procurement employee in one of the MMO companies. In the 8 years she has been in the company, she remembers particularly <u>one</u> urgent case that happened back in 2008. Someone from Shell called her to take a flight to New York to pick up a special key that they urgently needed for a shutdown at Draugen, but she could not do it. So instead, Shell found another person to fly from New York to Kristiansund to bring the piece of equipment. But when she picked up the person and the key from Kristiansund airport, the responsible from Draugen called her and said they have managed to fix it by making a key themselves. So a lot of money flew out the window. <u>But it is not like that at all right now.</u>*

Example 1 An urgent delivery example from 2008

The only company that has seen an increase in urgent deliveries is the supply base. They mention that there is a tendency in the industry that more and more is urgent, and they base that on the historical data of their operations. 2015 and 2016 are excluded from this statement, since they are not really normal years due to the low oil price and low activity, so they are referring more to 2013-2014. As a supply base, all the goods are gathered together at their location before they are loaded onto the vessels, so they have a different perspective of the situation. And according to them, there is always some delivery coming after the supply vessel is supposed to leave the quay. As a supply base, they do notice that some companies face more urgent delivery problems than others. Some of the companies are focused on keeping urgent deliveries at the lowest level. Whereas at other companies, even though they do have a focus on reducing urgent deliveries, the reality shows that there are a lot of urgent deliveries still happening.

What is more, the frequency of urgent deliveries is perceived differently even in the same company. In one of the operating companies, the purchaser deals with urgent deliveries quite often, whereas the warehouse responsible in the same company considers that urgent deliveries don’t really happen that much. This might be because of the different way they define urgent deliveries, or maybe because some of these situations can be contained at the purchasing level, and by the time the order reaches the warehouse, it is treated as a normal delivery.

For the MMO and chemical companies, urgent deliveries happen rarely and they attribute this to the nature of their operations that is more project based and allows a long planning horizon of even one year. One of the employees from an operating company even goes as far as to say that urgent deliveries should not occur in the ideal world – if Pareto principle was followed, then 80% of the activity should be preventive maintenance and 20% should be reactive maintenance, where the parts should be available in the storage.

Most of the times, the urgent delivery is generated from the offshore facility, so the companies further down the supply chain do not know the reasons behind it, but they just have to react to it and prioritize the order. It seems that the urgent deliveries generated from the offshore facility have the most consequences in the supply chain, since all the actors involved in responding to that situation have to treat it as an urgent delivery, from the supplier of parts or services, the 3PL company and the container company to the supply base, the warehouse and the operator. So there are a lot of actors involved in sending the delivery offshore, and their reactivity is equally important in both the material flow and the information flow of the urgent deliveries.

But the service suppliers down the chain have no control over the urgent deliveries. The urgent request gets to them only after it has happened, so they are there to help expedite the process. A lot of the times they do not know if the order is urgent or not and they only get to know that when their services have a longer lead time than normal, as described in Example 2.

For the suppliers further down the chain, it can be difficult to have visibility over what deliveries are urgent. If the container company receives an email on 2 big baskets for Shell and they ask at 8.30 if the baskets can be delivered before lunch, and they answer back that 'yes, I have the containers available', then for the container company that is not an urgent delivery because they can deliver it. If it is urgent for the customer or not, they would not know. But if they would have said that 'no, sorry, we cannot deliver today' then they would find out if it was urgent or not, because Shell would say 'oh, but I need this on the boat by 4pm today, I have to have it, can you fix that?' So then they would have talked to the staff and repaired a container or fixed something.

Example 2 Visibility of urgent delivery across the supply chain

All of the companies insist on the difference between drilling rigs and production installations and how this affects urgent deliveries:

- Production installations – activity there is more planned, more stable and there is less uncertainty in the operations. When it comes to the purely daily operations then urgent deliveries are not seen as a big problem, but of course there is always some express shipment of people and material. Situations that can cause problems on the production rigs are the shutdown projects or the well engineering (sometimes a new hole needs to be drilled in order to get more oil or gas up, or get more fluid down to increase the pressure)
- Drilling rigs – there is a lot more uncertainty in the activity of exploration drilling (e.g. suddenly the drill stops and cement is needed) so that is where many of the urgent deliveries happen.

When it comes to the generalization of urgent deliveries, the logistics coordinator from one of the operating companies confesses that when it comes to urgent deliveries there is a fairly generic situation and the problems they experience here they also experience in Africa. But of course, Africa has other issues as well, like guards with weapons on the rig to protect against pirates, issues around customs and imports or it is hard to get the equipment through the bureaucracy when you fly it down there. And this can further complicate or even generate urgent deliveries.

10.2 Definition of urgent deliveries

The companies interviewed do not really have a unified definition of urgent deliveries, and the understanding of this term can differ even from department to department within the same organization (and they are aware of this):

- From a supply chain management perspective, one of the operating companies considers all deliveries that have to be delivered from an external supplier in less than 11 days as urgent. If they need a pen and it is ordered today, then it is a rush order because it is needed within 5 days.
- From a purchasing perspective, in the same operating company, an urgent delivery is an order tagged with "HASTER" in their system.
- From a discipline responsible perspective, if there is a job that needs to be done offshore in less than 11 days for HSE or production concerns, then all the orders for this job are considered urgent (both people and material involved).
- In a movement context, the logistics manager from an operating company defines a delivery as urgent when it is so late and so out of scale that you need to take some actions around the normal supply chain routines (hold back a vessel, set up another sailing or mobilize resources outside the normal routines)
- For the supply base, an order becomes urgent when the schedule of the normal routines is not respected and they need to work harder or overtime in order to get that delivery on the supply vessel.
- For one of the inspection companies, a delivery is classified as urgent if it is received less than 8 hours before the requested delivery time. For example, if they get an order on Friday at 3pm that needs to be delivered on Monday, then this is seen as urgent, since they only get 1-hour notice to pack and send the equipment.

Based on the different definitions that the companies have given us, their perception and their examples, we have come up with a unified definition of urgent deliveries. We have asked some of the respondents in the last interviews on their opinion of this definition, and they agreed with it.

Proposed unified definition of urgent deliveries in upstream petroleum logistics (UPL): *If an actor in the supply network needs to take an action for a delivery of material or personnel to an offshore facility, and that action is outside of the normal routine/procedure, then this delivery can be categorized as urgent. Note that <u>not all</u> urgent deliveries generate extra costs, and there is a scale of urgency (some deliveries are more urgent than others) as illustrated in* **Figure 40**.

***Figure 40** Scale of urgency*

10.3 Causes and Consequences of urgent deliveries

10.3.1 Causes

Why do regular deliveries become urgent, instead of them being included in the standard delivery schedule? What makes them get to that point of having to be handled urgently?

One issue can be the *<u>uncertainty of the operations</u>*. According to some operators and service companies, they can make many mistakes and discover a lot of problems when they are drilling, and that may be because of the different formations down in the ground. But also, drilling a well and setting a well is not a very exact science. Moreover, sometimes damage to equipment is caused by sudden breakage (caused by involuntarily hitting or dropping the equipment).

> *One problem could be, often when they have drilled a hole. And they are starting to put down the casing, and we are talking about maybe five kilometers, something can get stuck, a pipe cannot be mounted together, technical problems, and that will require the pipe to be extracted and maybe get new pipes, extra pipes. So then that extra tube becomes an urgent delivery.*

Example 3 Uncertainty when drilling

Changes in *weather conditions* can also be a cause for urgent deliveries. Sometimes the operator might need equipment earlier than expected all of a sudden because maybe the weather forecast has changed so then they cannot get it to the rig when they were initially planning. Big waves and strong winds cause problems to the operation of both vessels, cranes and helicopters. Thus, uncertainty in operations and weather conditions cause unplanned events that cannot really be avoided.

> *MMO service companies explained that the maintenance and modification work on the platforms is quite complicated. It is divided into preventive and reactive, and it has high risk and uncertainty, thus, they cannot be so sure, even if they have done regular maintenance.*

Example 4 Maintenance work

According to some of the companies interviewed, the information flow works well in the companies, but the *information can be inadequate and unclear*. Such information causes misunderstanding in the chain, and it ends with an urgent delivery for something that is not supposed to be delivered urgently. In some cases, people did not do the job right based on lack of communication or due to the lack of common understanding of the supply chain. *Misunderstandings*, sometimes caused by *human error* can often occur between the various actors. Sometimes, an *inexperienced employee* that is new in the company is not aware of booking times at the transportation company and can transform a normal delivery into express.

An example of unclear information is in regards to the *definitions of Incoterms* for delivery, as described in Example 5. There are different contracts and different Incoterms for delivery. Thus, the vendor sends the delivery in a different time because of the different understanding of Incoterms. It might be how they suddenly generate urgent deliveries due to definition causes.

An operator explained how a normal order converts to urgent delivery. If someone from offshore orders an item and they expect that the order will be delivered on the requested date. But the purchaser thought the delivery supposes to be shipped from the supplier on that date. Because of this kind of situations, suddenly normal orders convert to urgent deliveries, since they do not get the delivery on the date, and they need it now, not in three days, then the delivery must be shipped from supplier urgently. This kind of misunderstanding generates urgent deliveries. The converting of a normal delivery to urgent due to this kind of situations will not be seen in the system. In the system, it shows the original order date and no changes.

Example 5 Unclear incoterm definition

According to an operator, *ERP works poorly offshore*, so they can have wrong parts in the warehouse offshore, or the offshore storage is not maintained. The ERP system shows that there is a part on stock, but in the offshore storage there actually is none, or the other way around. Sometimes, the urgent delivery is generated because of *wrong categorization of criticality* for that item in the operator's ERP system, where a short delivery date and urgent status is automatically given to critical articles, even though sometimes they are not needed.

According to one of the operators, they usually need to call offshore if they send the material deliveries via helicopter, because then the information flow does not go through the information systems. Helicopter transport is a hassle because they do not have control over the deliveries sent in that manner. Thus, the shipments are received by someone at the platform and lie around, no one has control over them or knows who is supposed to have the material.

Example 6 Information flow outside ERP system

Sometimes, the *quality of materials is not checked* before they are sent offshore. When the suppliers send out material with poor quality, it can cause urgent deliveries because it can cause significant issues and the consequence will be big at the installation. Usually, all oil service companies are responsible for their quality of deliveries. Thus, some companies do not use Asian suppliers due to poor quality although they are cheaper than Norwegian and European suppliers.

Wrong or incomplete documentation can also be a cause for delays and this can result in a need for an urgent delivery in order to get the material to the installation on time. The need for documentation for equipment is very high and the procedures change very often so it creates confusion in the marketplace over which documentation is necessary.

Engineers are confused over which documents are needed, so to make sure, they ask for all the documents from the supplier, and that makes the vendor's documentation department go crazy. This requires a lot of extra time at both the supplier and the customer. Moreover, the documentation they ask for from the suppliers require a customized front page, and most suppliers are not used to this, so the documents need to be sent back and forth before they are approved.

Example 7 Documentation

According to some service companies, urgent deliveries happen because of <u>*bad planning*</u> or lack of it, sometimes someone can forget something. Moreover, there is a tendency that just before the holiday season (Christmas, Easter) there is a lot of equipment going out, and this could have been better planned.

Draugen uses one of the scale inhibitors in production, about 1400 L/day, so that should be quite easy to plan, but not always. People forget, they wait until the end of the shift, or next person can take this responsibility and do the ordering, and suddenly there is bad weather as well. So then it needs to be ordered straight away and has to be treated as urgent.

Example 8 Poor planning + bad weather

Some other times, urgent deliveries are used because they <u>*save costs*</u>. When the equipment is rented hourly, sometimes the cost of renting outweighs the cost of the urgent delivery for the hours gained, so it is preferred to pay the cost of the delivery. Or if operators would store the chemicals at the installation just to avoid the emergency, it would cost a lot more than to pay the urgent delivery cost.

In conclusion, the urgent deliveries occur due to uncertainty. In some urgent delivery cases, people could not have control, for instance, some stuff is destroyed out there, on the rig, and then they just have to repair and send people or material and equipment whatever it needed. Moreover, something happens urgently because of people planning wrong and in other words human error. In this case, it means they do the job twice, and for these kinds of issues, they could have better control and plan it better of course. Because it costs a lot for them using the resources again, more working hours, and all transportation to and from the bases and so on. It is something they need to avoid. However, according to all companies interviewed, this happens very seldom these days.

10.3.2 Consequences

Urgent deliveries generate costs, but also disturbances, which can have an operational risk. Because, in the worst case, it can mean lost production or lost rig time (downtime) if they cannot fix the urgency and it comes too late, then the consequences are significant, and the value of these consequences in money will be enormous compared to what the urgent deliveries can cost.

When it comes to offshore activities, a common consequence of a late or urgent delivery might be that they need to hold back the supply vessel, and that can *destroy the sailing route*. According to the operators, now they sail together to the installations, that means in the bigger system, so if one of them has a late delivery, it might affect the other`s operation. Because of this, they might have some issues.

> *So, who should get the boat next and maybe they have opening hours for the crane crew and they need to take vessel at midnight meaning that the crane driver cannot drive the crane next day and all platform have their opening hours as well. Thus, there is this type of consequences might be from late deliveries.*

Example 9 Sailing route disturbance

In offshore activities, for instance, cranes play a vital role, especially in the efficient performance of an offshore vessel, ensuring trouble free operation and reducing downtime on the platforms.

The operators mentioned that when it comes to *costs*, the biggest impact is on the *logistics cost* (shipping, flying) although they are not significant extra costs compared to the overall operation or the project cost. For the logistics part, urgent deliveries do require some additional resources for handling them, and it is a bit significant, but maybe not very big compared to the overall costs. The issue of costs generated by urgent deliveries is discussed in more detail in 10.7.2.

Urgent deliveries can also generate a *stressful situation* at the workplace, when employees have to handle this situation outside of the regular routine and make the deadlines. And then maybe the personnel can make other mistakes that can also cost money, but this is difficult to measure of course. If it comes on top of other hectic periods for the companies (Christmas, Easter) while they have the fully-booked capacity, they have projects ongoing and suddenly comes urgent situations on top of everything, and they have to do this at the weekend or in the night. Sure that the stress level increases in this case.

A service company has experienced it negatively. Because having an urgent delivery requires a lot of time to handle it. So it is time-consuming. Moreover, it costs a lot having urgent deliveries in term of time. Sometimes merely, it is a little extra delivery, but it can be very stressful. They never experience it positively because when an urgent delivery occurs, usually it does mean that there is something went wrong or something is destroyed, and something needs to be repaired. The reasons for this happens might be varied.

Example 10 Stressful situation

Some service companies also mentioned that it is a little bit more stressful handling urgent deliveries for drilling operation (rig, ship, platform) than for production platforms. Since the activities there are more predictable and the operators usually plan ahead, and they have a new planning department onshore, so there are not a lot of emergencies from production while exploration and drilling have high uncertainty tied to the operation.

A transporter explained that express deliveries bring them more pressure to handle it. Because sometimes they do not have a truck available, then they cannot say no if they have a contract with the operator. And also due to low volume (cannot fill the truck with others because of lead time), so it happens that a truck drives empty from A to B, which means uncovered, costs to a certain extent.

Example 11 *Loss of income*

But there are also positive consequences. For some service providers, urgent deliveries represent more work and thus *extra income*. They can charge the customer for that overtime. If they have a contract with the client that defines the terms for what they can charge if they get an urgent order and the rate for overtime is included there. However, it will be an extra cost for the final customers due to that urgent delivery (see 10.7.2.1 for a more thorough analysis)

In conclusion, as an operator mentioned, when a need arises urgently in offshore, there is no reason to think about the cost of the delivery due to consequences of urgency. But merely the effects of urgent delivery might be high logistics cost for operators and uncovered additional charge for service companies. So more action means more money for drivers, but more action especially, outside of daily routine, can result in more stress for service providers.

10.4 Authority to make final decision

In offshore activities, the operators make a decision about urgent delivery due to their overall responsibility, and it is about extra costs in each case. According to an operator, the authority sits with the budget holder for that project. If it is simple operations, then it goes to the plant manager (OIM) on the platform that needs it. The plant manager is responsible for the daily and seven to fourteen days operations of the installations. For drilling rig, they address it to the senior well engineer who is the project leader for that drilling campaign. Because the cost ends up on his table, these people are who decide if they want it, or they can wait until the next day. They always present the cost for the operator or the one who is in charge of it, and they need to approve it. They need to decide if they stop the operations or order an additional vessel or a helicopter in the worst case.

For instance, if they have to stop, so the consequence is more than a million NOK/day/stop, and the cost of transporting the person is approximately 40 000 NOK, then it is very straightforward, and it does not require excellent analysis. Besides, if the equipment is rented and the cost of borrowing outweighs the cost of the urgent delivery for the hours gained, then it is preferred to pay the extra cost of the urgent delivery.

Example 12 Decision-making

Furthermore, the operators make a decision about deliveries, packaging and labeling instructions, and it is required suppliers to follow it. It has written in their contracts. When it comes to transport solutions, it is always the operators making the decisions, but the transporter can propose the solution to solve the urgent delivery. Usually, all transporters can make recommendations for the operators, but it is always the operator taking the decision since they are paying. Usually, the service companies have a responsibility to bring the accurate deliveries with the right documents in the right packing and at the right time in the supply base.

10.5 Handling urgent deliveries

Urgent deliveries are split into deliveries of people and material. One difference between these two types of deliveries is the ability to store. Most materials may be stored on the installations (space is limited of course) or on the warehouse at the supply base, and when the need for an urgent delivery arises, that item only needs to be sent via supply vessel. But when it comes to people, they cannot be stored in case an urgent situation will happen. If all of a sudden there is a need for a specialist, then the cost of the urgent delivery needs to be paid, unless of course a decision can be taken that the transport can be delayed by a few hours/a day, and the person is sent via regular helicopter transport. So there are more opportunities for cost savings when it comes to urgent deliveries of materials, by e.g. better planning to have the part stored offshore/onshore.

10.5.1 Resources involvement in handling of urgent delivery

According to operators that have the whole responsibility for the different offshore activities, exploration, and production, when a need arises that generates first by people from the operation on the installations, and internally there are different departments with their specific roles involved in the handling of the urgent delivery process. Thus, there are technical expert/specialist, requisitioner, purchaser, transporter, the duty team at the base and the head of an operation involved in the process. Exactly, how many people are involved, that would depend on the complexity of the process.

10.5.2 Urgent deliveries of people

In some urgent cases, there is a need for specialists for some specific tasks, often to deal with technical issues on the installations, and this will be the most common understanding of an urgent supply of people. Thus, this kind of situations generates an unplanned additional helicopter ride as well. Besides, if people are sick on the platform they also need to set up an extra helicopter.

Furthermore, all service companies that have a contract with an operator have a duty phone and a 24/7 service, which means they always have someone on duty that can pick up the call, in the middle of the night or the weekend. The person who is on the duty is responsible for receiving the order. After that, the company (usually someone who is in charge of the project) collects the information and makes a decision on who they should send out based on the information from the client (via phone or email). Most of the companies that provide this kind of services are very flexible and coordinate the resources among the network.

For instance, if a company requested a technical expertise and they do not have that person available, then that company contact other partners to find the right expertise.

Example 13 Coordination of the resources among the network

Moreover, in case to handle the urgency more efficiently, they can send a person with spares and tools out to platforms (this benefits both service and operators). Sometimes, they need to send a person first out to find out what kind of parts is required there. This process will require more time and resources. Otherwise, for service providers, this process can go very quickly as long as a helicopter is ready for the ride. Besides, the degree of urgency (**Figure 40**) decides if there is a need for an additional helicopter ride or not. Thus, the operators have to make the decision in each case.

10.5.3 Urgent deliveries of materials

10.5.3.1 Information flow

The information flow happens very fast in urgent cases. It is not straight and differs from situation to situation, depending on the scale of urgency (see **Figure 40**). To understand the urgent information flow, the regular information flow is first described and visualized in **Figure 41**. Note that this is based on our understanding of the information flow at the two operators and their suppliers, and it is a simplified version that does not include all the possible information flow scenarios. The situations are always so varied so that it is quite difficult to make a general information flow process.

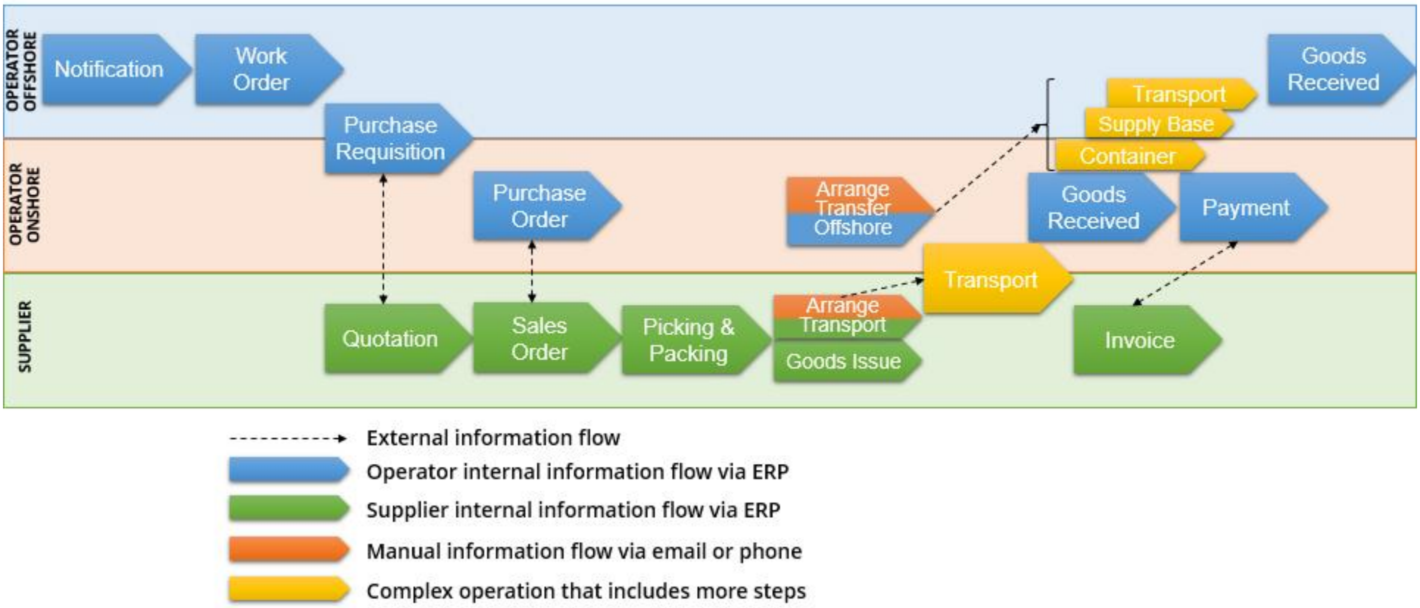


Figure 41 Regular information flow

The information flow starts with the operator at the offshore oil platform that identifies a job that needs to be done and issues a *Notification* in the ERP system. All the notifications made in the last twenty-four hours are revised at the daily morning meeting on the platform by the discipline responsible, where the notifications are approved or rejected. Then, the discipline responsible or an onshore planner creates a *Work Order* (an execution plan) for the approved notification. This operation can take from a few minutes to days or months even, depending on the complexity. When creating the work order, the onshore planner also contacts the supplier to check the availability of the part. Based on the materials included in this work order, a *Purchase Requisition* is automatically created by the ERP system. The purchaser transforms the Purchase Requisition into a *Purchase Order*, and they contact the supplier with the detailed description of materials, and they agree on prices (most of the times these are regulated through frame agreements, mentioned in 11.3.1).

