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TITTEL:
Logistics improvement projects in the Norwegian Oil and Gas industry

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Preface

This master thesis represents the completion of an Executive Master of Business Administration at the UiS Business School, started autumn 2020. The master program is experience based and has been followed in parallel with the ordinary work.

I would like to thank my mentor at Offshore Norge, Tormod Tønnessen, for advice and help during the writing of this master thesis. I would also like to thank my employer Wintershall Dea for supporting me and giving me the opportunity to follow this program.
Also, great thanks to my supervisor Jan Frick at UiS for good discussions and guidance in the process of writing this thesis.

Stavanger, May 2023

Abstract

The importance of collaboration between the parties in logistics is focused in the Konkraft report (2018), covering competitiveness on the Norwegian Continental Shelf. As an action to the report, NCS Logistics Collaboration Project was started in 2019. The research in this master thesis analyses the main logistics processes for the oil and gas operators in order to find the process challenges, check how these challenges are described and handled in the collaboration project, and analyses if there have been any spin-off improvement projects covering the challenges. Logistics is becoming more and more focused in the offshore oil and gas operations, as the margins are lower and the sustainability requirement higher. Cost effective logistics will reduce total cost of operations.

Process analysis and risk management methodology have been used to perform the analysis, combined with knowledge and theory from the industry.

The result from the analysis shows that actions have been taken from the NCS Logistics Collaboration projects, but there is still high potential for further improvement projects. The thesis gives recommendation for future improvement projects.

1 Introduction

When working within a specific field of operation in an industry, you get aware of areas for improvements as your experience rises. You also get involved in different improvement projects and find that some gives result while others do not, and the latter can be considered as waste of time and money.

I have my background as an engineer, and have worked within operations management, material management, logistics and IT since 1994. I started in the industrial production industry, and in 2009 I switched to the oil and gas industry. I have been engaged in several improvement projects facilitated by Offshore Norge, in addition to cooperation activities between my employer Wintershall Dea and other oil and gas operating companies. I all these years I have met and cooperated with a lot of people, and with that learned a lot on how we run logistics operations on the Norwegian Continental Shelf.

In the oil and gas industry, logistics has historically been perceived as a necessity being present when needed, like water in the kitchen tap. “We don’t care until it’s not there”. If we compare with the manufacturing industry, where the focus on cost of moving items from one location to another is very high, the focus is totally opposite in the oil and gas industry. The reason for this lack of cost and efficiency focus is mainly that we are talking of an extremely cost demanding industry, where logistics cost in the totality is very low. Over the last years, when the oil and gas reserves is scrimping, cost of exploration and production is increasing and focus on emission levels and taxes are high, the focus on operational cost per barrel produced have been significantly increased. As a result, logistics cost has suddenly become a focus area for cost reduction. This has led to a lot of industry specific improvement initiatives. These are the reasons why I find it interesting to analyse the performance and results of the improvement projects.

2 Background and case presentation

This master thesis is written in the area of Oil and Gas Exploration and Production on the Norwegian Continental Shelf (NCS). The area of operations is within Offshore Logistics, containing the movement of goods and personnel. The focus on this has been increasing in the last years, as it contains critical and cost demanding activities.
Offshore logistics is a complex and demanding activity, involving a wide range of activities, such as transportation, warehousing, inventory management, customs clearance, and security. The aim of offshore logistics is to ensure that the required materials, equipment, and personnel are available at the right time, in the right place, and in the right quantity, to support the offshore operations efficiently and cost-effectively.

Konkraft is an arena for cooperation between Offshore Norge, Norsk Industri, Norges Rederiforbund, Næringslivets Hovedorganisasjon (NHO) and Landsorganisasjonen i Norge (LO) with the sub-unions Fellesforbundet and Industri Energi.
The main task for Konkraft is to point out the premises for national strategies in the petroleum sector, and the committee work for keeping up competitiveness on the Norwegian Continental Shelf (Konkraft, 2018).
Offshore Norway (former Norwegian Oil and Gas Cooperation) is an employer and industry organization for companies with activites related with the Norwegian Contintental Shelf (NCS) (www.offshorenorge.no). All oil and gas operators operating on the NCS are members of Offshore Norway.
Offshore Norge was pointed out to facilitate the projects to realize the recommendations within logistics from the Konkraft report (Konkraft, 2018, s 4-9). As a result, NCS Logistics Collaboration Project (Norsk Olje og Gass, 2020), was started.
The project was run in three phases, and project phase 3 was initiated in 2019 with the aim to build a basis for a more supplier driven logistics model. The collaborating parties stated that they were chasing business opportunities of two billion NOK (NCS Steering committee meeting #16, meeting minutes, 30.04.2019).

2.1 Definition of Logistics Management

In 1991, the Council of Logistics Management defined logistics management as follows:
"Logistics Management is that part of the supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements" (CSCMP, 2023).

2.2 Definition of Supply Chain Management

In this master thesis, it is important to point out what the definition says, namely that Logistics Management is a part of Supply Chain Management (SCM), and a very integrated part. The CSCMP also defines SCM:
"Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies" (CSCMP, 2023).

2.3 Scope framing with reference to definition

For the sake of framing of the scope of this master thesis, the following break down of the above definition of logistics is done:
"… forward and reverses flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements".

The breakdown in more detail:

"Forward and reverse flow" will be the transportation on road, sea and air.
"Goods" will be spare parts and equipment needed to the offshore operations.
"Services" will be personnel and required tools needed to perform the operations.

“Related information” will be the visibility that is required to be able to manage the logistics.

“The point of origin” will be the supplier.

“The point of consumption” will be the supply base or the offshore installation.

“The customer” will be offshore producing plant or the offshore drilling facility.

3 Research question

The Konkraft report “Competiveness – Changing tide on the Norwegian continental shelf” (Konkraft, 2018) gave some clear recommendation for future competitiveness in the Norwegian oil and gas industry (Konkraft, 2018, s 4-9). Some of these recommendations were directly linked to logistics operations. As a response to the recommendations, the oil and gas operators established cooperation projects with the mandate to propose and implement logistics improvements. These projects were facilitated by the oil and gas companies’ interest organization Offshore Norge.

In this master thesis, I want to investigate the Offshore Norge facilitated logistics improvement projects which was started from the recommendations in the Konkraft report, with the following research questions:

- RQ1: How does the main offshore logistics processes for oil and gas on the NCS work, and what are the process challenges?
- RQ2: How are the process challenges from RQ1 handled in the NCS Logistics Collaboration Project?
- RQ3: Which spin-offs from the improvement projects have been started in form of other cooperation initiatives.

4 Theory

4.1 Logistics in number and size

Logistics is an important part of every world economy and every business entity. Figure 1 states that in Norway (as included in Other-Europe), 9,3% of the 2015 gross domestic product (GDP) is logistics cost (Transport Canada, 2015). Of a Norwegian 2015 GNP of 386 billion USD (www.ssb.no), 36 billion USD is then logistics cost, converted to 360 BNOK.

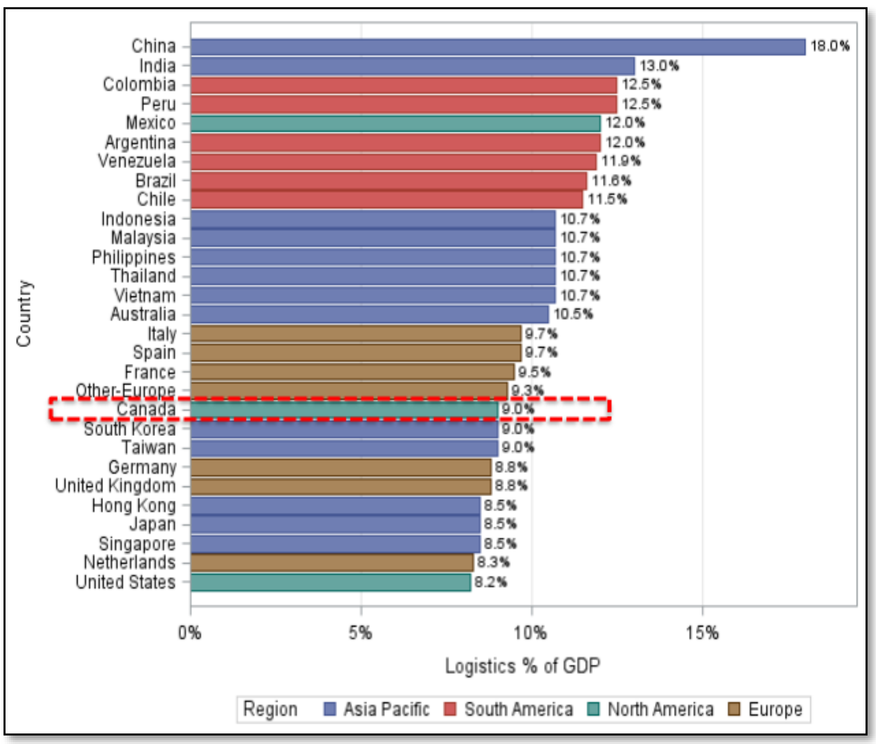

Figure 1 Logistics Cost as % of GDP for Selected Countries, 2015. Source: Transport Canada, page 5)

Compared to TØI-report 1052/2010, logistics cost for Norwegian goods suppling companies without oil and gas, was 14,2% of turnover and 14,7% of GNP in 2007 (Transportøkonomisk Institutt, 2010).