Once the supplier receives the *Sales Order*, they can initiate production, or if they already have it in stock, then they *Pick and Pack* it, and then they *Arrange Transportation* and once the part is ready to be delivered, they release a *Goods Issue*. The transportation is handled by a 3PL provider most often, and the goods are picked up at the supplier's warehouse and delivered to the operator's warehouse at the supply base. The information flow between the supplier and the 3PL provider similarly includes a purchasing business process at the supplier and a sales business process at the 3PL. Communication is usually done via email or phone, and if there is an integration of systems (discussed in 11.1.4), then communication happens directly via the ERPs.

While the goods are transported to the supply base, the operator arranges the transfer of the goods to the offshore facility. It includes ordering containers (detailed in 11.1.3.2.1), registering and ordering movement handling in the supply base system and booking the transport via vessel or helicopter. Once the goods are received at the offshore facility, this is again registered in the ERP system, and the offshore storage stock is updated, and when it's consumed this new operation is registered in the ERP system, and the stock is depleted.

The urgent delivery information flow is illustrated in **Figure 42**. Again, this is just a generalization of the information received from the companies interviewed and it reflects our understanding. The information flow varies from situation to situation.

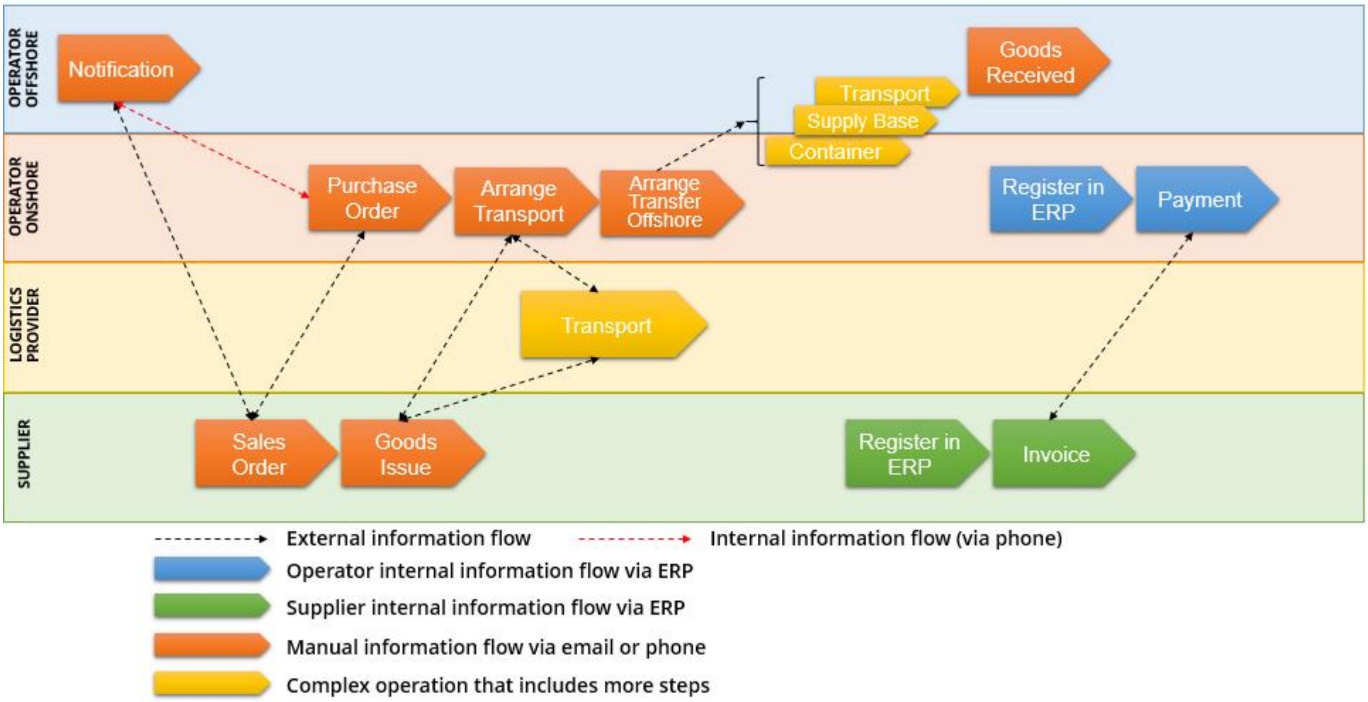


Figure 42 The urgent delivery information flow

When an urgent situation arises offshore, the discipline responsible is notified by the operator that noticed the problem and then they start handling the problem immediately. They call the purchaser onshore to inform them about this urgent situation and at the same time they get in touch with the supplier to check for part availability. The platform manager/discipline responsible offshore has an urgent phone number that connects directly to the purchasing department and that can be used in case of really urgent situations. Thus, the purchaser can already start ordering the parts needed even before the order shows up in the ERP system. This information triangle continues until the part is secured. If the situation allows for time to register the information in the ERP system, then the urgent orders will be marked with "URGENT/HASTER", otherwise the operations will be registered in the ERP system retroactively.

Next comes the transportation issue, which is crucial in urgent deliveries. A good transportation strategy can really expedite the urgent delivery process, like described in Example 14. It is really important that the situation is properly described (see Example 35) to the transportation company so they can find the best solution (both time-wise and price-wise). When it comes to fixing base-to-base transportation, the information flow is simple and the 3PL company can react very fast and already pick up the package in less than 30 minutes. But if it involves a more unique situation like chartering a plane, communication between the 3PL and the operator is important in order to make sure the operator agrees on the solution and the price.

One of the 3PL companies recalls how a few years back, Statoil asked for an urgent shipment from Houston to Kristiansund. There was a breakdown at the rig, and every hour they were not operational cost the company 300 000 NOK. So the Houston office of the 3PL company picked up the equipment and delivered it to the airport, they bought a first class ticket Houston-Oslo and the equipment was brought in a parcel. From Oslo, the Kristiansund office took over the shipment and they delivered 8 hours earlier than the equipment vendor would have been able to. The transportation was more expensive, but they still saved Statoil 2,4 million NOK. But this was just a rare situation.

Example 14 Urgent delivery from Houston

All of the information flow that happens throughout different supply chains culminates at the supply base, where logistics providers come with the urgent deliveries of their customers and the supply base has to do their best to handle it. Some of the times they are not even aware of the urgent delivery before it comes through the main gate, and this is stressful for their operations. So the information flow of urgent deliveries could be better at the supply base.

10.5.3.2 Physical flow

The delivery of material starts from the supplier after all necessary information for an urgent delivery is exchanged between the different actors. The service provider makes the delivery ready for a transporter. Transporter will be either the operator's or the supplier's transport solution, depending on the contract terms. The transporter carriers the delivery to the supply base where the operators have warehouses and items will be registered there. The delivery further will be sent either by helicopter or supply vessel to the platform.

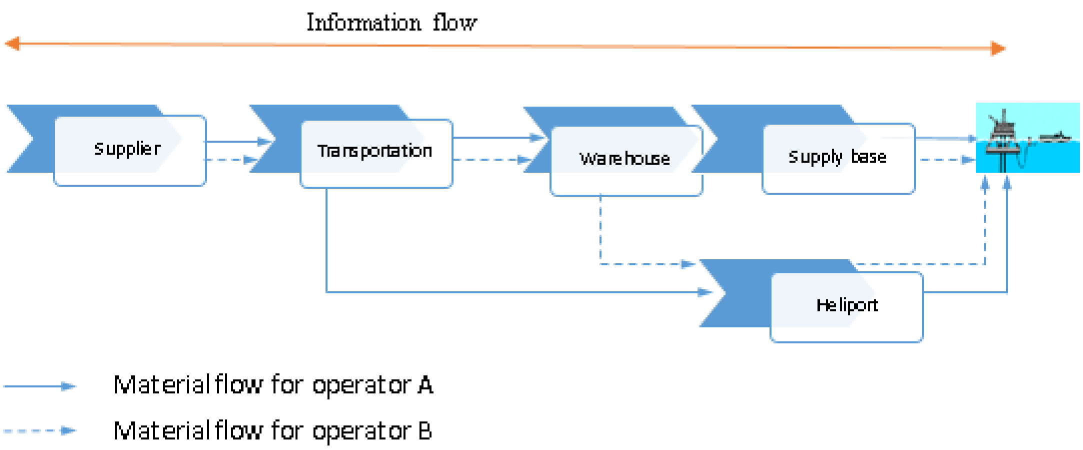


Figure 43 The material flow in handling of urgent delivery, UPL

The links shown in **Figure 43** represent the upstream supply chain links in the oil and gas industry. The links represent the interface between companies and materials that flow through the supply chain, and within each stage, there are many operations. For example, supplier includes receiving an urgent order, raw material inventory, production or finished goods inventory services, while transportation includes all services of moving materials along with this custom clearance and documentation. Warehouse includes goods receiving, registering in the system, unloading and preparing offshore shipment operations, while supply base supports all operations at the base related to moving the load to the offshore installations, for example renting necessary material handling equipment for loading and unloading operations. Heliport includes all services that are transporting both people and materials to offshore installation.

In an urgent delivery case, each stage of the links is a separate company, except warehousing, which is a unit of either operators or oil service companies. Also, the types of materials through these links vary widely from small critical parts to valves, pipes, cranes, chemicals, cement, drilling mud for drilling rigs, just to mention a few. Thus, the material flow in the upstream supply chain is comprehensive and most challenging as well. The common issue along this upstream supply chain is the lead time versus costs. The challenge will be to ensure that each company and operator along the upstream supply chain makes a quick response to the material needs on the platform.

According to the operator A, when a purchaser creates a PO and sends it to the supplier, then the supplier sends the delivery via a transporter (whom the operator already has a contract with) to the supply base where the trucks unload, a goods receipt from PO is created in the warehouse. Further, the delivery will be loaded into containers at the supply base, and the delivery is sent to the supply vessel to the platform. It is how the delivery process works through the supply chain in 90 percent of the cases. The other 10 percent is for urgent deliveries. Thus, the cargo handling process is the same until the joint where they decide the offshore transport by either helicopter or supply vessel.

The material flow through supply vessel applies only where the size of delivery is too large or heavy that transporting via helicopter is not allowed. Also, it depends on how urgent the delivery is (see **Figure 40**), if it's very urgent, then the delivery will be sent with a helicopter to the platform. In such a case as transporting a cargo via helicopter, there is an issue because when the shipment is sent by helicopter to the offshore, then it is not registered in the operator's system in the warehouse at the supply base, the delivery is transported directly to the heliport. Thus, operator A faces a huge problem because the delivery will be out of their system due to lack of integration in the information system with helicopter service provider (they do not use SAP). Then, the operator A is dependent on the response from goods receipt on the platform. Usually, when they send cargo by helicopter, they generate a shipment number that purchaser sends to the supplier, so the load is supposed to be shipped with that shipment number from vendors (which helps track the delivery), then the goods receipt offshore is updated in the system with the cargo number. However, this scenario is different in operator B's procedure. The operator B receives the shipment delivered to the supply base and registered in their warehouse's system, after that they send it to the heliport for the helicopter transport to the platform. In conclusion, the operator A's procedure is much more time and cost saving considering lead time, than operator B, but when it comes to information flow, then the operator B`s procedure is correct.

When it comes to handling urgent deliveries at supply base, the base has a duty phone and a handling team with 24/7 capacity out on the ground covering trucks, crane and all kind of handling equipment, plus coordinators in their warehouse. Thus, the people on duty handle the different steps, all from handling the carrier to the needed steps in the IT- system, to the shipment and everything.

For example, there is a truck coming at the supply base with an urgent delivery. In some cases, they get the information before the truck arrives at the base, in other cases they do not get any information before the truck is at the main gate and has to be unloaded as quickly as possible.

Example 15 Lack of information at supply base

This kind of situation can be very frustrating and very crucial considering the lead time, and occurs mostly due to poor information and lack of cooperation between the actors in this supply chain.

According to one of the service company, they have found a way to handle urgent deliveries so that it makes them more attractive to the customer and gives them a competitive advantage. With this, they ensure an excellent service. They predict the demand for the parts that are mostly required and have prepacked and pre-customized equipment ready to be used anytime. Besides, having a flexible logistics partner is crucial.

In fact, some operators measure their supplier's performance with KPI OTIF (on time in full) to check if the vendors deliver on time. With having this information, they might plan better for purchasing. Besides, the handling of urgent deliveries might give the service companies a competitive advantage.

10.5.3.3 The lead time

The companies we interviewed indicated that the impact of handling urgent deliveries was mainly related to the lead time of urgent deliveries and the resource utilization in their logistics. The lead time might present the total response time for the urgent delivery from different actors. See **Figure 44**. When a critical situation occurs on the platform, usually technical professionals are often involved in specifying the need. Besides, the operation management or the project leader who is in charge participates in decision-making and planning. Procurement plays a vital role, selecting the right supplier and sending PO at the same time ensuring the transport for the delivery. Warehousing involves all activities of planning inventory, goods receipt and picking to container loading. Suppliers are the ones who produce and send the requested item via transportation. The purchasers have a big responsibility here as ordering the right items that the platform needs, in the right quality and at the best price, and ensuring that the delivery time is achieved. Since it is about urgent deliveries, then the lead time is essential. Therefore, due to the priority of lead time, there is no need for negotiation. However, the challenge will be finding the right supplier who can give the best response time for the delivery. Example 16 shows a strategy for how to reduce the lead time in an urgent case.

If the vendor does not have the item available in stock and the item should be produced in another country in Europe. In this case, the Norwegian buyer can figure out the transportation and bring the delivery as fast as possible. That is done by using their freight forwarder to get the delivery directly to Kristiansund from the factory instead of having the supplier order it first from that factory to their place and then ship it to Norway.

Example 16 Strategy for reducing lead time

For service providers, all decisions are determined by the delivery time, for instance due to long delivery time (but also quality concerns) they do not use Asian suppliers. From a transportation perspective, the lead time is also the most important, express deliveries are usually ad-hoc, and they do not have a lot of time to plan. Thus, they have to improvise and do what is best for the customer to deliver the cargo at the right time. Admittedly, they choose the cheapest solution that respects the lead time. For instance, they have a lead time of 18 hours from Stavanger (most service companies have the main terminal there, and the city is known as the Norwegian oil city) to Kristiansund, and it is the minimum lead time they have. Then there are two drivers (because of the rule for drivers' hours), and the trucks are driving at full speed northward. The complexity of achieving this common goal is that all actors depend on each other's response time. See **Figure 44**.

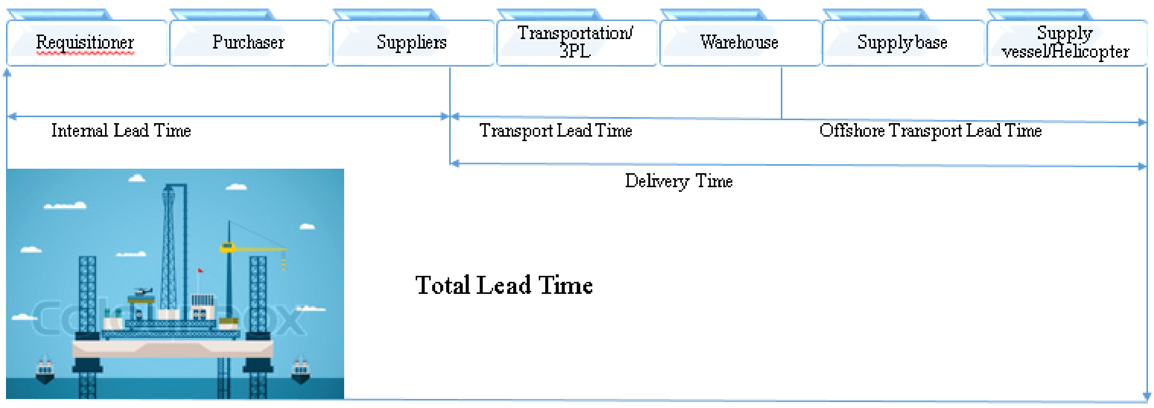


***Figure 44** Total lead time for logistics process in handling of urgent deliveries, UPL [Photo: Colourbox.com]*

According to all companies interviewed, the delivery time has priority in urgent deliveries because the consequence of critical situations can be very high. For operator companies, the lead time is crucial, and it does not help if they save some money in urgent circumstances.

Because what is most important here, they need the requested item delivered urgently to the platform to keep the production going.

10.5.3.4 Transport modes for urgent delivery

There are three types of transport modes used in the handling of urgent deliveries: (1) truck-road transport, (2) supply vessel – sea transport and (3) plane and helicopter- air transport. According to the companies interviewed, in urgent delivery case, the trucks transport most deliveries to the supply base and helicopter to the offshore installation (if no restrictions are violated).

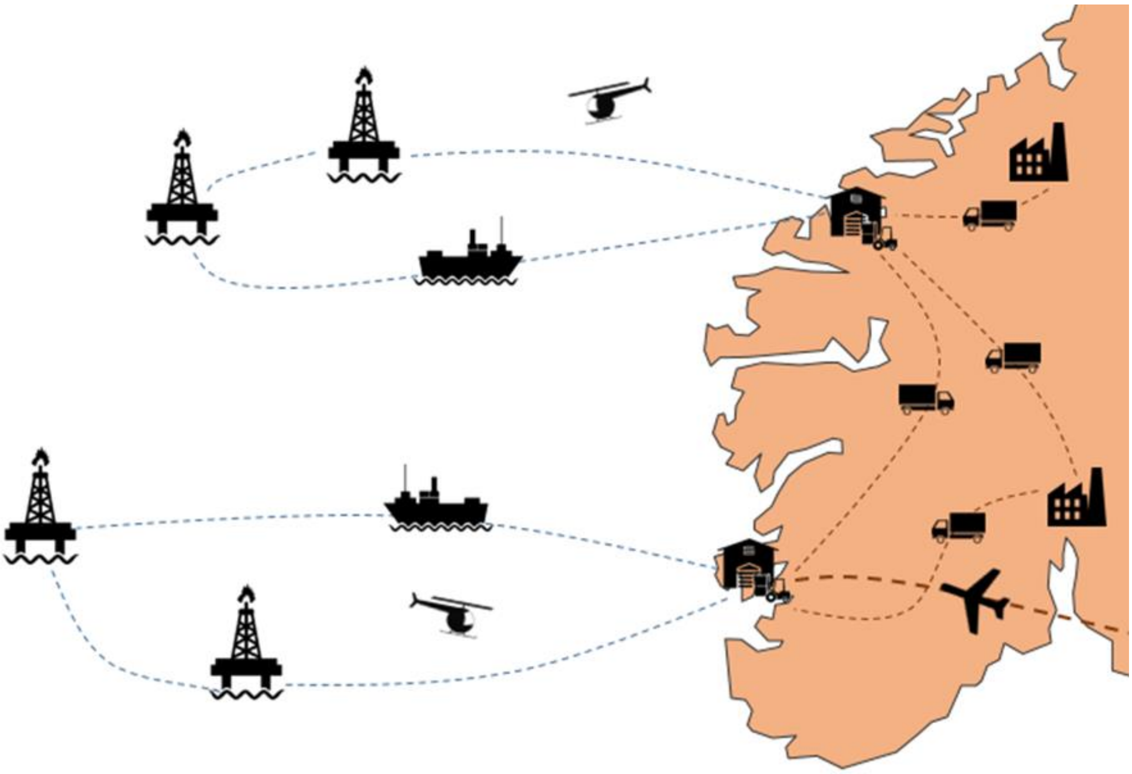


Figure 45 The transport modes for urgent delivery

***Delivery process via road*:** According to the transportation companies, this process starts when receiving an urgent orders from customers via phone or email. When it comes to operators, they have transport coordinators that are responsible for handling the urgent delivery for them. Next step is collecting the cargo: the transporter usually collects the shipments directly from the customer. If the distance is too big, then the transporter has to put one more driver on the trucks due to delivery time and the Norwegian driver's hours rule. Incidentally, the regular transport from Stavanger to Kristiansund is two days and express is one day. For example, a typical express delivery is:

The customer would call us Tuesday morning at 10:30 saying that they need equipment delivered from Stavanger as quick as possible. Then we contact our office in Stavanger. We always have some trucks available if we do not have a truck available then we cooperate with our competitors so that the urgent delivery can be executed. So usually our truck is ready with two drivers (driver one comes to Bergen and driver 2 takes over) by the supplier in 15 minutes because the suppliers are usually at the supply base and gets to the customer, and it`s back tomorrow morning here.

Example 17 A typical express delivery

For instance, a service provider mentioned that they preferred to use trucks instead of air transport considering both the lead time and transport cost.

For example, they had an urgent delivery that they need to bring it up at Vestbase from a factory in Mel (Romania). It went so right that they got it in two days by truck to Kristiansund. Compared to another a worst example they had some years ago, they used ten days for air cargo from Britain via Heathrow, Kastrup (international hubs) and further via Gardermoen and Værnes (domestic hubs) to Kristiansund.

Example 18 Truck vs. Plane

When it comes to sending shipments from abroad, it might be more complicated than domestic. For instance, sending cargo via European air transport is time-consuming because it concerns about different hubs in the various countries plus customs clearance and documentations. In **Example 18**, they tried to use the means of transport that minimizes the transportation time. Thus, better planning logistics and optimizing the transport routes for offshore deliveries can be useful for handling an urgent delivery in an efficient way.

Delivery process via air: First of all, before chartering an aircraft for urgent delivery it`s important to know what kind of materials need to be shipped, exact dimensions and exact weight. To charter plane, the transporter has to call to the airfreight brokers and tell them what kind of material they need to transport by a plane. Then the airfreight brokers check the market for the transporter finding the right aircraft that is available, and after that, they come back with some options that the transporter can consult to see which options is best for their customers. It applies mostly to abroad transport. Otherwise, if the transporter charters a plan for instance from Stavanger, then it goes very quick because flight time is very short, so it takes only one hour for that plane to land in Kristiansund (directly). After that, a helicopter transports the material to the platform. However, in some urgent cases, they need to charter planes from abroad although it costs a lot.

For example, a transport coordinator from one of the 3PL companies recalls a situation that took place back in 1998. They had to charter a plane to bring around 25 tons of casing from Japan, and that was very expensive, around 1 million NOK. It happened because the drilling operation went too fast and they had to get the casing earlier than planned. The casing was already on the ship and shipped to Kristiansund, but it wouldn`t have arrived for a few weeks. So they had to charter a plane to get the casing all the way to Norway as fast as possible.

Example 19 Bad planning - a typical urgent delivery by plane

Consequently, these kinds of situations could happen back in those days because of bad planning, but things are different today.

In another example of an urgent delivery, an operator company mentioned a situation that happened a year ago. They had to charter quite a big plane from Germany (because it was a heavy item) and then a vessel from Stavanger. Alternatively, the consequence was that the rig stops, and that could be 4-5 mil NOK/day. In this example, the extra cost of having it urgently delivered (immediate logistics) was around 0.5 mil NOK, which was a very high unit cost for that specific order.

Example 20 An urgent delivery as an alternative

In some urgent situations, the operators need to use a helicopter for transporting some smaller items to offshore installations. They prefer to send those items via the usual daily helicopter route. It would have to be a real urgent case that they need to charter an additional helicopter only for that item. Incidentally, according to a transporter, it is limited how large shipment they can ship by airfreight. For instance, on the regular passenger planes that go from Stavanger via Oslo or Bergen to Kristiansund, the limit for standard airfreight is one Euro-pallet (80cm high) and max 250 kg. If it is larger than that, they need to use trucks. For a very urgent delivery then they can charter an additional plane only for that urgent delivery. These kinds of deliveries frequently happened back in time in the oil industry, but not common nowadays.

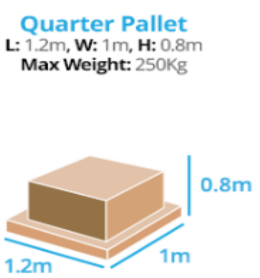


***Figure 46** Euro-pallet size for offshore air transport*

***Delivery process via sea*:** As usual, regular deliveries are carried by supply vessel. However, there are some materials still be transported by vessel in the urgent situation due to massive size and distance.

> *For example, when they need to ship drill pipes to the offshore installation, then it sends with supply vessel even though it is very urgent, they cannot send it by helicopter because the size of pipes can vary 30, 20, 15 and 10 meters long.*

Example 21 Urgent delivery by supply vessel

Especially, in the urgent situation the operators have to find a smart solution using their resources and company network along the bases instead of outsourcing a transport solution immediately. Sometimes, in offshore, transporting cargo by supply vessel can be faster than it goes by trucks although we know that trucks drive quicker than the vessel.

> *For example, if a material is not available at Vestbase in Kristiansund, then the operator may contact their office in Florø (the nearest base to here) and order it from there. Then it does not need to contact 3PLs to bring it by truck up to Kristiansund and ship to a platform in Haltenbanken. Instead, they can send it by supply vessel directly to the platform. Thus, it goes faster than the truck.*

Example 22 The handling of urgent delivery within the company network

Today, the operators try to use supply vessel as often as possible in urgent cases to avoid of using a helicopter, which they usually use for transporting materials to offshore installations. But this decision is determined by the urgency and the type of material. For instance, one transporter said that urgent sea freight could take one week from Stavanger to Kristiansund, and usually the vessels are sailing on a timetable. Thus, if they have a very urgent delivery of a particular item only for sea freight, then they could contact the charter market, and it depends on where the vessel is at that moment. Usually, the transport companies have their sea freight offices that can check where the vessel can be available to use.

For example, a transportation company has done some urgent deliveries by supply vessel from Aberdeen since the road delivery all the way there takes a lot of time. Besides, a Sea-cargo Express goes from Aberdeen, for instance, the vessel leaves on Sunday and is in Kristiansund on Wednesday, so it delivers once a week. The sailing route for the vessel starts from Aberdeen to Tananger, Haugesund, Bergen, Floro, Alesund, Kristiansund, Trondheim and then back, and it stops where there is cargo.

Example 23 Urgent delivery by supply vessel –Sea-cargo Express

Incidentally, urgent delivery by truck from Aberdeen could also be possible, because it is approximately 3200 km from Kristiansund to Aberdeen, taking the ferry to Denmark and passing through Netherland, Germany, France and UK. Google Maps estimates that at 36 hours. Probably, a truck could drive in 2 days.

***Figure 47** Aberdeen express*

For example, a service company ordered some materials from a supplier in Belgium, and it had to be delivered in Kristiansund as quick as possible. Then the Belgian supplier fixed the transport up to Bergen, and the service company took it over from there and brought it to Vestbase.

Example 24 Cooperation with suppliers for transportation

In some urgent delivery cases, the supplier can fix transportation, but it depends on what type of suppliers it applies to, and whose (supplier's, customer's or transporter's) framework agreement is going to be used, and a good relationship between suppliers and customers and so on.

10.5.4 Special procedures/routines

In urgent delivery case, some operators do not have specific procedures to handle it. Thus, they just follow the standard procedures because they do not want to introduce any risks by doing some shortcuts, the only additional thing is that if the operators use extra resources (have an extra flight or an extra sail), then they address it to the project managers. In a simple case, they just do it, if it is just something coming late and they have the vessel available, then they do not need to ask, then it is just part of the normal logistics routines. However, it varies from case to case and depends on the scale of urgency (see **Figure 40**).

Incidentally, the material that has been ordered urgently and is delivered never enters the warehouse, they just pack it into a container, and it never gets into storage, and it is just shipped directly to platforms. Additionally, in some operator`s case, an urgent delivery must come to the warehouse first to be registered, to be checked if it is the right equipment inside, especially if it goes by helicopter. For instance, if they spend 7 hours sailing out, it will be, at least 15 hours before they can take it back and order a new one. Therefore, they need to check it out and spend a bit of time on that to avoid time lost. Hence, the operators handle urgent deliveries little differently.

From transporter companies' perspective: for express deliveries they use dedicated trucks, which means that the truck will load at point A and deliver to point B. On the other hand, the transporter does have truck routes that follow a particular route and pick up/deliver goods on that route. However, express deliveries are in most cases not mixed with truck routes. Sometimes, the customer can request airfreight for example, but this does not mean it will also be possible. If the goods are dangerous, goods (ADR), they may need to find a different solution. Weight can also be an issue for transport modes. For instance, they use sea freight for larger components. In some case, the transporter also provides a designated truck for the customers that will only transport their goods. Back in time, they also had a helicopter route that they mainly used for individual special projects and cases.

The operator has requested all the way what kind of transport modes should be used for that special delivery. It was an urgent delivery where they need to bring something from France to Kristiansund as quick as possible. The transporter chartered a flight and upon arrival, the transporter loaded cargo on the truck and delivered to the base as requested. The customer booked with the transporter, and that transporter took care of the whole logistics process.

Example 25 A particular urgent delivery case

From service companies' perspective: Actually, they do not use air transport, but it will depend on their services. For instance, companies that are providing chemicals need special trucks because most chemicals are in bulk so that they could not use helicopter transport or airplane. Thus, those kinds of deliveries will be transported by supply vessel to offshore installations. Another service company explained that they mostly use trucks, but they have to use planes in some urgent delivery cases because a lot of their equipment is packed in

skid box (pallet-sized boxes) that fits into the aircraft. Moreover, they also send stuff directly with the operators that are going from Kristiansund airport by helicopter to the platforms. In case the small items that fit in a suitcase, they deliver that suitcase to the airport. So it is also important to have a local airport to deal with these short-notice deliveries.
Consequently, they do not have a specific routine, it does not properly go through the system, for the handling urgent delivery, but they control it manually.

10.6 Products most urgently delivered

The most urgently delivered products can be anything due to an unplanned situation. It also depends on the type of project activities in offshore. In drilling operations, it can be drill pipes, drilling fluids, cement, chemicals even so fuel are typical items for urgent delivery. For instance, if the drill stops they need cement and chemicals (they need to secure a well or a section of a well) while in production they also need production chemicals suddenly they get some changes or unexpected consumption of chemicals that needs a refill.

Especially, the operators need extra fuel for turbines on a platform because they have problems in the wells, and they need to run diesel turbines to power the platform, then it suddenly consumes a lot of fuel and needs an urgent delivery.

Example 26 Urgent delivery of fuel

According to cement and chemical providers, most commonly is cement shipments, blends, and a mixture of chemicals.

It is very expensive to have cement and the blends in the storage, and there is limited storage capacity on offshore installations as well. Usually, the service providers have to mix it together, for example just for one that special well (oil well) they have to mix certain chemicals (different type of chemicals). It can happen approximately ten times a year and two till three percentage of annual cement deliveries is urgent delivered.

Example 27 *Urgent delivery of cement and blends*

According to a service provider, there are some big tools during drilling operations that are needed on the rig to manage the well (e.g. frames with hydraulics, tools to loosen big screws). The big tools can be hefty. The suppliers often rent these big tools, and they are often from Stavanger, and they come with a truck to the supply base. Then they need to go out immediately, so it becomes an urgent delivery, but this only happens during drilling campaign.

Figure 48 *Drill pipes and cement storage at Vestbase, February 2016* *Photo: Kristanna Anderson*

In offshore activities, valves are probably the most urgently delivered. Because if the valve breaks down, then they need to shut down the rig or the platforms. The operators usually have most of the valves they need on the platform as spare parts. They usually plan to have it both onshore and offshore due to its critically. Thus, all components belong to the valve is critical and ordered mostly.

Figure 49 *Offshore valves and range of needle and ball valves* *Photo: Oliver Valves Source: offshore-technology.com*

According to a transport company, via express deliveries, it could be anything, but what is often express is fishing equipment.

In drilling, sometimes the bit stops during the drilling, and it is stuck in a hole. Thus, the drilling stops and the operators have to make a decision what to do. Sometimes, they have to cut the bit, which is worth a few million NOK, and they want to pick it up, so they need fishing equipment, which they usually do not have on the platforms. Thus, they often ship this equipment via charter planes (fits in the smallest cargo aircraft) and then via helicopter (take out the seats) to the platform. It has been very urgent delivery.

Example 28 Urgent delivery of fishing equipment

Besides the technical perspective, one of the service companies mentioned that food can also be a challenge.

The food supply companies would always like to deliver the food as close to departure time as possible, for obvious reasons, the freshness of the food and everything. But if they come late, and they are often, by 1 hour or 2 hours, they have a delivery point at 12, the boat is supposed to go at 4 pm, that's sometimes a big challenge and causing new transport.

Example 29 Urgent delivery of food

In conclusion, all companies insist that it could be anything due to unplanned situations and uncertainty of operations, but unfortunately, none of the companies have done any analysis or record of the type of products that orders urgently.

10.7 Frequency and costs

In this part we try to answer two questions: "How often do urgent deliveries occur?" and "What are the possible costs involved in handling urgent deliveries?"

10.7.1 Frequency

According to the information received in the interviews, the frequency of urgent deliveries differs from a pure production operation to a typical offshore drilling campaign, where critical situations can happen quite often, thus urgent deliveries are more common. In 2014 there were 8 exploration drilling campaigns in Haltenbanken. In contrast, at the moment there is no exploration drilling in Haltenbanken so all the frequency numbers are given for the production installations in 2015-2016, unless otherwise specified.

We asked all of the companies to estimate how much of their activity they define as urgent. As already discussed in 11.2, companies define urgent deliveries differently, so the estimates described below might not be comparable.

For one of the installations, an estimated 4% of deliveries are urgent. The frequency of urgent delivery of containers is 5%, 10% for inspection equipment, 5-10% for casing and tubing, 5-10% for crane parts and maintenance engineers, 2-3% of cement deliveries and 5% for ISS. On average, we can estimate that around 5-7% of total deliveries to a production installation are urgent.

When it comes to helicopter transportation, both operators acknowledged that an estimated 10% of the flights to an installation are extra flights due to urgent deliveries of people. For materials, around 10 times a month there are urgent deliveries of equipment, but these are usually sent out via the normal daily helicopter route so they don't generate extra costs.

When it comes to sailing an extra supply vessel for an urgent delivery, the supply base estimates that there were 10-20 extra vessel trips in 2015, and this number is higher when there are also drilling campaigns.

The supply base experiences around 10-15 urgent deliveries every week arriving at the base, and back in 2014 this number was higher, around 15-20% of total deliveries.
When it comes to delivery of materials via trucks from supply base to supply base, around 5-10% of the deliveries are express deliveries according to the 3PL companies.
According to one of the operators, a rig usually gets urgently delivered around 5 deliveries/year via plane.

All of this information is visualized in **Figure 50**. Note that this is just a summarization based on the numbers received from the different respondents. This does not represent in any way a generalization of the situation. Most of the respondents were hesitant to answer this question since they keep no clear statistics about this. But even if the numbers are not very accurate, the figure below still gives a more clear understanding of the frequency of urgent deliveries.

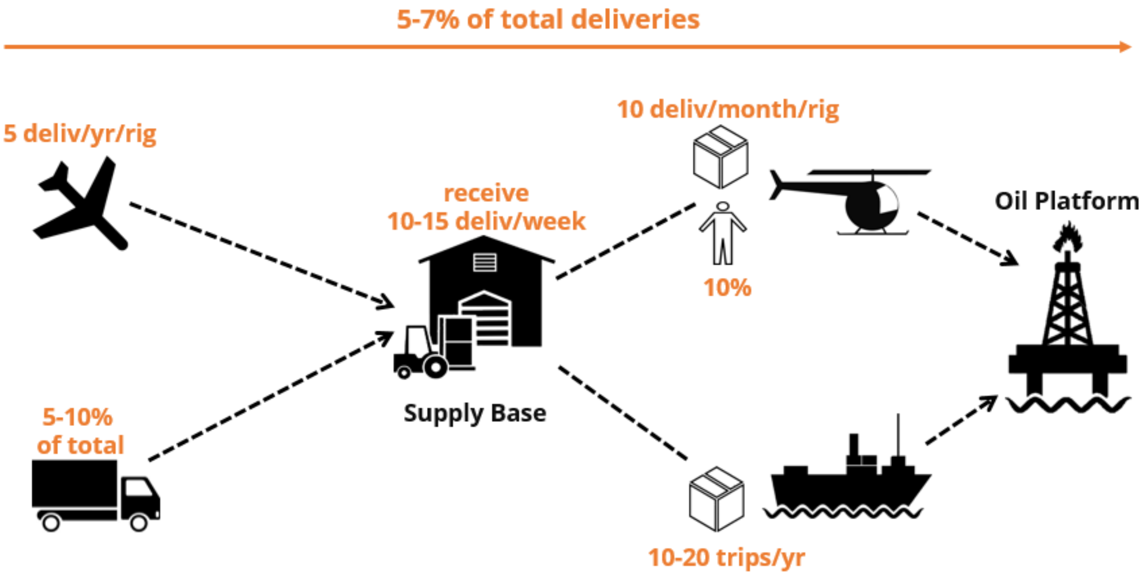


Figure 50 Percentage/number of urgent deliveries in the supply chain for Haltenbanken

Two things to note about the frequency of urgent deliveries are the unpredictability and the seasonality. Sometimes a company can go 1-2 weeks without any urgent deliveries, and other times there can be a couple of urgent deliveries in a week, as recounted in Example 30. When it comes to seasonality, winter period is very slow since not so much extra work is planned because of weather uncertainties. Whereas summer is very hectic since there is a lot of activity going on and then more service jobs are planned, and on top of that there can also be urgent deliveries. Also, the periods before holidays like Christmas or Easter see an increase in the frequency of urgent deliveries.

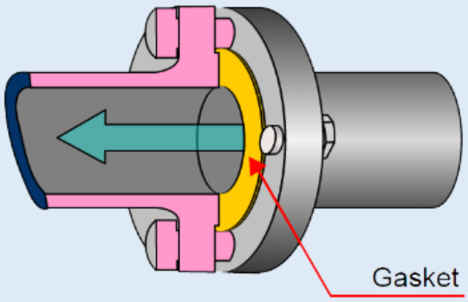
Two weeks before the interview, one of the 3PL companies had 3 express deliveries in 2 days, all from different clients – collected in Trondheim, Åndalsnes, Ulsteinvik, with delivery to Florø, Bergen, Stavanger. Each delivery was treated separately, so they were not able to combine any of them in a single truck. The request for urgent delivery came at different times, so they couldn't really wait around for other express deliveries, since a delay of 6 hours on a 12 hour delivery is not acceptable.

Example 30 Frequency of urgent deliveries is unpredictable

10.7.2 Costs

From a logistics perspective, one case of urgent delivery can have significant cost impact, as explained in Example 31.

One of the operating companies had to deliver a gasket to the rig. The normal price for this gasket was 300 NOK. They thought they had it in the warehouse, but they didn't, so they had to order it as soon as possible. As an urgent delivery, the cost became 32 000 NOK.



Example 31 The cost difference between normal and urgent delivery [Image Source: (Bengtsson 2015)]

Two types of costs can be identified: direct costs and transaction costs. They are further explained below and summarized in **Table 7**.

Direct costs

These represent the costs that can be quite easily measured and kept track of. The direct costs generated by an urgent delivery can be divided into 3 categories, and the total cost of an urgent delivery can be comprised of a combination of them:

(1) Transportation costs:

- Helicopter costs
  - An extra flight (be it personnel or material) to one of the oil rigs in Haltenbanken is 40 000-50 000 NOK. The operator has a helicopter frame agreement and they pay a fixed rate for the helicopter to stay there and they pay a technical hourly rate for the hours they fly and then they pay the airport fee for taking off and landing. So this cost is just the specific extra cost for taking off and flying that helicopter.
  - Most of the items that are delivered urgently via helicopter probably go via the normal daily helicopter route, so they don't generate extra costs.
  - If it is not possible via the normal daily route to that rig, they can do a split flight and pay a little extra for a helicopter that goes to a nearby rig to make an extra stop.
- Vessel
  - If the vessel is already on charter, an extra sailing to one of the oil rigs in Haltenbanken is 40-50 000 NOK that covers the fuel and consumables on that vessel (the other costs are already covered through the contract)

    - If you need to charter a new vessel, the cost could be up to 500 000 NOK. Nowadays it is cheaper because there are unused vessels available on the market.
- Plane
    - Small Cessna Caravan which takes 11-1200kg is 40-50 000 NOK from Stavanger to Kristiansund.
    - Larger plane – a lot more expensive, price depends a lot on the conditions on the spot market and where the nearest plane that fits the criteria is located at that moment, the distance it should fly and the size of the cargo. A large plane from Europe can be up in 2-3 million NOK, and from USA it can even cost 9 million NOK.
- Truck
    - Normal delivery from Stavanger to Kristiansund of one pallet 7-800kg is 1-2000 NOK and delivery time is 2 days.
    - Express delivery from Stavanger to Kristiansund of one pallet up to a full truck is 25-30 000 NOK (you need to pay whole truck and extra driver) and delivery time is 1 day.

(2) Personnel

- If the vessel must stay 2-3 hours at the quay waiting for an urgent delivery, then it can cost extra for the delay and for the loading and unloading, since you need to have people working extra
- Overtime hours for suppliers that have to inspect equipment on short notice
- Overtime hours for own personnel that needs to work on weekend or in the night to handle an urgent delivery

(3) Supplier – if the supplier understands that the customer is in trouble and this delivery is urgent, and they know that they are the only supplier for this type of equipment, then they can require extra payment. Even though the item might normally cost 100 NOK, the supplier can charge 1000 NOK or even 10 000 NOK. After experiencing this, one of the operating companies has modified their procedures, so that when they contact the supplier, first they check the availability of the material and the price, and after that they specify that the item is needed as fast as possible.

Transaction costs

Internal processes generate transaction costs represented by the extra time spent by different employees on dealing with urgent deliveries. When handling urgent deliveries, the staff does not really follow the normal procedures and has to spend extra time following up on the urgent order and communicating with supplier, transportation company, supply base and staff on the oil rig. This cost is not as easily measured, but considering the high salaries in Norway, it can generate quite high extra costs that companies do not really consider when measuring the cost impact of urgent deliveries. These costs are most probably written off on another budget of another department and it is hard to trace them back to urgent deliveries.

One very important cost to consider is the cost that the operator pays in case the rig stops producing. This cost differs from rig to rig of course, but it can be between 150 000 NOK and 300 000 NOK/hour of lost production, so a company can easily end up losing 4-5 million NOK/day in case the production stops. This cost is important to consider, because this is the cost companies compare against when they make the cost-benefit analysis to decide if to use urgent deliveries or not.

<table>
<tr><td rowspan="13">Direct Costs</td><td rowspan="11">Transport</td><td rowspan="3">Helicopter</td><td>Extra flight
40-50 000 NOK</td></tr>
<tr><td>Split flight
~20 000 NOK</td></tr>
<tr><td>Regular flight
0 NOK</td></tr>
<tr><td rowspan="2">Vessel</td><td>Already chartered
40-50 000 NOK</td></tr>
<tr><td>Spot market
max 500 000 NOK</td></tr>
<tr><td rowspan="2">Plane</td><td>Cessna Caravan (S-K)
40-50 000 NOK</td></tr>
<tr><td>Bigger plane
Expensive, varies</td></tr>
<tr><td rowspan="2">Truck</td><td>Normal delivery (S-K)
1-2000 NOK</td></tr>
<tr><td>Whole truck (S-K)
25-30 000 NOK</td></tr>
<tr><td>Personnel</td><td colspan="2">Overtime hours</td></tr>
<tr><td>Supplier</td><td colspan="2">x10 or x100 unit price if they understand company is desperate</td></tr>
<tr><td>Transaction Costs</td><td colspan="3">Salary for internal processes related to urgent deliveries</td></tr>
</table>

Table 7 Costs of urgent deliveries - summary

10.7.2.1 Cost or profit for the company?

Urgent deliveries generate costs, but this is not a cost that all companies cover themselves. For one of the MMO companies, the percentage of cost of urgent delivery has not been a big subject since the consequences of delayed milestones are huge. And a similar situation might be at the operators. Urgent deliveries are seen as a "means to an end" and they are necessary in order to avoid the higher costs of stopping production or delaying projects.