Crude oil and natural gas export accounts for 73% of Norway's export of goods in 2022 (Norwegian Petroleum, 2023). Looking closer to this sector, logistics cost is defined as a part of the operational cost. The oil and gas industry is a high cost industry. Income is driven by commodity prices of oil and gas, and the focus is to get the CAPEX investments done to get pay-off when hydrocarbon starts to flow to the customers. The higher the commodity prices are, the less focus the OPEX gets. In the last years, the industry is experiencing higher volatility in commodity prices and less stability in tax regime, together with higher emission costs. This has set a stronger focus on the OPEX and forces the oil and gas companies to change their way of working and planning their operations.

The total operating cost forecast for oil and gas in 2023 are 92 BNOK, as shown in figure 2 below.

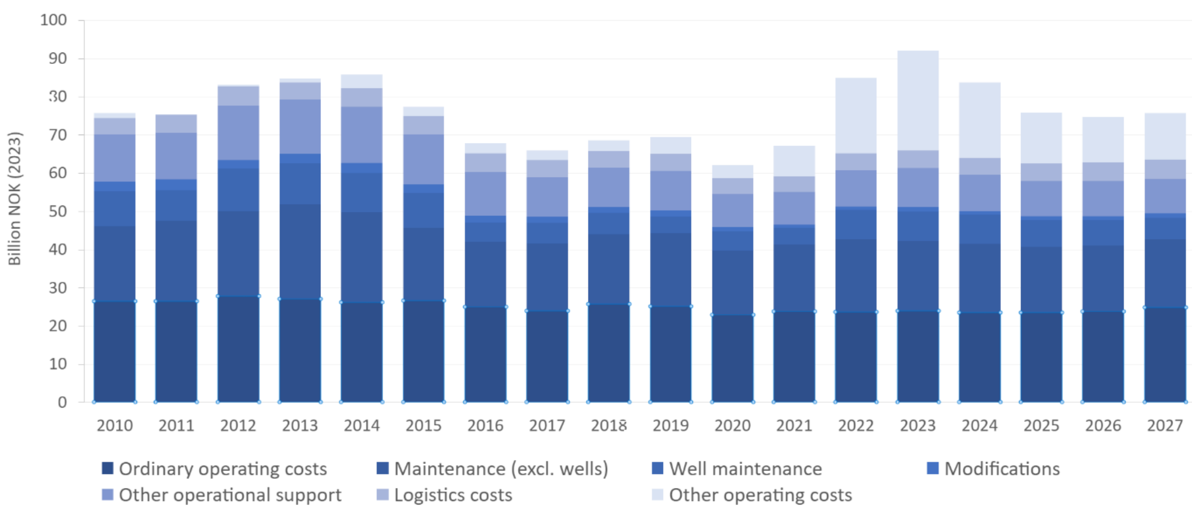

Figure 2- Historical operating cost figures for 2010-2021 and forecast for 2022-2027. Source: Norwegian Petroleum Directorate 2023

Now the operational cost is isolated from figure 2, and pull together ordinary operating cost, other operational support, other operating costs and logistics cost. This is visualized in the yellow bars below in figure 3. Comparing this with the isolated logistics cost (that is vessel, helicopter, supply base and road transportation) visualized in the blue bars, it is visualised that logistics have a high cost base in the Norwegian oil and gas industry (Norwegian Petroleum Directorate, 2023). The grey graph shows the relationship between logistics cost and total operational cost. What is worth noticing, is that the forecast for logistics cost going forward is increasing from 7% of the operating cost in 2023 to close to 10% in 2027, while the total operating cost is decreasing from 65 BNOK in 2023 to 51 BNOK in 2027.