Each category of companies is analyzed from the cost vs profit perspective and all the information is summarized in **Figure 51** in a visual based on the supply chain network in **Figure 38**. Note that this is just a subjective interpretation of the situation based on the interview statements, and it relates to the company interviewed.

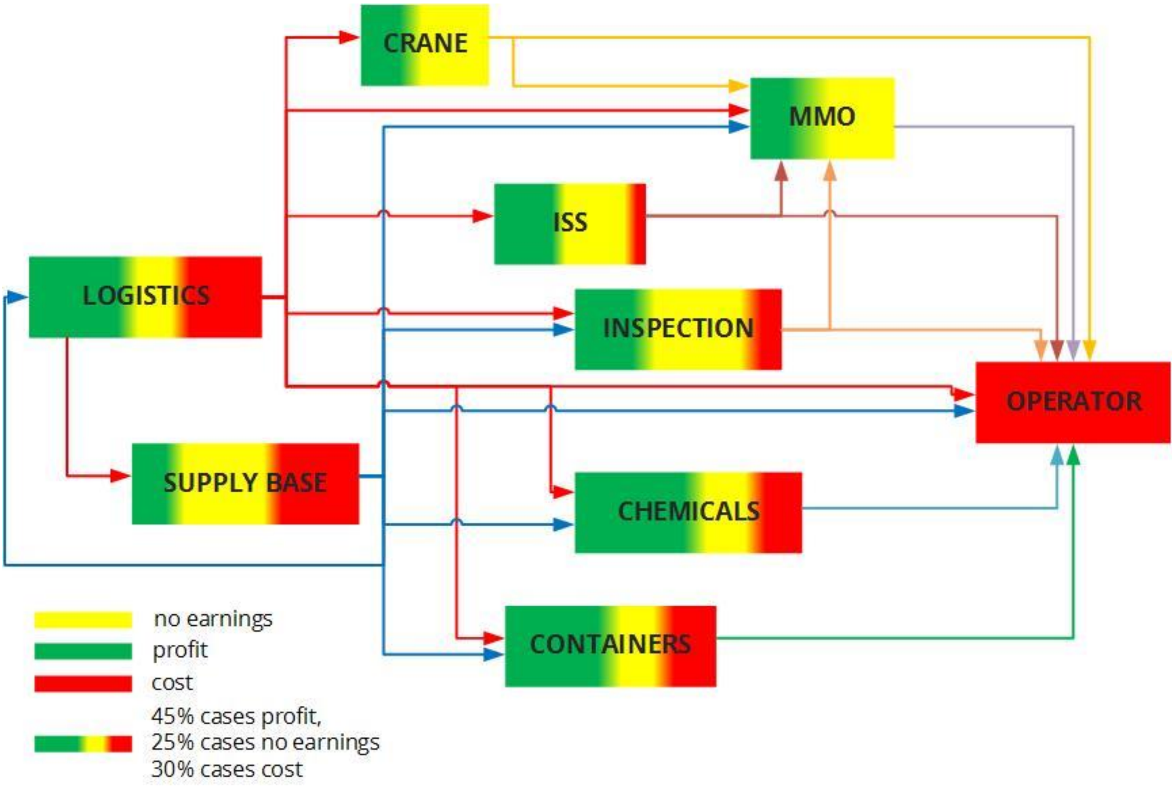


Figure 51 Cost or profit for the companies

For the *operators*, the urgent deliveries represent a cost that they cannot avoid. Since in most of the cases, urgent deliveries are generated from the operator side, the suppliers need to react quicker and incur extra costs because of the operator's needs. So it is only natural that the supplier's costs are transferred to their customer, and sometimes even with a profit margin to justify the effort.

For the *MMO* companies, urgent deliveries are not an issue, but when they do need to deal with them, they further invoice them to the operator, with their approval of course. Sometimes, the MMO can deal with an urgent delivery in a very efficient way and save costs for the operator and thus receive a bonus, as exemplified in Example 32.

During a project that an MMO company executed for the operator, there was a planning error on the operator's side. The operator was responsible for securing the valve and their ERP system showed that they have a certain type of valve in the inventory, but the valve was not there in the warehouse. So they gave the task of ordering the valve to the MMO and promised them a bonus if they solve it quickly. So the MMO asked for a rush order from the valve supplier, they delivered the valve unpainted and they organized an urgent delivery from Italy. This resulted in a 25% extra cost, but this was a small cost to pay compared to the cost of being late. This valve was planned to be installed in week 12, and extra personnel for offshore that could install the valve has already been ordered and planned for week 12. So if they had to cancel that, the operator would have lost a lot of money, plus all the delays to the project and re-planning the project execution.

Example 32 Cost saving in a project

For the *logistics* companies, the urgent deliveries most often generate profits, and bad planning that leads to urgent deliveries is good business for them. But this also depends from company to company, and how well they can plan their logistics operations. Sometimes, if they have 2 different customers that need express delivery on the same route, they can combine them and make money out of it. The customers are charged for a full truck, according to the contract, and because of the good logistics planning of the transportation company, the profit margin is double. But Example 30 shows a different case, where the transportation company was not able to benefit from the urgent delivery situation. In some cases, for the logistics company, good service is more important than making profit, so they can even lose money on some deliveries just to keep the customer happy. For example, when it comes to deliveries to Hammerfest, it can be very difficult to find cargo to fill up the truck for the return delivery, so the logistics companies end up covering that cost themselves. In some other cases, if the logistics company gets a good rate from chartering a plane, they will transfer this good price to the customer, instead of profiting from it.

For the *supply base*, the urgent deliveries of their customers can generate extra costs that they need to cover themselves. The supply base is operational 24/7, but their normal operating hours are 7-17. If they receive urgent deliveries during the normal operating hours, they cannot charge extra for handling them, so they might need to call in extra people to cope with the sudden demand, and an urgent delivery is charged the same like a regular delivery. But when they get urgent deliveries in the night, then they can charge overtime to the customers.

For the *chemicals* company, urgent deliveries normally generate profit. But if they get an order for a special mix in a rush order and when they are ready to send, they get a call that the order is cancelled, it can represent a problem for the chemicals company if they don't have an order number for it in the system, because they don't get paid (sometimes when there is an urgent delivery, the order is dealt with over the phone and it is put into the system only after it has been delivered). And that chemical mix is unique, so it ends up blocking the storage and they need to give it away. Another situation when urgent deliveries generate costs for the company is when they don't have a chemical at the base. According to the contract, it is their responsibility to have the chemicals available at the base in order to handle the orders of their customers. So if they didn't plan that well, then the chemical company needs to cover the urgent transportation cost to deliver the chemicals to the base.

For the *container* company, most of the time they do not really earn anything extra on the urgent deliveries. Sometimes, if they do not have containers available, they need to get them urgently delivered from other bases and cover the costs. However, this also depends on the contract they have with their customer. They can have a contract that specifies that if the volume is x% over the basis volume, then the customer pays the urgent transportation cost (e.g. if company A normally has 20 containers on hire and the contract specifies 20%, then when company A request 3 containers and they are not available, the container company has to pay the transportation cost to get them delivered to the base)

For the *inspection*, *crane* and *ISS* companies, urgent deliveries don't really represent costs for them, since they can transfer these costs to the customer. But they don't really make a profit either. Instead, they chose not to make a profit and create themselves a competitive advantage by being able to offer better prices to the customers and show they are reliable by creating a history of successfully handling urgent situations. They will have to charge for the overtime or for the transportation cost, but they will try to keep it to a minimum and sometimes use the good relations with the logistics partner to get lower transportation prices.

11 Differences with regards to

11.1 Information Flow and Information Systems

11.1.1 Information flow inside the company

11.1.1.1 Good practices

Meetings. They are regarded as important by most of the companies interviewed. Without proper meetings the communication with the other departments can get problematic and then errors can occur. One of the MMO companies has weekly status meeting during the planning phase of a project and meeting 2-3 times a week during the execution phase of the project. This way they can better react to possible delays or problems that appear, and they can avoid the use of urgent deliveries. For the container company, having daily meeting with the offices at the other supply bases allows them to quickly solve any problems they might have and also gives them a competitive advantage. During that meeting they get an overview of the containers available at the other locations and they can better answer to the customer's requests during the day, as discussed in Example 33. Through these daily meetings, the company can be more reactive to possible urgent deliveries. Other companies interviewed also have weekly meetings inside the company where they update themselves on new orders and new jobs or discuss priorities.

When the container company gets a call from their customer for 10 tanks they can reply with a solution straight away. If at the Kristiansund office the company doesn't have the tanks available, they can rely on the information received during the daily national meeting. During that meeting, the Bergen office mentioned they have a lot of tanks available, so then the container company can answer the customer that they have containers available in two days. Without getting the information from the meeting, the manager from the Kristiansund office would have had to make 4-5 phone calls to each individual office in order to find out. These meetings have made him more responsive and he can offer better service.

Example 33 Importance of daily meetings

Cooperation between departments. At one of the MMO companies, the procurement and engineering department cooperate all throughout the planning and execution phases of a project and they make sure that nothing has been forgotten. This cooperation works really well. At a different service company, most of the disciplines are involved in the sales process, and they all give their input. For example, the purchasing department gives their input on prices for manufacturing, prices for parts and technical solutions. This way, the planning is done more effectively and it leaves less room for urgent deliveries due to bad planning.

Emails available in the ERP system. The emails the company exchanges with their suppliers or strategic partners is attached in the ERP system for that specific order. This way, everyone in procurement team has access to the communication and they do not depend on a person to be at work. Moreover, the saved emails can be accessed for historical orders so if another purchaser needs to buy one part from a supplier (after 2-3 years), they can easily read the previous exchanges with that supplier. This can help with connecting to that supplier, gaining trust, having better relations, negotiating better terms or getting better prices. Better relations with a supplier can help handle urgent deliveries more effectively. And if there are any problems with a part, a few years after it was ordered, the email exchange can help once again with better dealing with the situation.

Proximity and personal connection. One company stressed that for the procurement department it is important to get to know the warehouse staff personally, and this can be extended to people from other departments. This makes it easier to call them when there are problems and makes it easier to cooperate to solve difficult situations, like urgent deliveries. Getting good reports of the activity, skyping regularly all helps. But the ideal situation is when the warehouse/department is in walking distance because it encourages face-to-face interactions.

Double checking. From the operator side, one good way to avoid paying extra costs is to always check with the platform manager if that part really cannot wait. The alternatives and their costs need to be presented upfront and the platform manager needs to really assess the situation and consider the cost-benefit analysis. In most of the cases, they can wait an extra day and get the part through the normal delivery and thus save the money they would have spent on the urgent delivery.

Register tentative orders in the system. Sometimes the project manager forgets to tell the warehouse manager about an order and he forgets to update the system. By registering tentative orders in their system, the warehouse manager can plan his day around these possible orders and he can call and check on the project manager if the tentative orders don't change their status. Sometimes, the project manager just forgets to inform the warehouse manager about the order, so these kind of check-up calls are very welcome and can avoid internal urgent delivery situations.

11.1.1.2 Bad practices

Not all the people involved in handling the urgent delivery are informed about the situation. At one of the operating companies, the warehouse manager complained that they don't get enough information internally. One specific situation is explained in Example 34. When something is urgent, everybody else that is involved is informed, the people that need to purchase, the supplier and the logistics company, but the warehouse, that is responsible for packing and sending the order offshore, is left out of the loop. They do manage to solve the situation, but it is stressful and it would be easier to plan the day if they had this information.

The warehouse manager of one of the oil operators frequently has vendors bringing in urgent deliveries they have not been informed about. One week before our interview, a vendor came with some hoses and they said that they need to be delivered with the vessel that day. But nobody from the office informed her about this, and it's not normal to hear from the vendor this kind of information. It would be better if they were in the information loop when urgent deliveries happen.

Example 34 Communication challenges inside the company

Improper use of ERP system. All the orders and the tasks should go through the ERP system the company is using. This is the safest way to do it, this way the stock can be kept up to date and the power of the ERP system can be fully harnessed. As long as everyone in the company is using it, the ERP system benefits the whole company and can streamline the work. If one employee uses the system wrongly, then this affects the whole department and can generate urgent deliveries through errors in the system. The more errors are in the system, the more employees will lose trust in the ERP system and they will resort to email and phone for the information flow. So companies need to invest in educating their personnel to use the system correctly and efficiently, and companies need to be aware that these kind of skills need follow up as well. There can always be misunderstandings and the system can be misused, and there are always ways to use the system more efficiently.

Urgent delivery date proposed by the ERP system. At the moment, at one of the operators, for items that are categorized as critical, the delivery date is automatically set by the system as for an urgent delivery, and the person that orders the item from offshore needs to modify the delivery date in case it is not needed that urgent. So instead, the proposed delivery date for critical items should have been later by default and in case the equipment is needed earlier, then it can be modified in the ERP system. At the moment, the ERP system generates unnecessary urgent deliveries, since most employees just accept the default data proposed by the ERP system.

11.1.2 Information flow with strategic partners

11.1.2.1 Good practices

Trusting the partner's knowledge. For one of the MMO companies, vendors are partners and they are experts in their fields of producing a special equipment. The technology is very complex in the oil and gas industry, so as a customer it is very difficult to know the technology very well, so you have to rely on the suppliers. From suppliers you can buy only their know-how or their know-how plus some equipment. Moreover, whenever specialized equipment is bought from a supplier, they are asked to also come up with suggestions for spare parts that should be bought additionally to the equipment. This way, the most important spare parts are already in the storage.

Interaction with the partners. The most important suppliers are seen as part of the group and there are daily interactions with them. Through interaction with partners, risks are mitigated and potential problems can be solved much earlier, thus avoiding the need to resort to urgent deliveries.

Integration of ERP system. Even though one of the service suppliers uses a different ERP system than the operator, they also have a lighter version of the operator's ERP system, and these two are integrated when it comes to ordering forms, project planning and registering of work hours. And the integration is an ongoing process. This decreases the time needed to handle an operation and gives a better overview of the status of an order.

Common IT solution. One of the 3PL companies has developed an online booking system for some of their biggest customers. By using this system, their customers get a special service and it saves them time, it clarifies and it saves some confusion.

Keeping everyone informed through frequent meetings. One of the operating companies has a daily meeting between platform, supply base and people from logistics department. In these meetings they discuss the normal supplies, and they agree on the sailing or the flying. Any problems are also discussed during that meeting, and this way everyone has all the information they need to run the operation that day. The operating company also has weekly meeting with the pipe inspection company and the supply base leader for OCTG where they discuss the short-term deliveries of pipes to offshore. This way all the parties involved in the smooth operation can plan their week. A similar monthly meeting is also taking place between one of the operators and the container company, where they discuss the short-term operations.

Visits. For the suppliers of critical parts, one of the MMO companies has a lot of contact and follow-up, but also planned visits. They usually fly down to the supplier for 3 visits: a verification meeting, a kick-off meeting and a final inspection meeting. By having these visits they can directly check the work and the certificates (which are very important in Norway). Similarly, the other MMO company has one of their engineer fly down to visit the producer and the production facility, get the progress report and do supply quality surveys. This way they avoid delays, poor quality and poor documentation, which could all cause urgent deliveries.

Collaborations. All the transportation companies that deliver to oil and gas industry collaborate with each other in Kristiansund. If one of them has more cargo than capacity, then they call one of the other companies to see if they have some space for their delivery. It is not a national agreement, they just know each other locally and they need to rely on each other to offer good service to the customers. These deliveries are not as profitable, but they need to satisfy the customer in any way possible when they need an express delivery. Failing to do so can ultimately mean losing the contract with the client.

11.1.2.2 Bad practices

Unclear specifications. For a supplier to do the best job for the client, they need the specifications from the client to be as clear as possible from the beginning. For a 3PL company for example, these specifications should include a good description of the situation, where to collect the shipment, where to deliver, when to pick up and when is the expected delivery time. If one of these details is missing, valuable time is lost through clarification emails.

One of the 3PL companies showed an email that one client sent 8.37am saying it's an urgent delivery. But the email was incomplete - he just mentioned it's urgent but didn't specify how urgent and by what time it should be delivered. Based on just that email the company could put one truck on this delivery. But maybe it's not that urgent, so then this delivery could be consolidated with others and the price could be lower for the client. So this requires more follow up and more time spent on clarifying. It would be better if the client would send a clear email with all the information straight away, especially when it comes to urgent deliveries, since both time and money could be economized.

Example 35 Poorly described email can waste time and money

11.1.3 Information flow with suppliers

11.1.3.1 Good practices

Not disclosing immediately the fact that the delivery is urgent. One of the operator companies has learnt from their mistake and they have updated their purchasing routine to reflect that. If a delivery is urgent, they will first check with the supplier the availability of the material and the price, and only after that will they mention they need the item as fast as possible.

Local sourcing. When choosing how far away the supplier is, local sourcing can be a good strategy. This allows the engineers to quickly go there and check the part. And allows the company to be more reactive when it comes to urgent deliveries.

Not depending on one supplier. One of the companies always has 2-3 suppliers to ask for price quotation for a part. This way, they know they can get a good price. And even when they have a preferred supplier for a part, they still ask more suppliers for quotation and let their preferred supplier know about this. This way, the supplier can be more cost effective.

But of course, the choice cannot always come down to price. Developing a relationship of trust with a couple of suppliers is always a good strategy, because if communication is faulty, there can be other costs that add up to the low price (e.g. quality problems, delays, documentation problems, breakdowns)

Good communication. Sometimes a delivery becomes urgent for a supplier just because they are informed about the delivery too late. The earlier a supplier gets the information, the more they can plan, and if they can plan things then it can be avoided that they become urgent. One service supplier interviewed believes that if they would have been involved earlier than they are today in some cases, then they could have planned better and delivered quicker.

11.1.3.2 Bad practices

11.1.3.2.1 Number of suppliers

More actors involved can mean a longer information chain and also more complicated physical flow. Sometimes, during the tendering process of a contract, operators look only at the immediate cost savings. And this way they can miss out on the consequences that some of their choices might have, like increased lead time in the supply chain, less reactive supply chain, more time spent on following up. And having a less reactive supply chain means that it takes longer to handle urgent deliveries.

Before 2013, the container/chemical company had both the chemicals and the container contracts with Statoil. So if they got an order on chemicals, the staff would pick the tanks and fill them with chemicals. So that was very easy. This operation took less than half a day. This operation is illustrated via a cross-functional flowchart in **Figure 52**.

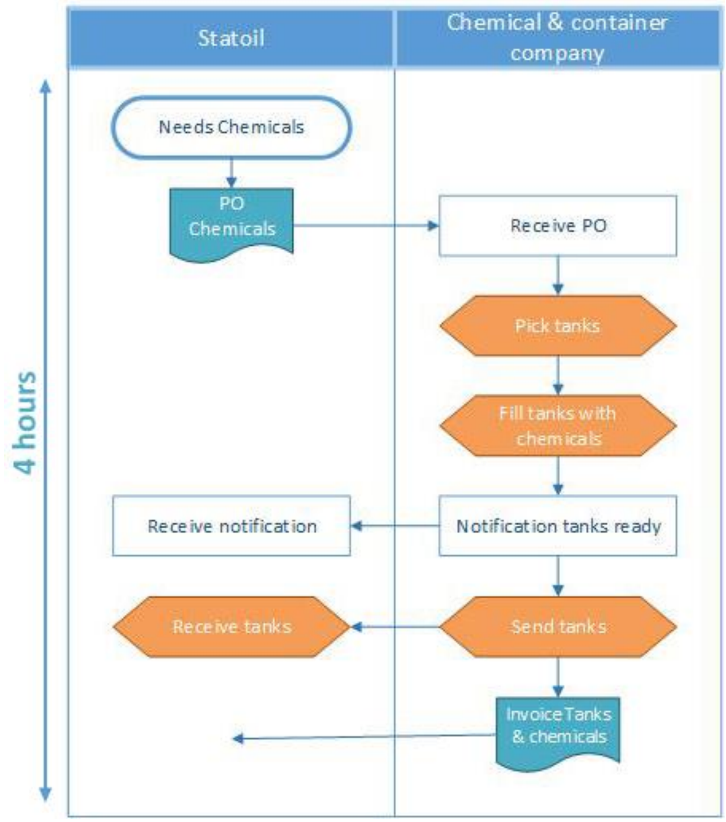


Figure 52 *Business process model for 2 parties*

But in 2013 they lost the Statoil container contract to a competitor, but still kept the chemicals contract. So what happened then is that when the staff gets a chemical order, they would have to order the tanks to Statoil, Statoil needs to go to their new supplier and tell them the chemical company needs tanks. There is no direct communication channel between the container company and the chemicals company, since things need to go through Statoil so they can be in control of what is going on. This container supplier answers to Statoil and notifies them that they can have the requested tanks, and then Statoil would answer to the chemicals company saying that the tanks are on the way. The container competitor does things differently, and doesn't wash the tanks when they are returned. So, sometimes, when they get an order from Statoil, the container company would send the tanks to the chemicals company and say "we need them washed". But maybe the chemical company doesn't have time to wash them that day, so delays this by one day. After they are washed, the container company is notified, and they in turn notify Statoil that the containers are ready to be loaded. And Statoil notifies the chemicals company. So it's a much more messy process that involves more people and takes 2 days instead of 4 hours. This process is also illustrated via a cross-functional flowchart in **Figure 53**

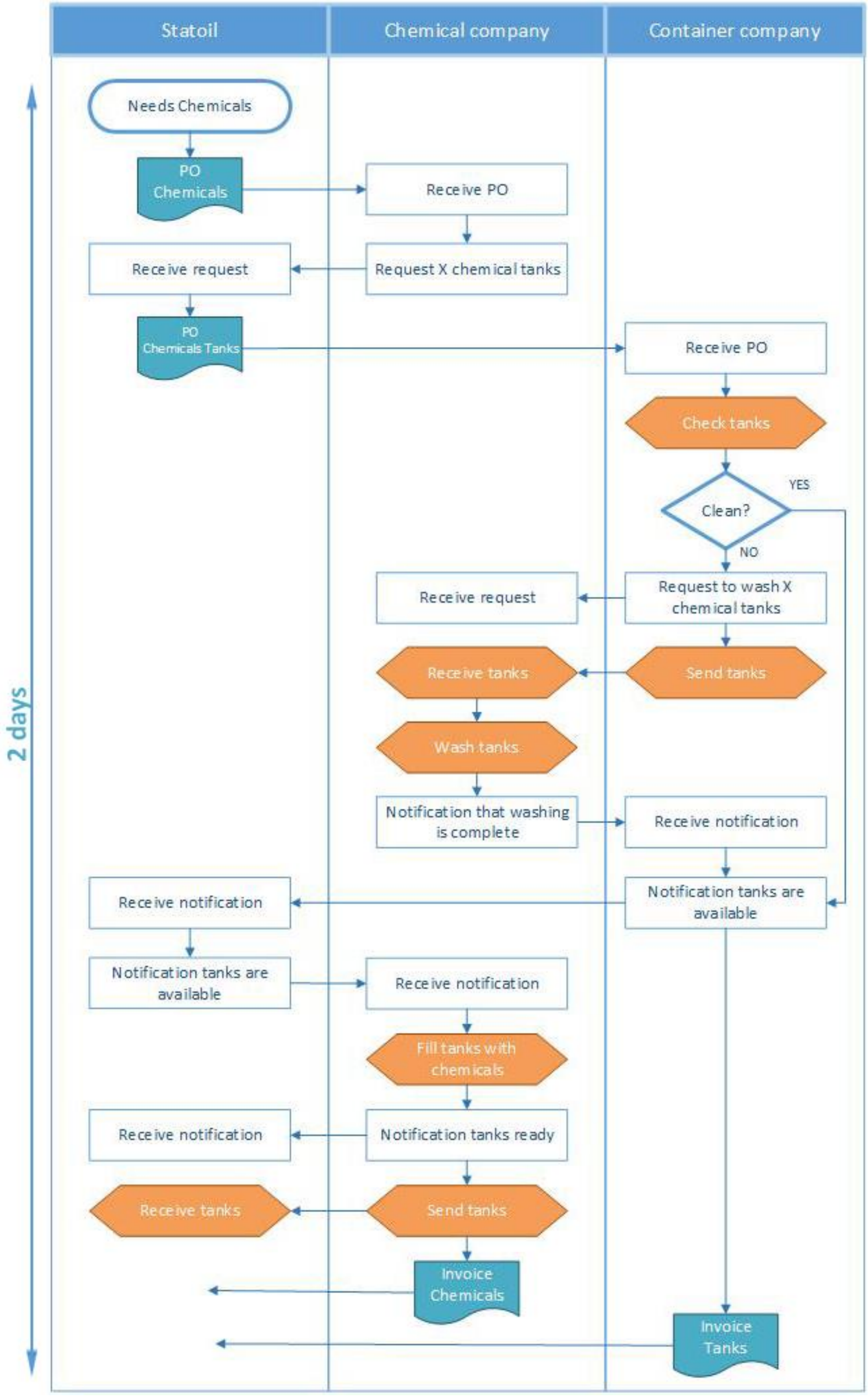


Figure 53 *Business process model for three parties*

And this here is just a process that involves 3 parts, and they are all located in Vestbase. So it can get a lot more complicated than that.

11.1.3.2.2 Feedback loop

One of the oil service suppliers had a lot of suggestions on things that could be improved and ideas on how they could be improved. But they felt there isn't really a place where they can address these problems. Companies should try and make each other better and more efficient and work smarter, and especially today if you look at how the industry is and the focus on cost-savings. In lean, all the supplier are making all the small changes themselves in order for the whole operation to get better, and they have more autonomy and a lot more power. And in this case it seems like there should be more communication. The supplier, from his level, can have a different perspective on the situation. They may have noticed a problem that maybe the operator will never notice, and they have also figured out a solution. If the supplier believes that the operator could improve their operations in a certain way, from a lean perspective it should be a lot easier for this idea to be passed along.

11.1.4 Information systems

All the companies use some kind of ERP system plus other information systems, and the main problem is the integration of all of these systems both within the company and among the different companies. The innovation in technology that lies ahead is quite exciting, but getting the IT developers to make the systems "talk" to each other is not easy, even though it sounds like an easy thing to do.

The multitude of ERP systems available out there is overwhelming. We have tried to illustrate this through the visualization in **Figure 54**. In this figure, each cluster of IS represents a company, and the arrows illustrate some of the possible ways of communication between them. We have not included all the companies interviewed in our study, since the visualization would have turned out to be quite messy.

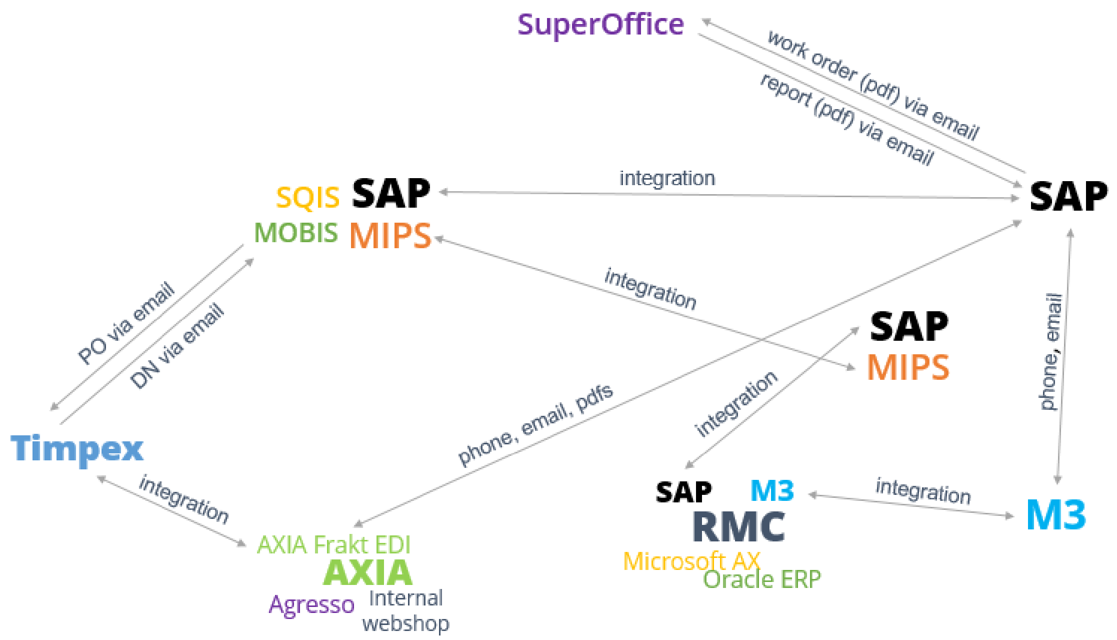


Figure 54 *Example of ERP and IS systems inside companies and communications between companies*

When it comes to usage of IS/IT tools inside a company, their utility is undoubtedly high. But there are a lot of challenges with using the systems properly. Employees use several years to learn how to use some systems, and for older employees it's an even higher learning threshold. Plus, a person needs to use a system regularly to maintain their skills. If one person doesn't use the system correctly, then this can affect all the other employees. If a company uses too many IS that lack integration, then valuable time is spent transferring the information from one system to the other, and errors can more easily occur. All these can have a big impact on urgent deliveries and sometimes even generate them. One of the employees from a service company interviewed, admitted that they could handle 20% more deliveries in a day if their internal systems were integrated. That means that handling urgent deliveries would take less time, and they could even save money by having less staff on the job.

When it comes to communication between the companies, they mostly transfer the information via emails and phone. Most of the times documents (e.g. requisition, PO, DN, work order, invoice) are exported as a PDF from their ERP system, sent via emails and then the receiver spends some time inputting those details in their own ERP system. Some degree of integration does exist, but only when the 2 companies have a common system. Statoil, for example, asks most of their suppliers to use SAP, which can be a very heavy program for a small supplier. Another solution to facilitate integration is the electronic data interchange (EDI). A 3PL company that uses Timpex TMS can get an order directly from their customer that uses AXIA Frakt EDI.

Challenges appear at the meeting point of all the information streams, which is represented by the supply base. There they use 5-6 different IS in order to accommodate all the different systems of their customers, since the logistics coordinators that man different positions in the warehouse need to get the information in the customer's supply system. This represents a challenge for them to do effective operations, because during nighttime or weekend they could handle more equipment if they could use the same personnel. At the moment, if they have one urgent delivery arriving at the supply base for one customer in one warehouse, and then they have another urgent delivery for another customer in another warehouse, then they need to use personnel in both places. If they had just one system, then they could use the same person to handle both customers that night. Of course, this could be turned completely around if they could have their own system that supports all the other systems and is able to communicate with the different customer systems.

A lot of the companies interviewed have expressed their wish for the integration of the systems or for a common logistics hub that collects and shares information. Also, a lot of the companies expressed that they prefer to get an order directly in their ERP system rather than getting it through an email in a PDF format. This way they save time inputting the order, they avoid any kind of errors or misunderstandings and they have less paperwork.
For example, one of the operators complained that they have no overview in their ERP system over what happens between sending the PO to the supplier and receiving the goods in the warehouse. They cannot see all the information, and they would like to know more about the order status, they want to be able to track it and know how the order is handled by their supplier or by the 3PL. Only when the delivery status at goods receipt changes, do they know the equipment has been received. This problem is visualized in **Figure 55**.

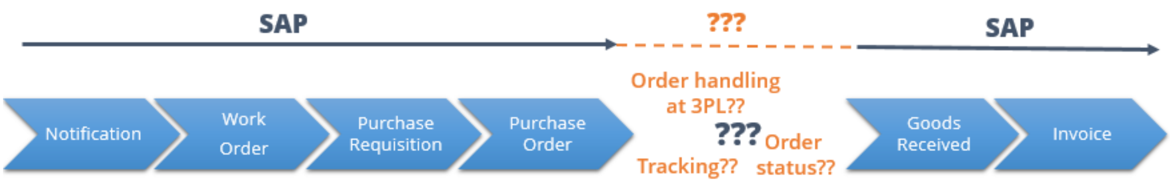


Figure 55 *Breakage in the information system flow*

Besides using an ERP system, some companies have disclosed some other interesting IS they are using:

- Supplier Qualification and Information System (SQIS) is used internally by one of the MMOs to document the experience with a supplier throughout the entire global company. This way, when making a purchase, they don't only depend only on their personal experience, but also on the experience of all the other purchasers in the company. Plus, whenever they order something, that supplier needs to be registered in SQIS (e.g. they cannot go to a local shop and buy a cake for the office if that company is not in SQIS)
- MOBIS is a documentation follow-up system used by one of the MMOs. Since their work is very documentation intensive, they need a way of following it up. Through this system they can very easily see what documents have been received and most importantly which ones are missing. This way it's very easy to send a report to their suppliers and request the missing documentation. If they didn't have such a good overview, some deliveries might transform into urgent because of wrong/missing documentation.
- Internal webshop. Because one of the inspection companies is lacking a proper ERP system, they have created an internal webshop for the warehouse. This way, the project managers can use it to order equipment internally, instead of calling or sending emails. This webshop is especially helpful for new project managers that don't have that much experience and don't know the equipment so well. It has saved the company quite a lot of time that would have otherwise been spend on clarification phone calls. And it also helps with handling short notice orders much faster.

11.1.4.1 Accuracy of information in the ERP system

Accuracy of the information in the ERP system is crucial. If one person forgets to modify the inventory stock for a part, then this can have serious consequences and can further generate urgent deliveries (if ERP system showed 1 unit available in stock, but in the warehouse there was none) or generate unnecessary urgent deliveries (if ERP system shows no item in stock, and in the warehouse there actually is one item available). Since most urgent deliveries are generated from the operator side, we analyze the accuracy only in the operator's ERP system.

One of the operators has registered in the ERP system all the parts for the oil rig and they are up-to-date. But when it comes to subsea equipment, they are still working on having all the info in the ERP system. These subsea materials information has been stored in Excel lists or in some of the worker's head that have been working with that for a long time. And since there are a lot of older people retiring, the operator has to avoid that they take all this information with them when they go. As long as everything can be found in the ERP system, the warehouse personnel just needs a material number to retrieve and deliver the equipment, and no further knowledge of subsea equipment is needed.

For the other operator, their discipline responsible admits that the information in the ERP system is not updated to reflect the real situation at the offshore storage facility. But the information at the onshore warehouse at the supply base is pretty accurate. The reason for this is that they were bad at following up the spare parts. Once they switched from the old system to their new ERP system, they did not transfer all the products correctly, thus the job was not done properly and this affects the current situation.

Another issue is the criticality level assigned to the products. They split the products into two categories: critical and non-critical. And the critical products are further split into less critical, critical and very critical. The very critical items should be stored at the storage facility offshore. The critical items should be stored onshore at the supply base warehouse. And the less critical items can be ordered from the supplier when they are needed. This is summarized in **Figure 56**.

Figure 56 *Criticality of product in the system and where it should be stored*

In theory this is of course a great system, but only if the items are correctly tagged. Sometimes, a group of products is tagged as very critical, even though not all the items in that group should get this tag, like in Example 36.

Offshore cranes are categorized as very critical, since a non-functional crane on the oil platform can cause a lot of problems. So in the ERP system, all parts that are related to a crane are tagged as very critical. That means that the windshield wiper on a crane is tagged as very critical, even though the crane can be operated without a functional wiper.

Example 36 Criticality of a group of products vs each individual product in that group

The discipline responsible for this operator does not agree that the criticality assigned to a product in the ERP system is always correct. And this has further consequences. When the offshore personnel registers a requisition in the system, depending on the criticality score of the product they get a notification that the item will be urgently delivered and the expected delivery date. Of course, the employee can edit the expected delivery date and input a later date (transforming the delivery from urgent to normal), but it's very easy to just accept the default date suggested by the ERP system. And this can generate an unnecessary urgent delivery because of the inaccuracy of the information in the system. After all, the quality of the information that goes into the system affects the quality of the results.

So then if this problem is acknowledged by the discipline responsible, why isn't there something done to fix it? Again, we go back to the problem of the feedback loop (discussed in 11.1.3.2.2), but this time from an internal perspective. The discipline responsible does not have the authority to change the criticality status in the system directly, and they need to notify a different person that works onshore about the problem – send a case in a different system and explain the whole problem – and then this is evaluated and approved/rejected. But this whole process is seen as too complicated by the discipline responsible, so then he prefers to just input changes to the delivery date instead (every time he creates a requisition for that product).

Of course, a different solution would be if an internal project would be started to reassess the criticality of the products. A team of specialists from both offshore and onshore would decide and discuss the criticality and where it should be stored. But more than this one-off project, it would be very important to have a continuous improvement program since it cannot be expected that the categorization will be perfect from the beginning. As personnel orders products, when they notice a wrong categorization they should feel empowered to report it.

11.1.5 Tracking: RFID and GPS

Tracking has been quite a big focus in the last years on the NCS, and at the supply base in Kristiansund there have also been a couple of project that concentrate on tracking. A TAGhub project to implement RFID was started at the supply base in Kristiansund a few years ago as a cooperation between the operator companies and some suppliers, but it has not gotten very far. One of the operators has implemented GPS tracking system on their containers together with one of the container companies, and this has been successful. Now the operator can track their containers using the online platform designed by the container company. And the other operator is still working on it. Plus, one of the inspection companies has experimented with RFID on their equipment that is in suitcases or aluminum boxes, and this has helped a lot with the automatic registration of goods movement in their system. It helped so much that they increased their work productivity by up to 75%.

There are many benefits with tracking systems, either via RFID or GPS: it's easier to measure the timings at the different steps of the chain of logistics and this allows better KPIs; there is a full real-time record of the containers on maps which allows tracking the exact location; it helps with the information flow; it streamlines the operations; expiry date of certificates on containers can be tracked; better planning of chemical refills and orders – an area around the rig can be defined and when the container enters or exits the area, one of the employees can receive an email notification; the exact location of expensive equipment can be tracked; possible to keep track of containers rented (a lot of containers end up travelling around by being misused and thus generate costs for the company when they are not returned when they should be); movement of goods is automatically registered in the ERP system.

The problem with the RFIDs is not the cost of the device, but the entire infrastructure that is needed around it in order to make it work. In one of the implementation projects at the supply base one of the reasons why the project stopped was because of technical issues to gain signals from the transmitters. With GPS on the other hand, only the tag is needed, since the already available network can be used.

But at the moment most of the tracking projects have been stopped because of the low oil price and low activity. And here lies the paradox. When the activity is too intense and companies barely have time for their normal day-to-day activities, there is no time to develop a better system, in this case tracking via RFID or GPS. And when the activity is low and the future is uncertain, then there is no money to invest in a better system.

11.2 Planning

Based on the interviews, we thought it is necessary to include this topic in this paper because all companies mentioned that there is something can do with planning in order to improve the efficiency of logistics in the upstream supply chain. Some companies mentioned that they have changed from a two weeks operational plan to a four weeks integrated plan, which highly presented in the Norwegian petroleum industry for a decade ago, in order to force everyone to do better planning. So, with better or improved planning they can reduce the frequency of urgent deliveries in the UPL.

In fact, planning is important to the businesses, and it helps companies to achieve their goals and to use the existing resources in an efficient way. When a something unplanned happens in offshore operation, on either the production platform or drilling rig, so the companies have to use extra resources to handle it, thus, it also can generate extra costs. In order to avoid this kind of extra cost, they do need to improve their planning and consider the challenges or risk in planning.

It seems when an urgent need arises, the operator companies make a decision how to handle it and what kind of suppliers they need to contact, and they decide on the quantities of material, the specific vehicles that carry the deliveries, and the lead time that the deliveries should be delivered to the final destination. Therefore, the operators mainly are responsible for handling the urgent situations. However, the frequency of urgent deliveries is unpredictable in many circumstances either it is from drilling rig or production platform. Even it can suddenly happen something urgent in a well-planned and efficient operations.

Besides, the operator companies operate together the vessels in Haltenbanken, two to three vessels a week. When it comes to weather condition, so much weather in the Norwegian Sea as same as the North Sea, there are more strict restrictions on helicopter transport than vessels. It often happens that there is a strong wind offshore that the helicopter cannot unload, and then the delivery will be packed again in a container and shipped with the vessel to the platform. Such changes can quickly destroy the operation planning and sailing routes for supply vessel, which probably can impact negatively for other platforms.

Example 37 Uncertainty in the planning

This example explains a case of uncertainty in planning. Thus, the companies have to have a good availability and capability to respond to such circumstances in an efficient manner as quick as possible.

Furthermore, it also appears to be the MMO companies usually work on projects and not on the day-to-day operations in offshore. Thus, they usually have a long planning horizon of one year or several months, but it depends on the projects. Therefore, they can have a long preparation time and for example, they can use several months on most of the purchases. Maybe, it provides the opportunity to MMOs to make a solid plan with regular commissioning and installation spares considering uncertainty, which sometimes represents things will break down unexpectedly. Besides, they do tune the whole operation process and spend extra time in the planning stage in order to avoid of urgent deliveries. Consequently, the continuous improvements are vital in planning for offshore activities.

Lately, according to the operators, the number of helicopter routes to offshore in a week has been reduced, and they sent cargo with personnel by the helicopter if the urgent delivery is not too big and dangerous. With this, they conclude that better planning can contribute to reducing the number of urgent deliveries.

One of the service companies mentioned that with better planning between the operators and service companies can contribute to having reduced urgent deliveries. The company offers their customers a product called TRIM (total rig integrity management), which they suggest their clients to plan all the maintenance for the equipment based on an annual basis that can contribute to avoiding of unplanned activities or inspections.

Example 38 Total rig integrity management- a product

Above example displays that the classification of equipment in maintenance is vital. For instance, some equipment may not be used very often that it requires less maintaining or inspection while there is equipment that is crucial to the operations on the drilling rig or platforms that needs proper maintenance. Considering the classification of equipment in the operational planning could be some cost-savings in term of money and working hours. Thus, the companies primarily have to focus on better planning and using their resources efficiently today. In conclusion, *with better and integrated planning for operations on the offshore installations might reduce the number of urgent deliveries, and having a reliable supply chain could help to handle it better.*

11.3 Purchasing Strategy

Both the operator companies and the MMOs deal with a lot of suppliers, one of them has more than 20 000. So they all have some kind of information system to keep track of the suppliers across the whole organization. Such an information system, SQIS, has already been described briefly in 11.1.4, but there are other systems out there, like Achilles (Achilles 2016). An order can be sent to a supplier only if they are in the supplier database. If they are not in the supplier database, then a request needs to be sent to the central office of the company, and a specialized team will start a rigorous process to check if the supplier is up to the standards required by the company. This can include doing a credit check, verification of any corruption cases, and analysis of their supply chain, plus a lot of forms that need to be filled in. For a small company this can be a lot of work.

The country of origin of a supplier (and even their sub-suppliers) plays an important role. One of the MMO companies has acknowledged that Shell and Statoil usually do not approve of Asian suppliers, and that is because of poor quality and very little flexibility in production. Moreover, countries like Irak, Iran, Israel or Syria are completely forbidden at the moment because of geopolitical tensions. First they prefer to use a Norwegian supplier, and if that is not possible, then they prioritize a European supplier. And when they do decide on a vendor, even if they are European, they also check the list of sub-vendors of that potential supplier, to gain transparency in the supply chain and make sure of their origin.

A big challenge that some companies are facing is monopoly situation. For some equipment or components only one supplier holds a patent, which makes them the only supplier available. And in some cases, the customer represents just a small "fish in the sea" for that supplier. If we are to analyze this situation in the terms of the Dutch Windmill proposed by Van Weele (2009, 202), the operator in this case is a "nuisance" for the supplier (see **Figure 57**). So what they try to do in order to decrease the purchasing risk is to establish a frame agreement where the prices and conditions are predetermined.