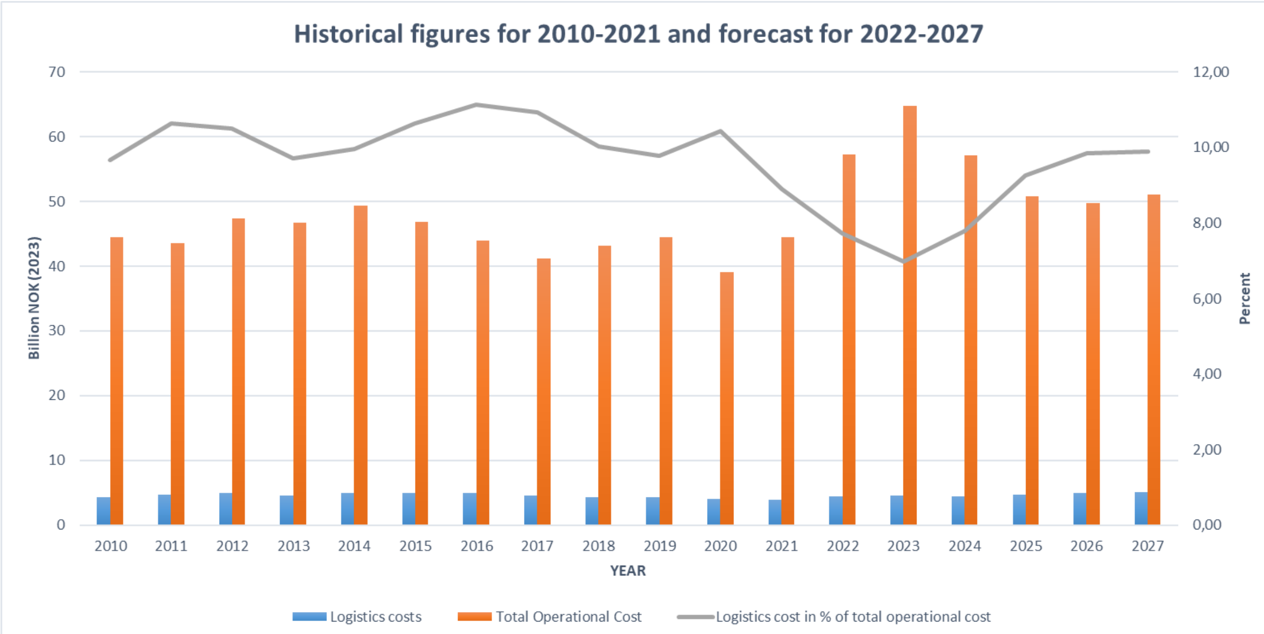

Figure 3 - Operational cost, NCS. Source: Norwegian Petroleum Directorate 2023

4.2 The Konkraft report

On 16.01.2018, Konkraft presented their report «Competitiveness – changing tide on the Norwegian continental shelf» on Oil industry political seminar in Sandefjord. In this report, they gave clear recommendations of need for cooperation between oil and gas companies within logistics operations if NCS is to continue to be competitive in the future as markets are changing. In the summary and conclusion of the Konkraft-report following recommendation is given:

The operator companies must open for more sharing and cooperation over logistics.

Directly written, the Konkraft report states that "Logistics is an area where significant effects can be achieved through extensive collaboration and sharing. Areas that relatively fast can provide synergies for the NCS, are within helicopter transport, land transport, supply base services and supply vessels. The report also states that digitalization and sharing economy can drastically improve interaction between different players in the value chain. The report specifically mentions the digital interaction tool LogisticsHub.

4.3 Cargo and transportation

One of the main observations in the NCS Logistics Collaboration report is the need for consolidating cargo. Benoit Montreuil states that we are shipping air and packaging, and that containers are often half empty at departure (Montreuil, 2011). He also states that a large porting of the emptiness is filled with packaging material, and that the global transport efficiency is estimated to lower than 10%. Montreuil writes about the physical internet and the modularity of unitary and composite containers. He also describes the unsustainability symptoms of transportation, which has been adopted in the analysis of the logistics processes to find the consequences of lacking cooperation in logistics on the NCS.

4.4 Lean theory

Toyota have from the foundation adhered to 14 core principles to manufacture high-quality product and services. This is collectively known as The Toyota Way (Liker, 2004). Today this is adhered to as Lean. Lean is a management philosophy and approach focused on maximizing value for customers while minimizing waste and inefficiencies. It emphasizes continuous improvement, waste reduction, and the involvement of employees at all levels. Lean principles aim to streamline processes, eliminate non-value-added activities, improve quality, and create a culture of problem-solving and efficiency. The goal is to deliver products or services faster, with higher quality, and at lower costs, resulting in increased customer satisfaction and organizational effectiveness. Lean methodology is the backbone of the improvement projects within logistics on the NCS – to eliminate waste, work for continuous improvement and maximize value through the people working in the logistics value chain.