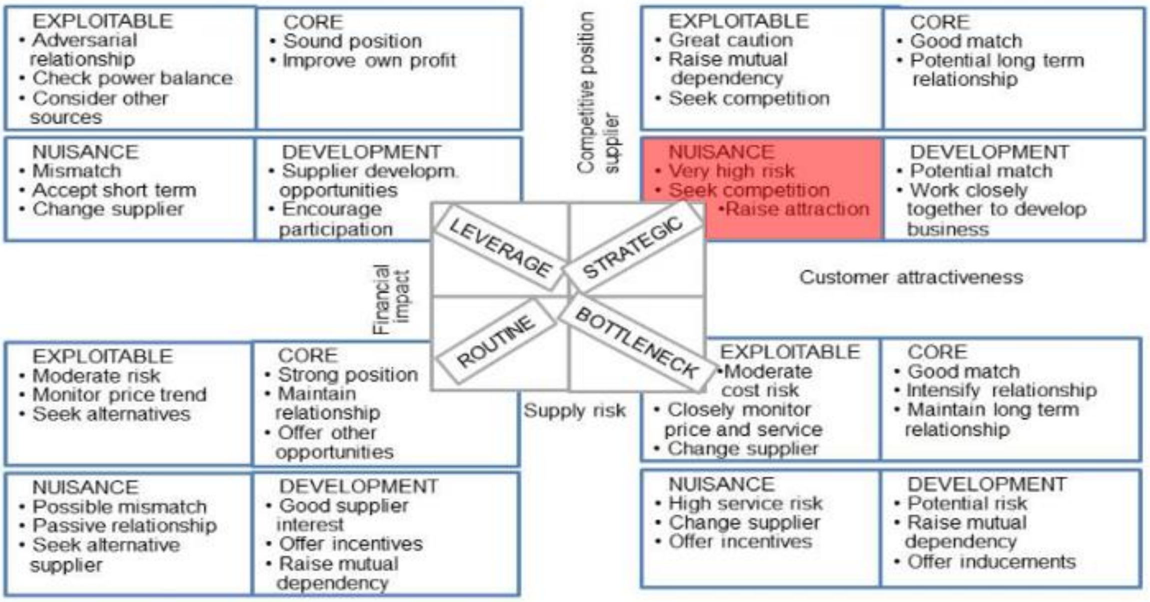


***Figure 57** The Dutch Windmill adapted for this case [Source: (Van Weele 2009, 202)]*

For some bigger companies, that have their Norwegian headquarters in e.g. Stavanger and branches all along the coast, we notice practices of *centralized purchasing*. One of the chemical companies orders their chemicals from abroad through the Stavanger office, and the branch in Kristiansund orders their chemicals directly from Stavanger office. This way they can benefit from better prices through *economies of scale*.

11.3.1 Frame agreements

Frame agreements (FA) can help expedite the urgent delivery process. When pre-determined framework agreements are used, the customer does not need to negotiate any of the terms when placing an order (like price and relevant requirements). For example, if they need to order express delivery from Stavanger to Kristiansund, the price and lead time can be found in the frame agreement with the 3PL, so no time is lost agreeing on the price, and the 3PL company cannot charge extra to take advantage of the circumstances. Of course, if it is a more unique situation, like chartering a plane, where the price depends on the conditions on the spot market, the costs cannot be explicitly covered in the FA.

Usually, companies have frame agreements with the companies they use the most. They are usually for two years and they can be renewed. When a company needs to order a product, they have to prioritize the supplier they already have a FA with (it is even mentioned in the FA).

Moreover, even if a frame agreement does not exist between two suppliers, an "adoption" contract can be used when they both serve the same customer and a frame agreement already exists in that relation (see **Figure 58**). In this case, the same terms and conditions from the original FA will apply.

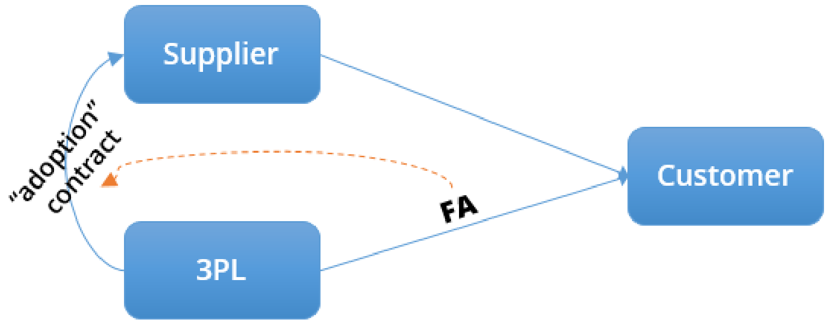


Figure 58 "Adoption" contract in Frame Agreements

11.3.2 Power relations

Throughout the interviews we have had with the different companies, a certain theme has surfaced: the operator has quite a lot of power over the suppliers, and the smaller a supplier is, the more power the operators has. One of the service companies acknowledged that they sometimes give too much service, and the operators get spoiled. Thus, the operators stop doing such a good job planning when they know that the supplier will in the end deliver even if they forget to order on time and they order too late. So the urgent delivery "stress" is transferred to the supplier. And it's difficult to change things around and impose new rules to the operators.

And it is a similar situation at the 3PL companies. The customer has quite a lot of power in choosing the transportation company they want, so then the customer can impose their own procedures and way of working. When they send the PO to the transportation company, they export it straight from their system and send it in PDF format via email. So the transportation company has to spend time inputting the order into their system. But if the transportation company had more power over the customers, then they could impose their own system over the customers, in a similar way that Statoil does.

A different case of power relations is the sudden *purchasing power issue* experienced by one of the operators when they would tell their supplier of parts that they have an urgent delivery. As described in 10.7.2 when the supplier understands that the customer is in trouble and that the delivery is urgent, and they know that they are the only supplier for this type of equipment, then they can require extra payment. Even though the item might normally cost 100 NOK, the supplier can charge 1000 NOK or even 10 000 NOK. After experiencing this, the operating company has modified their procedures. This way, when they contact the supplier, first they check the availability of the material and the price, and after that they specify that the item is needed as fast as possible. Moreover, they have also started better *coordinating their logistics activities*, and setting clearer task delimitations between the requisitioner and the purchaser. The requisitioner can talk to the supplier in order to check the availability of the item, but once they have found it they need to pass along the task of ordering the item to the purchaser.

12 Proactivity/Improvements

Proactivity refers to different actions that companies are already taking in order to improve their handling of urgent deliveries. Improvements, on the other hand, are suggestions received from the company as to what might positively impact the handling of urgent deliveries. All together, these represent good practices that companies can adopt.

12.1 Proactivity

Planning. One of the operating companies moved from a 2 weeks plan to a 4 weeks integrated plan in order to force everyone to do a much better planning.

Lean thinking. Focusing on “what can be done to improve the situation?” led to one company becoming creative with their solution.

In order to avoid the late rush of deliveries during Easter, the container company goes down to Statoil's yard and checks how many containers of each type they have available. Based on this evaluation, they contact Statoil and suggest what containers they should order to avoid any problems in case something happens during e.g. Easter. Moreover, if they see that Statoil has just one 10ft container and they know they do not have any in their inventory, then the staff would start repairing 10ft containers, just in case an order would come. This proactive service helps both the container company and the operator, and it has come with the lean thinking.

Example 39 Proactive thinking

Warehouse hubs. One of the service companies, together with their logistics partner, has established hubs at the supply bases in Stavanger and Bergen. This way, they can store a few pallets with equipment in their 3PL's warehouse. In case they get an urgent delivery from one of their customer in Stavanger or Bergen, then they can directly deliver the equipment from there, this way saving two days of lead time.

KPIs. Measuring the performance of handling urgent deliveries is a great way to put this issue into focus inside the company. And not only inside the company, but also to the suppliers or customers, like described in Example 40

Earlier, the container/chemical company would get an order on a Monday for 15 different chemicals that should be delivered the day after (this is stressful for the workers), and since it is not possible to do that, their customer would be disappointed with the service. And the chemical company would get the blame, when it's actually the operator that could have ordered the chemicals one week in advance. So instead of hiring more people, the company decided to create reports for the customer. So they started to log the delivery time and the expected shipping time of every delivery, and they would have KPIs that show how many deliveries are within 48 to 24 hours and how many are same day deliveries. Because of these reports, their customers understood the strain they were putting on the supplier, so they now have a bigger percentage of customers that are ordering in advance. There will of course always be urgent situations due to uncertainties in the operations, but they can better handle them by getting rid of the unnecessary urgent deliveries.

Example 40 KPIs

Similarly, one of the MMO companies has TV-screens all throughout the offices where relevant KPIs are monitored and everyone can check their performance in real time. This

makes the employees more aware where they should focus their improvement efforts during their activity. And everyone has a unified view of the priorities inside the company.
One of the other service companies also measures urgent deliveries. They register all delayed deliveries from their warehouse, they record the deviation and they analyze it. This way they hope to learn how to become better.

Prepacked and precustomized equipment. One of the inspection companies has prepared kits for their inspectors, which are ready to be delivered when they are requested. Moreover, when they are getting the used kits back, they inspect the equipment directly and they refill the kits and prepare them so they are ready to be used. Similarly, the container company directly washes and inspects their containers when they are getting them back. This way, when an urgent delivery comes, they do not need spend time washing and inspecting.

Spare parts. Whenever specialized equipment is bought from a supplier, they are asked to also come up with suggestions for spare parts that should be bought additionally to the equipment. This way, the most important spare parts are already in the storage.

Preventive maintenance. One of the inspection companies offers a service called TRIM (total rig integrity management). They plan all the maintenance for the equipment based on an annual basis, and then they create a schedule which reduces the need for unplanned inspection. Some of the customers think that it is not a cost-saving package for them, but the company believes that it costs less than all the unplanned inspections.

12.2 Improvements

Monitor equipment via sensors. Breakdowns could be prevented by monitoring equipment and being proactive, and this in turn could decrease the need for urgent deliveries. Technology is rapidly advancing and sensors have been getting cheaper and easier to incorporate. So if sensors could be installed on already existing equipment, then monitoring the status could be possible. And based on different parameters like temperature, humidity, conductivity, the situation could be monitored and machine learning algorithms could be used to learn from breakdowns and predict future problems. By fixing problems before they happen, urgent deliveries could be avoided.

Integrated systems with strategic partners. Unnecessary hours are used on the phone to call suppliers, 3PL or supply base and get information or inform about status of a delivery. This costs the company money and makes the supply chain less reactive. By integrating the information systems, all the information get to the necessary parties with less effort and the lead time of handling an order is reduced.

Cloud solutions, big data and apps. Imagine a scenario at the pipe inspection company. All the pipes have their identification number and based on that number, the work history can be traced back. If the systems would be integrated, when Statoil send the company an order of 200 pipes, the SAP program of Statoil sends the data into the cloud and over there it's captured and translated via EDI protocols to the ERP that the pipe company uses and transformed into a work order. Thus, the only job of the department manager is to approve the work order. Then, using e.g. Microsoft's PowerApps, the inspection worker would automatically receive on their touchscreen handheld device the work order. They would start with first pipe in the work order, scan the number on the actual pipe they are inspecting, that would automatically be registered in the app and then a confirmation screen would appear with two options – 'approve' or 'reject'. The inspection worker would choose the corresponding box and if 'reject' is selected, further boxes with most common courses of action would show up. Once all the pipes have been inspected, the head of department has a ready-made report he can then send to Statoil (via cloud again) and this way he saves a lot of time by avoiding manually inputting the results. Also, he has a much better overview of the status of the pipe inspection via a real-time dashboard: he can check how fast the inspection workers are doing their job and who is doing the best job, maybe he could better split the workload among the inspection workers, etc. So there are many advantages to implementing such a solution: a lot of insight can be uncovered from all this data and by automating routine tasks, the head of department can focus on what is really important.

PART V: DISCUSSIONS AND CONCLUSIONS

13 Problem statement and research questions

The following section seeks to answer the research questions addressed in the introduction and research methodology chapter, based on the theoretical framework outlined in part 2 and the analysis outlined in part 4. This should give an answer to the overall problem statement, restated below:

How do different oil and oil service companies that operate in Haltenbanken area of NCS perceive and handle urgent deliveries and what can be done to improve the current situation?

13.1 Research question 1
How do companies in Haltenbanken handle urgent deliveries and how suitable is the supply network for this task?

In order to answer the first research question, we first discuss the definition of urgent deliveries in the context of UPL. To our knowledge and based on our review of relevant literature in the field of urgent deliveries, there is little research and no clear definition. Searching for similar concepts, we have found in the literature a definition for emergency logistics (see 3.1), but it mainly refers to how to design a supply chain that can respond to disasters quickly and efficiently. A similar concept that is defined in the literature is the express deliveries (see 3.2), but this is more like a transportation service. Based on the interviews, the concept of urgent deliveries can have different understandings between the different companies, and sometimes even inside the same company. So there is a need for a unified definition of urgent deliveries, and we propose one below.

Proposed unified definition of urgent deliveries in upstream petroleum logistics (UPL): *If an actor in the supply network needs to take an action for a delivery of material or personnel to an offshore facility, and that action is outside of the normal routine/procedure, then this delivery can be categorized as urgent. Note that not all urgent deliveries generate extra costs, and there is a scale of urgency (some deliveries are more urgent than others) as illustrated in the figure below.*

Figure 59 Scale of urgency

Mostly all companies we interviewed acknowledged that *they do not have a specific procedure to handle urgent deliveries*, but considering the information flow, the urgent delivery procedure (see **Figure 42**) ideally follows the normal procedure how they handle work orders (detailed information in part **10.5**). Practically, usually does not follow the procedure as described above, but it handles manually, which outside of the system. It is again about the scale of urgency (see **Figure 40** in part **10.3.1).**

Consequently, in most urgent delivery cases they use a lot of time to call each other and make sure everything over the phone and the system updates afterward. If the situation allows registering the information in the ERP system, then the urgent orders will be marked with "URGENT/HASTER," otherwise, the operations will be registered in the ERP system retroactively (described in **10.5.3.1**). In this handling process, external actors as service providers also have a duty phone that is for receiving urgent orders outside of their working hours. From the supply chain perspective, this kind of shortcut is necessary for the handling of urgent deliveries due to the shortest possible lead-time. Therefore, urgent deliveries are part of logistics operation that implements Just-in-Time delivery principle, following by Tseng et. al. (2005).

Moreover, the delivery of materials described in part **10.5.3.** In an urgent delivery case, as mentioned above the service provider receive the urgent orders via phone or email and further preparing the delivery for the transport. Also, the types of materials through the urgent delivery supply chain vary widely from small critical parts to valves, pipes, cranes, chemicals, cement, drilling mud for drilling rigs, just to mention a few. Thus, the material flow in the upstream supply chain is wide-ranging, and the logistics that handling is most challenging as well. The material flow through supply vessel applies only where the size of delivery is too large or heavy in case transporting via helicopter is not allowed. Again, it is about the scale of urgency, see **Figure 59**.

In normal deliveries, the lead time versus costs challenges this upstream supply chain, but in the urgent delivery supply chain, the lead time is the only consideration and challenges most. The challenge will be to ensure that each company and operator along the upstream supply chain makes a quick response to the material needs on the platform (see **Figure 44**).

Incidentally, shortest lead time can be a definitive source of competitive advantage for a company (Tersine and Hummingbird 1995).

In order to answer the second part of the question and discuss the suitability, we analyze the supply network in our research study from the prism of the ten critical success factors (CSF) suitable for an emergency logistics supply chain. They are proposed by Pettit and Beresford (2005) in their paper and discussed by us in section 3.1.1.

We deliberately look at the supply network in Haltenbanken as a whole, because we believe that the efficiency of handling the urgent deliveries is a supply network effort, where the individual efficiency of each company involved can affect the overall result in terms of lead time or costs.

(1) Strategic planning

The companies interviewed seem to have a good strategic planning. The operators outsource most of their non-core activities, and they have good partnerships in place with their 3PLs. The location of storage facilities seems to be also well thought of. One of the operators uses a pooling system between their warehouses and their suppliers. And one of the oil service companies has established warehouse hubs together with their logistics partner, which allows them to have critical equipment closer to the possible urgency area.

(2) Inventory management

The inventory management strategy at the operators interviewed is good in theory, but there are some clear shortcomings when it comes to practice. Each product is assigned a criticality level in the ERP system, and based on the criticality, the storage location is decided (see **Figure 56**). This is in line with the process criticality control characteristic discussed by Huiskonen (2001). But problems arise when items are incorrectly tagged in the system, and according to our interviews, this occurs quite frequently.

Whybark (2007) suggests that for emergency situations, inventory should first be “pushed” into strategic locations and then “pulled” when the precise area of need is known. This is similar to our findings, where the operator “pushes” inventory of moderately critical parts to different supply bases and “pulls” them to the installation only when they are needed. But for the very critical parts, the storage space on the installation is used. “Pushing” the very critical materials as close as possible to the source of the problem seems to be a good strategy.

(3) Transport planning

From the feedback received from the companies interviewed, all the companies outsource their transportation needs to 3PLs. These 3PL companies seem to be quite efficient and reactive and able to successfully handle a varied range of situations.

(4) Capacity planning

As Cottrill (2004) discusses, capacity can be increased in times of urgency through collaboration with other companies. This is similar to what we have uncovered in our study, where in order to increase capacity in times of urgency, the three 3PL companies in Kristiansund have entered a local cooperation. If one of them has more cargo than capacity, then they can call one of the other companies and they might be able to deliver. This is not a national agreement, just a local one, where they need to rely on each other in order to handle urgent deliveries and offer good service to the customer.When it comes to the capacity planning at the supply base, there can be some issues because of lack of proper information flow. The supply base has the ability to handle extra capacity and can be available 24/7, but they need to be notified beforehand.One issue when it comes to capacity is related to the low storage capacity on the installations. This puts some limitations to the capacity planning that can be undergone. Åsgard, one of the oil installations has a storage ship nearby because of the low capacity on the actual installation, so solutions can be found. But the costs of such solutions need to be measured against their benefits. And in some cases (e.g. chemicals), despite their criticality, it’s better to store them onshore and deliver when needed.

(5) Information management

Similarly to emergency logistics, the information management in urgent situations is crucial, and the speed at which it happens can have an impact on the effectiveness of the response. But we are not sure we could go as far as agreeing with Long and Wood (1995) that this is the “single greatest determinant of success”. A lot of the companies interviewed rely on real-time communication via phones when handling an urgent situation (detailed in 10.5.3.1), and this seems to be in line with Long’s (1997) observation that the most important method of reacting quickly for effective coordination remains real-time communication.

But the quality of information is also critical, since poor information can lead to further complications or further delays from trying to clarify the situation. In our research, one of the companies has complained about the issue of getting incomplete information from their customer.Information management seems to also be important when assessing the criticality of the urgent situation. A few years back, many situations were urgently handled despite the fact that the delivery of the material could have been delayed. But the companies interviewed have acknowledged that these days there is more communication happening and the offshore and onshore personnel at the operator discuss the need for an urgent delivery before committing to it. Similarly, the 3PL company can discuss with the operator about the necessity of an express delivery.

(6) Technology utilization

All of the companies interviewed use some form of information system inside their offices. In some cases it is one complex system, in other cases the operational functions are distributed among different systems. The effects of the technology are in line with Gunasekaren and Ngai (2003), who discuss that IT systems provides accurate information, performance measurement and control. One barrier to effective external coordination seems to be the lack of system integration between the companies. Power, et al. (2001) argue that IT is an indicator of supply chain best practice when it connects customers, suppliers and value-adding activity. And in some cases, the IT lacks in directly connecting the companies with their supplier and customers (see **Figure 55**), so they still need to rely on email and phones for the external communication. Valuable time is spent by employees transferring the information into their own system, errors can occur and more paperwork is involved.

One other issue faced by companies is the improper use of the information systems. Employees use several years to learn how to use some systems, and for older employees it's an even higher learning threshold. If one person doesn't use the system correctly, then this can affect all the other employees. So making sure that relevant employees have the necessary IT skills and providing accurate training should be an important focus for the companies.

(7) Human resource management (HRM)

In an emergency situation it's important to get the right people at the right place as soon as possible (Pettit and Beresford 2009). Similarly, the urgent delivery of people (discussed in 10.5.2) is also an important aspect. In our research our focus has not been on this aspect, but from our understanding, the task of finding the right people for the job is outsourced by the operators to some of their suppliers, and they seem to handle this efficiently.

(8) Continuous improvement

According to Power et al. (2001) organizations need to focus on having a holistic and continuous improvement approach in order to become efficient and meet the needs of the customers. Throughout our study we have found that some companies lack an internal continuous improvement focus. At one of the operators, different employees acknowledged that there are some issues that could be fixed, but they do not feel empowered to report these improvements, instead continuing the way they have always done things (this is discussed in 11.1.4.1 and improvements are suggested in 13.6.)

Moreover, there seems to be issues with implementing continuous improvements between companies in the supply network as well. One of the oil service suppliers had a lot of suggestions on things that could be improved and ideas on how they could be improved, but they felt there isn't really a place to address these problems (see 11.1.3.2.2).

(9) Supplier relations

Petit and Beresford (2009) mention that close supplier relations are widely acknowledged as important and that trust between various partners allows more effective operations. Ideally, in this relations, both partners have an interest in sharing benefits and costs. Our overall impression is that the companies in our study handle their supplier relations efficiently. Since outsourcing is a main strategy, there seems to be trust in the knowledge of the strategic partners (be it manufacturers, MMOs, 3PLs) and monthly, weekly or even daily interactions with them are widely practiced.

(10) Supply chain strategy

Lean, agile or leagile are relevant supply chain strategies for emergency logistics supply chains (Pettit and Beresford 2009). In our study we did not focus on this aspect, so we cannot conclude if the supply chain strategy in the Haltenbanken supply network is appropriate. This issue is discussed in the further research chapter (0).

In order to summarize the answer to this research question, the suitability on each CSF is visualized in **Figure 60**.

Figure 60 *CSF analysis for Haltenbanken supply network*

In conclusion, based on the CSF analysis, the supply network in Haltenbanken area is partially suitable for handling urgent deliveries, and the areas of improvement are represented by inventory management, technology utilization and continuous improvement. The supply chain strategy needs to be further researched in order to draw a conclusion.

13.2 Research question 2
What are the causes and consequences of urgent deliveries?

In order to better visualize the causes and consequences, we look at urgent deliveries as a risk and thus create the bow-tie diagram related to this risk. The bowtie methodology is used for risk assessment, risk management and (very important) risk communication. The method is designed to give a better overview of the situation in which certain risks are present and to help people understand the relationship between the risks and organizational events. (BowTie XP 2016)

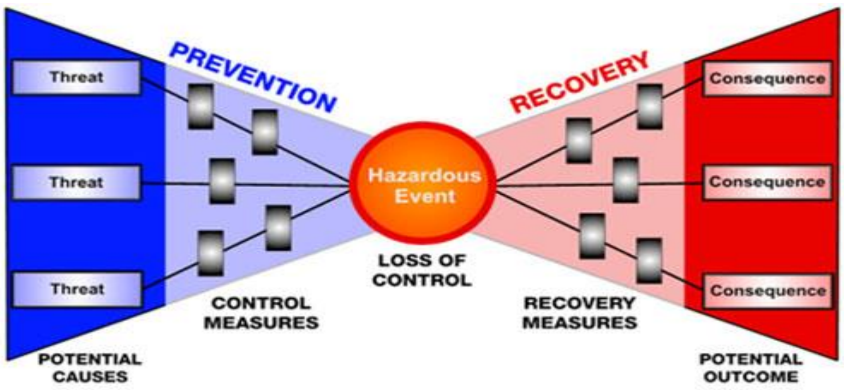


Figure 61 Structure of a bow-tie diagram [Source: (BowTie XP 2016)]

Note that the focus with the diagram we have drawn is only on the causes and consequences and not on the barriers that could prevent or reduce the effects (control measures and recovery measures), since this was not an emphasis in our research.

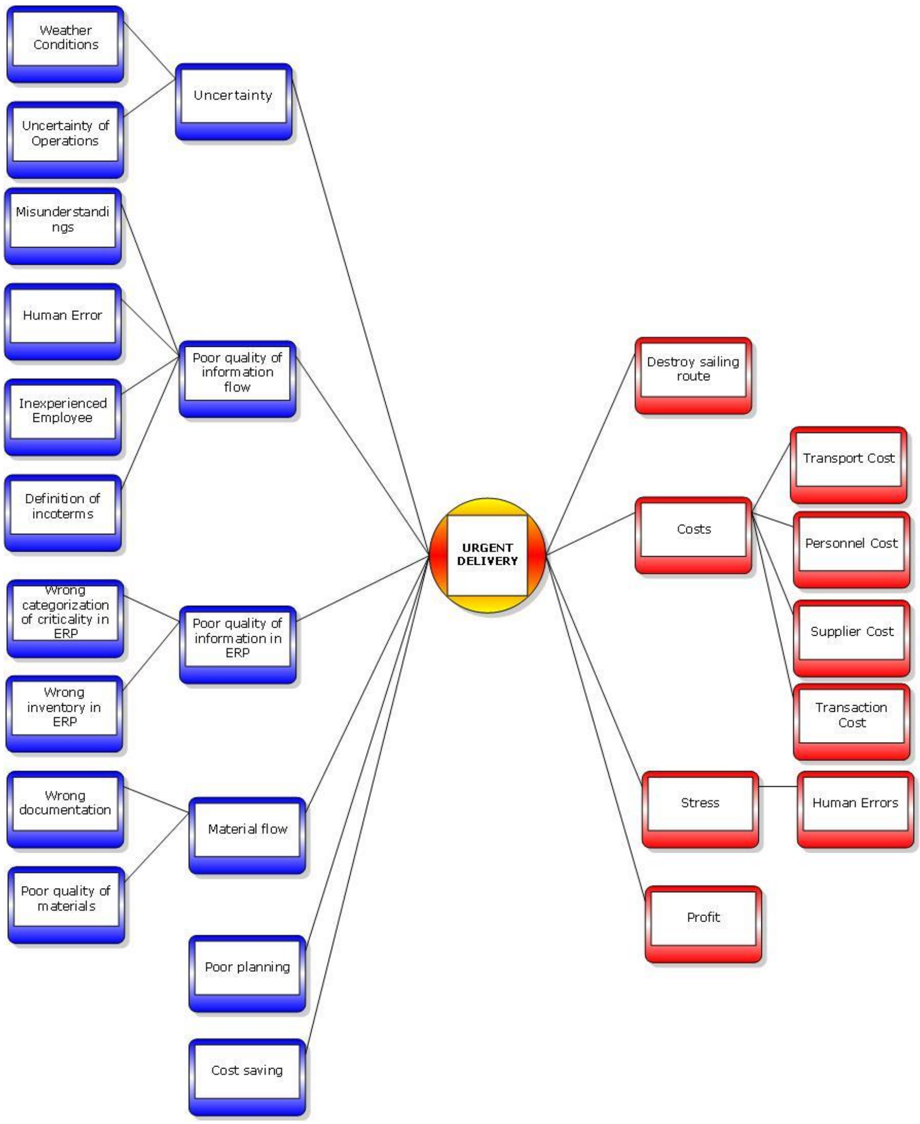


Figure 62 Causes and consequences of urgent deliveries in UPL

The causes of urgent deliveries are varied. Some are difficult to prevent and relate to uncertainty (that comes from the nature of the operations and from weather conditions). But others could be preventable, when they are caused by poor quality of information flow, poor quality of information in ERP, problems in the material flow or poor planning. In some situations, urgent deliveries are even deliberately used to save costs.

Urgent deliveries mostly have a negative impact, by disturbing sailing route, causing stress (and thus human errors that can lead to more urgent deliveries) or generating extra costs. These extra costs can be represented by transporation, personnel or suppliers, but there are also some hidden costs in the form of transaction costs, which can be overlooked by companies. For some of the oil service companies, urgent deliveries actually generate profits, as discussed in 10.7.2.1.

13.3 Research question 3
How does the information flow and use of information systems impact urgent deliveries and what can be done to improve the situation?

Similar to what Jæger and Hjelle (2015) discuss, in our research we also notice that the information flow involves a lot of people from the same company being responsible for doing different tasks in the information chain. Sometimes the delimitation between these tasks is not so clear, which can cause inefficiencies. So when it comes to dealing with urgent deliveries, this information chain is immediately simplified, but is not necessarily efficient. During the handling of urgent deliveries, all the parties involved seem to be in “survival mode” where they just need to find a way to fix the situation, and there appears to be a lack of clear coordination. No procedures are followed, information flow happens outside the normal routines and the reaction and the handling of the situation depend on the skills and experience of each individual person.

Since so many people are involved in the process, there is a need for synergy, which needs to be achieved both inside the company and outside of it. All the actors that will be involved in the handling of the urgent delivery should be notified of the situation as soon as possible and the information should be clear and complete. Critical suppliers should be seen as partners and should be consulted as to what can be done to improve the process. In order for the suppliers to feel comfortable enough to share such inputs, trust needs to be built through efficient communication in the form of regular face-to-face or Skype meetings, or location proximity. These meetings should create an arena that encourages honest and constructive feedback so that the processes can be continuously improved. Moreover, information flow chains and physical flow chains should be analyzed to find out how they can be improved and if some intermediary suppliers could be removed (as discussed in 11.1.3.2.1). Long information chains can mean a less reactive supply chain (Chopra and Meindl 2010) and thus it takes longer to handle urgent deliveries.

A lot of the companies interviewed rely on real-time communication via phones when handling an urgent situation, and this seems to be in line with Long's (1997) observation that the most important method of reacting quickly for effective coordination remains real-time communication. But then, this should be part of an operator-wide urgent delivery procedure, and the suppliers should be included in the creation of this procedure. Similarly to how procedures for handling different kind of risks are put in place, urgent deliveries should be seen as a risk and handled accordingly.

As discussed by Knabke and Olbrich (2013), information systems are not built upon agility, but on reliability and robustness over a period of time. Thus, it comes as no surprise that, faced with an urgent situation, the companies have to rely on communication outside the IS. Thus, in order to better handle urgent deliveries, the IS should be upgraded with agility considerations in mind.

Another issue with the IS companies use is the lack of visibility. This is in line with another master thesis, (Kvie 2015), who found that for Statoil there is no real time tracking information for the extended supply chain, and there is no common visibility of the transportation for the actors. Moreover, communication within the extended supply chain mainly happens via emails, phone calls and uses extra workforce to compensate for the lack of visibility.

As IBM (2011) argues, good supply chain visibility helps resolve problems before they escalate. We can extend this to say that good supply chain visibility can help avoid urgent deliveries. Not all types of urgent deliveries, since some uncertainty cannot be removed from the system. But the urgent deliveries caused by order errors or lack of follow-up could possibly be avoided.

Visibility could be improved with integration of systems. Most of the companies interviewed mentioned that they communicate with other companies via email or phone, and they complained about the lack of integration of systems. Some companies use different systems inside their own company even, and the lack of integration is also visible at the internal level, similar to Cecere's (2014) conclusion. Only one company acknowledged the use of EDI in relations to their 3PL provider. Is it that none of the other companies use such technology to facilitate data interchange? Or did they just fail to mention it during the interviews? As illustrated in **Figure 20**, almost 80% of companies that were part of Cecere's study (2014) admitted to using EDI, so then why such a discrepancy in the UPL? EDI has its drawbacks and there are other alternatives to it, like B2B supply chain networks, discussed by Cecere (2014). Some of the suppliers in the study can be even 'forced' by the operator to have a certain ERP system, since this can allow a certain degree of integration. But such an ERP system can be too heavy and expensive of a IS for small suppliers.

Companies are aware of the benefits of integration, and this is not such an easy issue to solve (Jæger and Hjelle 2015). On the NCS there have been projects like EPIM's LogisticsHub (discussed in 6.2.2) and companies have been experimenting with tracking on their own as well (see 11.1.5). Even though there many clear benefits, the current pressure on cost reduction has put a hold on such projects. And here lies the paradox. When the activity is too intense and companies barely have time for their normal day-to-day activities, there is no time to develop a better system. And when the activity is low and the future is uncertain, then there is no money to invest in a better system.

Although information systems have the ability to reduce risks and remove uncertainty, these are standardized tools and cannot replace people completely (Zuboff 1988). In a complex supply chain, the human brain is still necessary to deal with changes that occur in the operations, problem solving, taking decisions or performing the necessary communication. But advances in technology, such as artificial intelligence, machine learning, big data management and cloud computing can definitely make it easier for humans to react to changes and take better decisions.

13.4 Research question 4
How does the purchasing strategy impact urgent deliveries?

Purchasing is a vital function in petroleum logistics and it indirectly supports offshore production of petroleum raw materials. The purchasing strategy has an impact on urgent deliveries at a more strategic level (similar to Anderson and Rask's discussion (2003)) and it can have an effect on the efficiency of handling urgent deliveries. In order to have a more agile and efficient supply chain, the companies interviewed employ practices such as local sourcing, centralized purchasing, contractual purchasing (through frame agreements) and collaborations.

For example, the sourcing strategy of the companies seems to prioritize local Norwegian supplier and then European suppliers and tries to avoid as much as possible sourcing from Asian suppliers. This way, companies avoid future urgent delays caused by poor quality, transportation issues, documentation problems or frequent breakdowns. This is similar to the benefits of local sourcing discussed by Tunisini et al. (2011) and Jin (2004), and these are benefits that can help avoid future urgent deliveries.

In one case, practices of supplier monopoly have been discovered, and Van Weele's (2009) dutch windmill analysis (see **Figure 55**) showed that the operator was in a very risky position as a "nuisance" for their supplier. This can cause power issues (Emerson 1962) and make the customer vulnerable in crisis situations like urgent deliveries. For example, there are situations when the supplier can ask for a premium price when they know the customer is desperate and does not have any other supplier to turn to. Therefore, a better purchasing strategy (e.g. seeking other suppliers, raising the attraction or entering a frame agreement) can help reduce the incidence of such situations and thus avoid extra supplier costs for urgent deliveries.

Power issues exist also between the operators and some smaller suppliers. Such suppliers try to give as much good service as possible and the operators can "get spoiled" and do a less good job with e.g. planning, since they see that the supplier can handle the urgent delivery. In such power relations, the stress of urgent deliveries is transferred to the supplier, and it is difficult to change things around and impose new rules to the operators.

13.5 Research question 5
How does planning impact urgent deliveries and what represents better planning?

An urgency can occur as a result of a breakdown in operations. Thus, the urgent deliveries create some unforeseen demand in the project planning or maintenance planning or well planning that companies need to react on quickly. Most of the companies we interviewed usually blame on and quickly say that urgent deliveries often occur due to poor planning. However, it was unclear what type of planning the companies are blaming it on. Based on the understanding from the interviews, it seems the planning connects more and less to the causes and consequences of urgent delivery. Nevertheless, the planning might give an impact on handling urgent deliveries. Additionally, Chang et al. (2007) mentioned that improving the efficiency of emergency logistics might depend on circumspect preparation plans made in peacetime.

However, the poor planning often leads to inefficient use of logistics resources, and it should be avoided (Aas and Wallace 2008). Thus, the poor logistics planning might cause that they cannot execute that urgent delivery on time. Because a quick response to the urgent need is a critical issue, described by Sheu (2007). To avoid or reduce the frequency of urgent deliveries then the operators should into the operational planning (see **Figure 9**) that is defined by Yang and Haugen (2016) in part **5.1.1** and described more in **5.1.2** (Sarshar, Haugen and Skjerve 2015). Moreover, it is further discussed by Sheu (2007) in challenges of emergency logistics management, and Balcik and Beamon (2008) in **3.1**. Therefore, **the key challenges to logistics planning in the UPL considering the urgent delivery cases might be as following:**

a. ***Uncertainty*** (on the well, weather changes, harsh environment, resource capacity, demand)
b. ***Lack of communication*** and complex coordination (silo-thinking, unclear information between actors, involvement of many different parts, a complex organizational structure)
c. ***The limited capacity of resources*** (availability of materials and people, transportation capacity).
d. ***Lead time (*** discussed in part **3.4** and total lead time for logistics process in handling of urgent deliveries, see **Figure 44*)***

The characteristic of the urgent delivery logistics is that the logistics planning in urgent delivery is lead-time oriented. As mentioned in Harrison and Van Hoek (2011) lead-time is defined as the time it takes from the point a customer sends an order to the moment the customer receives the product. Thus, the driver in handling of urgent delivery is a lead-time that is as short as possible in every single point of the supply chain. Considering the offshore activities, logistics planning in urgent deliveries involves delivering materials (e.g., spare parts, equipment, chemicals, food, specialists, etc.) to the drilling rig and the production installation as quickly as possible so that the operations are kept going, same as in the emergency logistics described by Özdamar et al. (2004). Therefore, the purpose of *logistics planning* is to move the requested materials across *a network* with a suitable transport mode, in *the shortest time* possible when *an urgent delivery* is required.

Furthermore sometimes the urgency is from the demand side, in the well or platform, which is something to do with uncertainty. As described in part **5.4** that uncertainty associated with plans is the most challenging thing in operational planning (IO Center 2008). In such case, how can better planning be done?

Mainly, uncertainty is associated with maintenance work in offshore. With this, Okoh and Haugen (2013) clarified the connection between a given accident and its maintenance related causes, consequences, and barriers (see **Figure 14**). Thus, it is important to look into the causes of urgent deliveries (described in part **10.3.1**) that can be found in uncertainty, to understand why it occurs to improving the plan. Then identifying the possible risks or challenges in the earlier planning phase can contribute to making a better plan. Besides uncertainty, there are thirteen factors identified that cause accidents in the offshore operation, and they are described in part **5.4**, and more detailed in (Sarshar, Haugen and Skjerve 2016). In addition, the classification of work process for maintenance related causes, see **Figure 15** and more detailed in Okoh and Haugen (2013), possibly can contribute to understanding better the causes and improving the planning.

Based on the ideas from emergency logistics network (Sheu 2007), we propose the following conceptual framework (**Figure 63**) that illustrates how ***the urgent delivery logistics network*** look like in urgent delivery cases. This urgent delivery logistics network is contributing to handling urgent deliveries in a better way that all parts of the supply chain are included in the planning process and have to be integrated considering logistics resources and lead-time. The purpose of this urgent delivery logistics network is that operators and service companies within the network of the supply chain can respond quickly through cooperation and integrated planning to the urgent material needs of its project on the installations in offshore. As described in part **10.5.2** that mostly all companies that provide services are very flexible and coordinate the resources among the network.

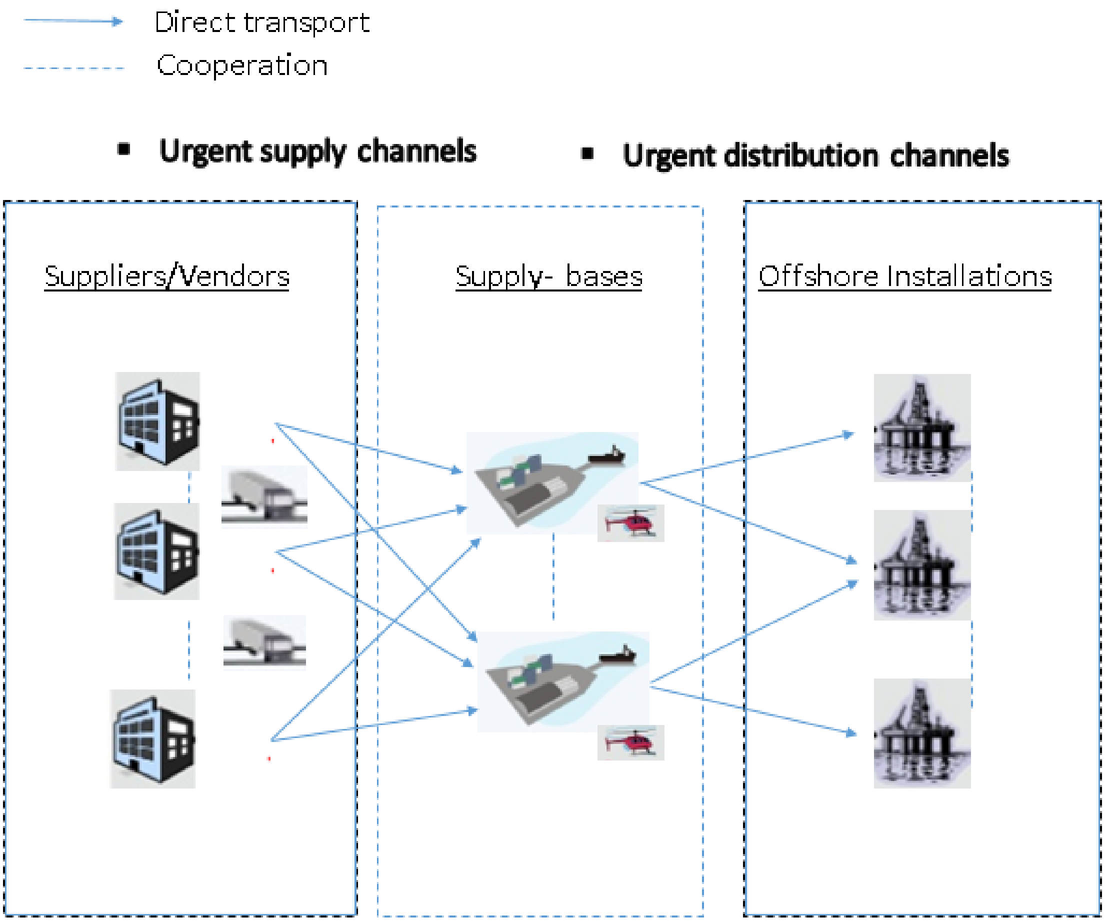


Figure 63 *A Conceptual framework of the urgent delivery logistics network*

Besides, all companies believe that a better planning might help to reduce the frequency of urgent deliveries. Within the UPL on the NCS, a better planning might refer to integrated planning, that is described in **5.3.1**, which is implementing the integrated operations (IO) concept into the planning domain ((Rosendahl and Hepsø 2013).

One of the operators explained that they have moved from a two weeks operational plan to a four weeks integrated plan one year ago.

Example 41 Integrated plan

Since some of the companies have implemented the integrated operations concept, they are planning more carefully and better, so that they use their resources as much as possible in every situation.

A service provider explained that the efficiency of workflow depends on the planning in offshore if the team leader or foreman offshore does the plan well, and it predicts well the future activities, then usually the work will be executed very well.

Example 42 The efficiency of workflow

So good planning is one of the things we were expecting to be lacking in companies that have problems with urgent deliveries. On the other hand, in some MMO companies, it is good planning and good procedures set in place, good relations with the suppliers, very clear purchasing strategy. Thus, these points are what we have thought would reduce the need for urgent deliveries.

In conclusion, *a better logistics planning might contribute to reducing the lead-time in the handling of urgent delivery* while *the operational planning can contribute to avoiding urgent deliveries.*

13.6 Research question 6
What can be done to handle urgent deliveries in a more efficient way?

The ability of the supply network to efficiently handle an urgent delivery is derived from the strategic and tactical decisions taken at a higher level in regards to workflow procedures, purchasing strategy, information systems, planning strategy and supply chain strategy. In order for urgent deliveries to be handled in a more efficient way, all these other processes need to work properly, as visualized in **Figure 64**. The one thing that might make a difference in the direct better handling of urgent deliveries could be the competency of the persons involved. If they are smart, they react fast, they are quick problem-solvers and have some experience in the company so that they know who to contact, then the outcome can be more efficient, with lower lead time and lower costs. So the human resource management can help as well.

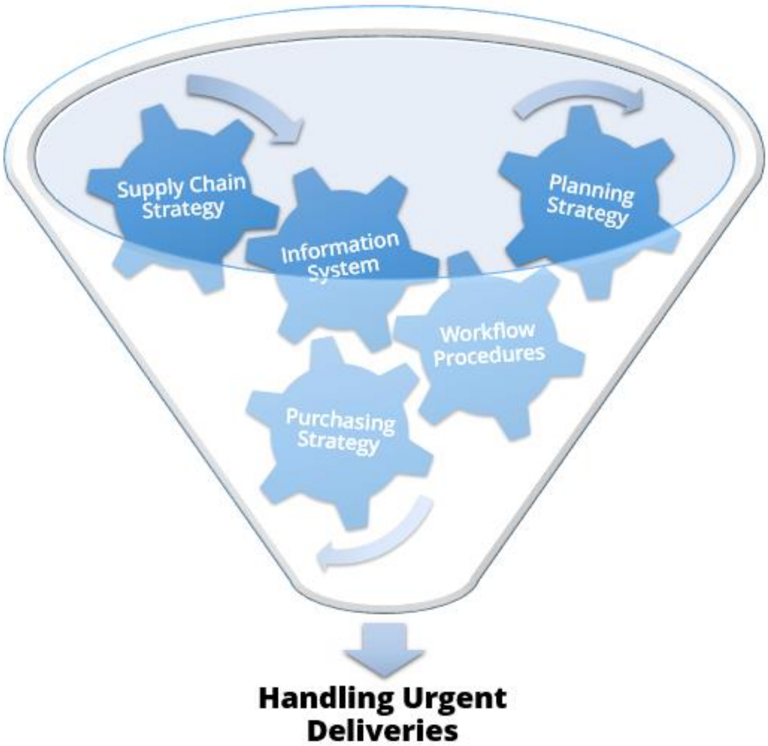


Figure 64 Factors that impact the efficiency of handling urgent deliveries

Different good practices and bad practices that companies are doing have also been presented all throughout chapter 11 and 12. Moreover, through the CSF analysis in RQ1, three areas for improvement were identified: inventory management, technology utilization and continuous improvement.

Below, we discuss one issues that we consider important and that came up during the interviews and we propose some direct actions that could be taken in order to increase the overall efficiency. Related to both technology utilization and inventory management, one area that could be improved is related to the *accuracy of data in the ERP system* of the operators (analyzed in 11.1.4.1).

First of all, in some cases there is a discrepancy between the equipment registered in the ERP system and the actual equipment at the offshore installation. This creates big issues in the system since the onshore personnel relies quite a lot on the accuracy of the information in the ERP system to handle their daily operations. This can generate urgent deliveries when e.g. the planner relies on a part that appears to be in stock but actually isn't.

Second of all, criticality of products is not properly defined for some items. Since the criticality is further used for inventory management, planning and ordering, properly defined criticality is crucial to the operations. And this can generate an unnecessary urgent delivery because of the inaccuracy of the information system. After all, the quality of the information that goes into the system affects the quality of the results.

So then, what could be done to improve the situation? Why is it that even though these problems are acknowledged by the employees, there hasn't been something done to improve the situation? From our understanding, it seems that some of the employees do not feel empowered to report such problems or they feel that the reporting procedure is too strenuous. One solution would be to simplify this process or have a training with the employees on this topic to increase their confidence in the procedure. Another solution would be to start an internal project to reassess the criticality of the products and the storage synchronization.

14 Limitations

Firstly, there are some limitations connected to the literature review. The resulting literature from our search for "urgent delivery" and similar keywords may be limited. Valuable work might not be found in the first few pages of the databases results, may not be published in common journals or may simply use a different terminology that we have not considered.
Another limitation could be that we only focus on certain branches of literature. This is an exploratory study, so we have tried to look at as many different aspects as possible. Nevertheless, we had to also limit ourselves. One of the aspects that could have been discussed in this context is the relevance of lean and agile principles, so we briefly touch upon this in the further research chapter.

Secondly, some limitations may be related to the collection of empirical data. Since from Kristiansund office, Statoil only operates Njord and Shell operates Draugen, the other oil installations have not been covered from the operator perspective. We should have also had an interview with the Statoil office in Stjørdal, in order to gain a better understanding of the situation in Haltenbanken. But since it is the same organization, the way they operate should be similar.Also, a lot of the companies have expressed the fact that urgent deliveries are more common among drilling companies, but we did not interview any such company. This is because there are no drilling operations in Haltenbanken at the time of research and drilling companies are only present in Kristiansund with a warehouse office. The companies we did get in touch with, like Transocean, Seadrill, Oceanrig, Dolphin, Songa Offshore, COSL, directed us to their Stavanger office. Limitations related to the research methodology are discussed in 2.7.6 and they relate to the quality of the interview process, asking leading questions, lack of a pilot interview, the subjectivity and bias of respondents and quality of transcribing of Norwegian interviews.

15 Further research

Since this is an explorative study that is carried out in Haltenbanken area, it would be very interesting to repeat the same study in other areas on the NCS. The same research methodology could be used, or a more in-depth research could be conducted in regards to one of the theoretical concepts we have described. For example, more research could be focused in the planning direction on integrated operations and how operational and maintenance planning affect the cause of urgent deliveries. Or further research could be carried out in regards to information systems and how to efficiently use them to better handle urgent deliveries.

In RQ2 we discussed the causes and consequences of urgent deliveries, so one area of further research is to expand this discussion and look into the different barriers that could help prevent or reduce the effects.

One theoretical concept that we have not discussed in our thesis but we see as very relevant to more efficient handling of urgent deliveries is related to supply chain strategy. It would be interesting to discuss how lean and agile impact urgent deliveries. Considering that drilling and well operations are more prone to uncertainties, we believe that an agile supply chain might be more appropriate to react to urgent situations. On the other hand, production installations have a more stable demand, thus we believe that a lean approach to the supply chain will be more appropriate. Suitability of leagile could be discussed as a supply chain strategy.

One of the companies interviewed brought up the fact that administrative costs (mainly related to documentation of equipment) are quite big, sometimes ending up being six times more expensive than the actual unit cost of the part. Thus, a further research topic, unrelated to urgent deliveries, could be into administrative efficiency, the costs involved, the causes and how they could be reduced.

16 Conclusions

Urgent deliveries in the UPL are not seen as such a big problem these days, when there is less activity in the oil and gas industry, but because of the low oil price there is a focus on cost-reduction. And the bottom line is that urgent deliveries generate extra costs, so there are savings to be made from avoiding or handling them more efficiently.

The objective of this master thesis has been to discuss how different companies in Haltenbanken perceive and handle urgent deliveries and to provide suggestions as to what could be done to improve the situation.

To our knowledge, there is a lack of literature in this field, so this thesis provides a unified definition of urgent deliveries applicable to UPL. Furthermore, looking at emergency logistics literature, 10 critical success factors are used to analyze the suitability of the current supply network, and we propose three areas for improvement: inventory management, technology utilization and continuous improvement. We find this comparison to be quite insightful, so we suggest that the same framework could be used to analyze the suitability of other supply networks.

When it comes to handling urgent deliveries, the efficiency of the information flow and physical flow are equally important, but the companies in the study lack a clear procedure for such situations. They usually handle urgent deliveries manually, outside their normal routines, relying mostly on phones, and lead time is the most important aspect when dealing with urgent deliveries, although costs can also be significant. So the efficiency of handling the situation depends on the competence of each individual person. Thus, there is a need for a proper urgent delivery procedure at the operators.

Urgent deliveries can be caused by uncertainty, but there are preventable causes as well, like poor quality of information flow, poor quality of the information in the ERP, material flow inefficiencies and poor planning. The main consequence of urgent deliveries is represented by higher costs for the operators, but it can mean good business for some suppliers or even a chance to gain competitive advantage. The operators in the study seem to lack a clear overview of the cost impact of urgent deliveries, and usually only consider the transportation cost. So our suggestion to practitioners is to spend some time gathering statistics and looking into the total cost impact before they consider urgent delivery costs as negligible.

When it comes to the information flow, there is a need for synergy both inside companies and between them. Good supply chain visibility helps resolve problems before they escalate, and this can be achieved both through better information flow and integration of systems. Inaccuracy of data in the information systems can be a grave issue that affects urgent deliveries, since quality of information that goes into the system affects the quality of the results, thus it should be a priority for companies facing such issues.

The purchasing strategy impacts the efficiency of handling urgent deliveries at a more strategic level, so it is an important aspect to consider. The purchasing strategies used by the companies in the study to become more responsive, are in line with literature. Power issues are very clear in the UPL supply network, where the operators, as final customers in a way, have a great deal of power over their suppliers. Thus, improvements in the supply network should be generated from the operator side, since the suppliers have little influence.

When it comes to planning, our study finds that better logistics planning might contribute to reducing the lead-time in the handling of urgent deliveries while the operational planning can contribute to avoiding them. Thus, integrated and better planning for operations on the offshore installations might reduce the number of urgent deliveries, and having a reliable supply chain could help handle them better.

One important finding of the master thesis is that the efficiency of handling urgent deliveries is derived from the strategic and tactical decisions taken at a higher level in regards to workflow procedures, purchasing strategy, information systems, planning strategy and supply chain strategy. Moreover, the efficiency of handling the urgent deliveries is a supply network effort, where the individual efficiency of each company involved can affect the overall result in terms of lead time or costs. Thus, operators looking to handle urgent deliveries more efficiently should have a holistic view of their supply network when trying to make improvements.

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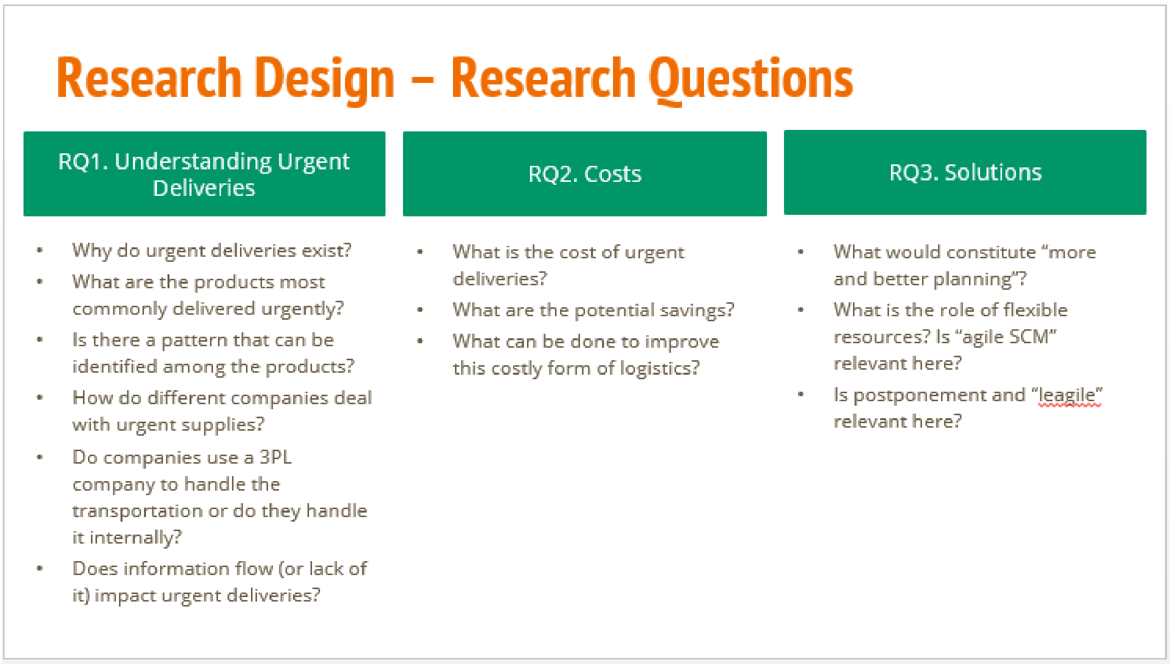
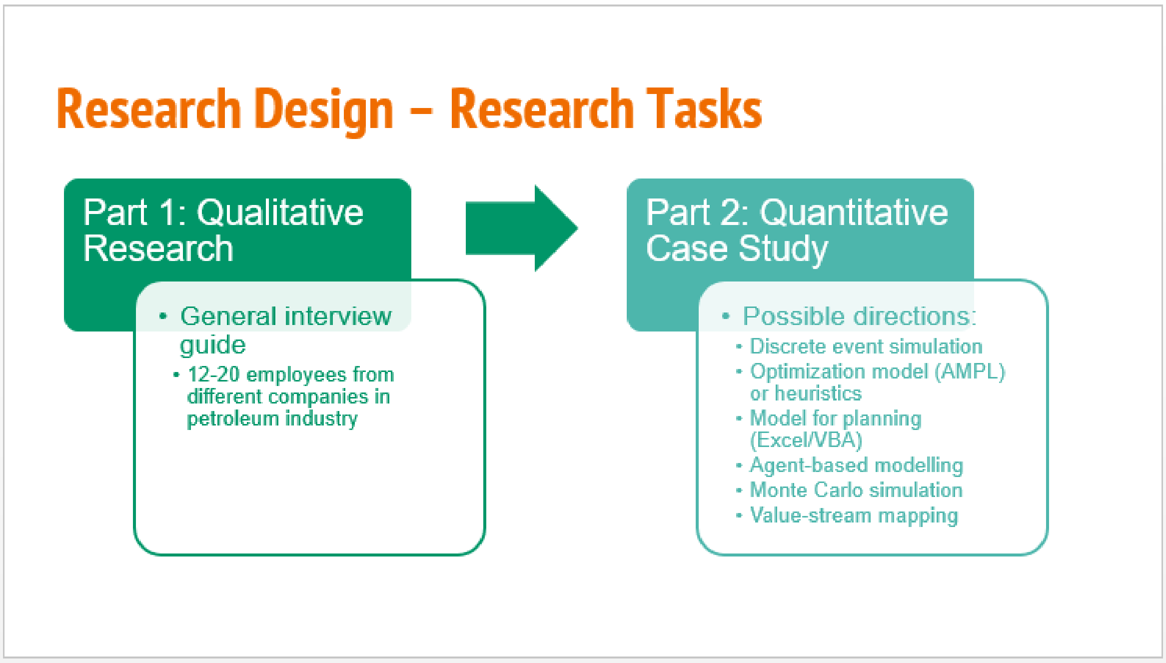
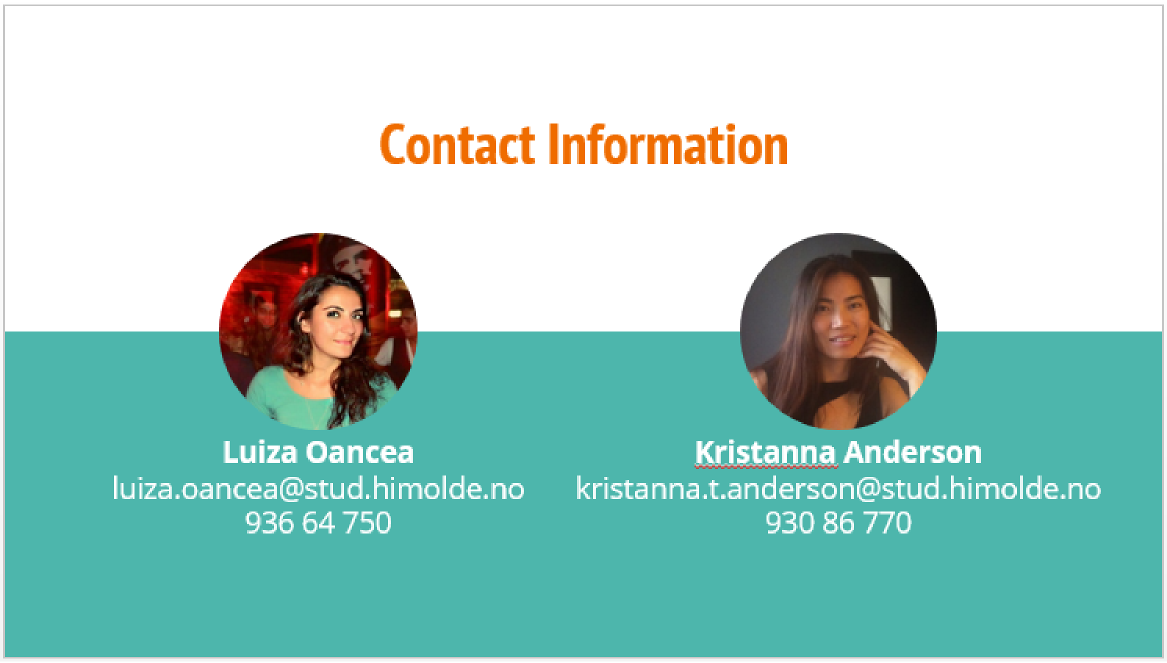
APPENDICES

Appendix A First contact with companies - presentation




Research Design – Research Tasks
Part 1: Qualitative Research
• General interview guide
• 12-20 employees from different companies in petroleum industry
Part 2: Quantitative Case Study
• Possible directions:
• Discrete event simulation
• Optimization model (AMPL) or heuristics
• Model for planning (Excel/VBA)
• Agent-based modelling
• Monte Carlo simulation
• Value-stream mapping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Appendix B First contact with companies - plan

Appendix C   Interview guide

Introduction: Present ourselves and the research project.

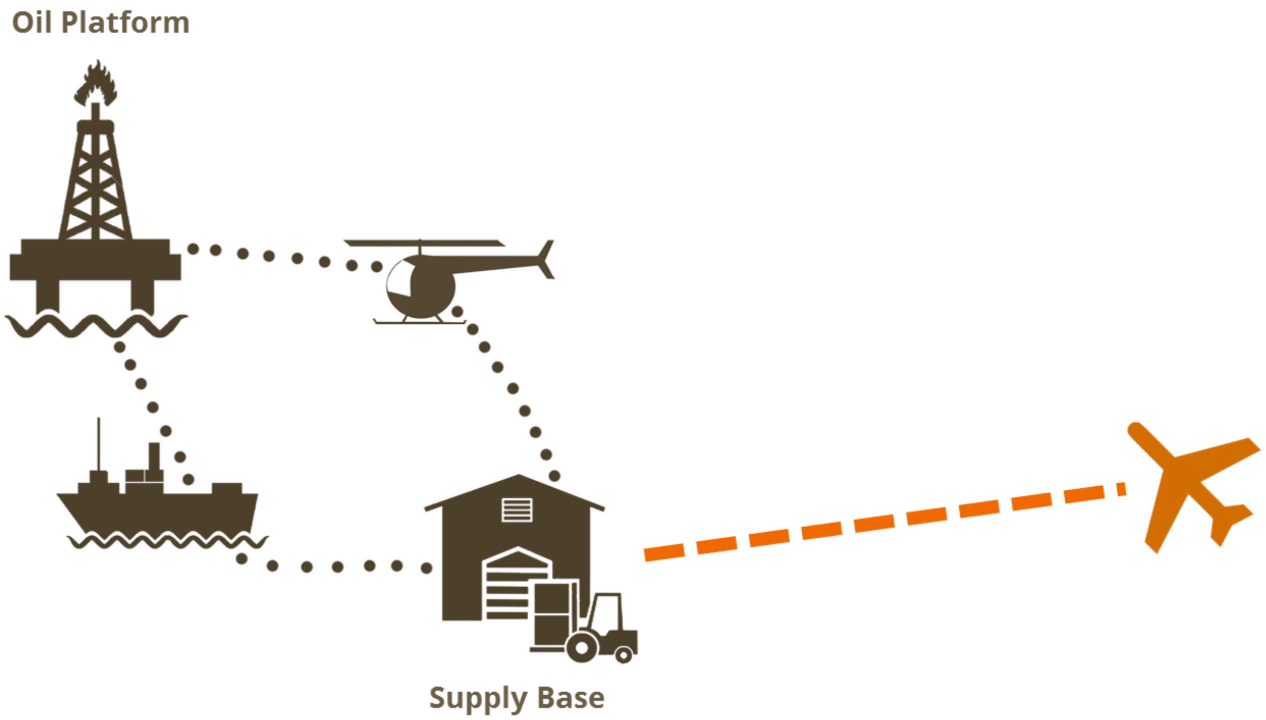
Is it ok if we conduct the interview in English?

Is it ok if we record the interview?

(Confidentiality?)

A) Initial understanding of situation

- Can you tell us about the company and your role?
- Do urgent deliveries represent a problem for your company? To what extent? Can you detail?
- How does your company define urgent deliveries?
- Describe how your company handles urgent deliveries - both the physical flow and the information flow.
- Why do urgent deliveries happen?
- How does your company decide that this product should be delivered urgently? Who has the authority?
- Does your company have a specific strategy for urgent deliveries? Have you made some routine procedures for how to handle it?
- What significance do urgent deliveries to the freight budget of your company?



- (show the helicopter/plane drawing and explain our understanding of urgent deliveries) Do both type of urgent transportation occur in your company? (helicopter and plane). Does one of them represent a bigger problem? Can you detail?

B) Quantifying the situation (Frequency and Costs) - continue with the previous drawing

- How many urgent deliveries occur during a year? What is the cost of those urgent deliveries?
- How many urgent deliveries are transported by helicopter in a month?
- How many urgent deliveries are transported by plane in a month?
- What is the cost of a helicopter delivery? What is the cost of an urgent plane delivery?

C) Products

- What are the type of products most commonly delivered urgently?
- What is the reason?
- What is the size of these products?
- What is the cost of these products?

D) Suppliers

- Does your company handle all the processes involved with the urgent delivery of a product?
- Does your company use 3PL companies to handle the transportation or do you handle it internally?
- How complex is the supply chain of an urgent delivery?

E) Consequences

- How do urgent deliveries (negatively) impact your company? (e.g. higher costs, disturbing the schedule of the logistics personnel, disturbing the delivery schedule of other products, creating a stressful situation at the workplace that can cause further errors by the employee)
- Could shipping cost/ freight be the highest cost resulted by urgent delivery?
- How does the urgent delivery impact on production time?

F) Proactivity

- What does your company do to avoid/diminish the use of urgent deliveries? What more do you think could be done?
- Could some of the urgent deliveries be avoided? Why/why not? What would be the potential savings?
- Could a better logistics planning be helped to avoid of urgent deliveries?
- Does your company have "Beredskapslager" (preparedness) for urgent deliveries? How much does your company invest for the budget of "beredskapslager"?
- What is the present level of "beredskapslager" at your company?
- Have you ever experienced that your " beredskapslager" run on empty? How often occurs it ?

G) Potential causes for the urgent deliveries

- Poor logistics planning?
- Lack of information?
- Human error?
- Uncertainty?
- Flexibility? Reactive Supply Chain?
- Capability?

According to our literature research, we have identified possible causes for urgent deliveries. We will further ask some questions to see if these might represent a problem in your company.

Use of Information system & Information availability

Could you describe the use of information system (ERP) (in the project of Draugen) ? What kind of IS do you use, for example SAP?

- How is the information flow in your company? Do you get all information you need when you handle an order?
- Could the lack of information be one of the reasons why urgent deliveries occur?
- Have you experienced that the lack of information has been a problem? - How did you experience it? What have been the main reasons? (Financial-issues, intra-organizational issues, human-issues and IT-related issues) What were the consequences?

- Could too much data sharing be a problem, too?
- How does the data sharing work in your company?
- Do you do some specific analyzes in your company regarding to:
    - The cost and value of information availability
    - Technical limitations to using increased information availability

Purchasing and Relations with suppliers

Purchasing has become a crucial function in Petroleum Logistics (70% of costs in Statoil go toward purchasing) and it has a strategic role in supply chain management.

- Does your company have a strategy for handling suppliers? (e.g. Kraljic Portofolio Matrix, Transaction Cost Theory)
- Does your company develop business relationships with the important suppliers? How important is trust when dealing with suppliers?
- Does the country of origin of a supplier have an impact on the relationship with the supplier?
- Would you say that your relationship with a certain supplier could have affected an urgent delivery (or the need to use an urgent delivery?)

H) Further References

- Are there any other colleagues in your company that are working with urgent deliveries to the offshore platforms that could be of help to our understanding?
- Do you know some colleagues in other companies (maybe your suppliers or customers) that have knowledge about urgent deliveries to the offshore platforms?