4.5 Agile theory

Agile is an iterative and collaborative approach to project management and software development. It emphasizes adaptability, flexibility, and customer collaboration throughout the process. Agile teams work in short cycles called sprints, where requirements and solutions evolve through cross-functional teamwork. Key principles include delivering working increments of a product, embracing change, and continuous improvement. The traditional way of thinking is to first completely work out and idea, and the do an accurate estimation of the time spend to put the idea in production. The agile way is to first think out and idea outline, then work out the idea, try it out, and adjust (Johnsen, 2021).

The agile framework with sprints was used in the NCS Logistics Collaboration Project, and work are still ongoing with iterations and adjustments.

4.6 UN sustainable development goals

Despite of its rumor and despite producing hydrocarbons, The oil and gas industry is focused on sustainability, and adheres to the UN's seventeen sustainability goals (FNs bærekraftsmål 2023). This has been considered in this master thesis, as the analysis has a sustainability element in addition to the economical element.

4.7 Environment and logistics

Within logistics management, the environmental focus is growing stronger. Green logistics is on the agenda. It is about alternative fuel type and emissions, and it is about including suppliers and end users of logistics, like the offshore installation. MGO (Diesel) is replaced by alternative power sources like LNG and electrical power on battery packages. The interest in developing green logistics from companies, government, and the public is increasing dramatically especially because traditional logistics cannot meet the requirements of modern society and has huge impact on the environment (Seroka-Stolka, 2014). This can be directly converted from traditional logistics and on to offshore logistics.

4.8 Financial- and operational efficiency

Logistics operations on NCS is cost demanding, especially for assets like vessels and helicopters. There are usually financial trade-offs that could reduce uncertainty and the costs of running a logistics system (Aas et al, 2009 s. 322). The most cost-effective setup is not always the most sufficient for the totality of the logistics operation. Financial models have to be considered when deciding on how to utilize the assets.

4.9 Project risk analysis

Theory on project risk analysis is used for evaluation the risk that gives the highest economical and sustainable consequence of lacking cooperation between parties in the logistics chain (Brydøy, 2022).

5 Method

To be able to answer the research questions in this master thesis, business process analysis is used as a method together with risk analysis.

The method of Business process analysis is a systematic approach used to understand, evaluate, and improve business processes within an organization. It involves examining the inputs, activities, and outputs of a process to identify inefficiencies, bottlenecks, and areas for improvement. The goal of business process analysis is to enhance efficiency, effectiveness, and overall performance by streamlining processes and eliminating unnecessary steps or redundancies.

The approach in this thesis is the following:

1. Process Identification: The first step is to identify and define the specific process to be analyzed. Three processes have been identified as the focus areas for this master thesis.
2. Process Mapping: Process mapping involves visually representing the steps, activities, and interactions within the process using flowcharts. This provides a clear understanding of the sequence of activities, and which parties are involved in the process.
3. Identify Areas for Improvement: By analyzing the process, challenges and areas for improvement are identified.

Risk analysis methodology analysis is used to enhance the understanding of potential challenges and opportunities, with that allowing for improved decision-making and increased foundation for the further analysis in this master thesis.

In addition to these to methodologies, information is collected from sources in Offshore Norge and within Wintershall Dea. User experience from project work has been valuable, including projects facilitated by Offshore Norge and cooperation projects between own employer and other oil and gas operating companies.

6 Analysis

6.1 From report to reality

What are the challenges within logistics on the NCS?
It is important to have a look at the activities defined as logistics. As the definition says in chapter 2, it actually covers all physical movement of goods and personnel including information needed for planning and follow-up.
There is a lot of scenarios within logistics. The following chapter will analyse the main scenarios and describe them in detail. After describing the scenarios, the challenges will be analyzed within each of those in a cause and consequence table. In this table, the consequences will be grouped and weighted according to economic consequence. In addition, inefficiency and unsustainability symptoms will be added (Benoit Montreuil, 2011).
When this is done, there will be an overview of the economical and sustainability consequences if the industry does not utilize the potential in cooperating. It will also give an overview of which areas of change that will give the best results.
At last, it will be analyzed according to the research questions how the challenges have been handled, in what degree the actions taken are a result of improvements from the cooperation projects, and if there are improvement actions taken as spin-offs to the NCS Collaboration Project.

6.1.1 Concept of offshore logistics

Offshore logistics as a concept can be visualized in figure 4. It shows how a security valve is planned to be shipped offshore.

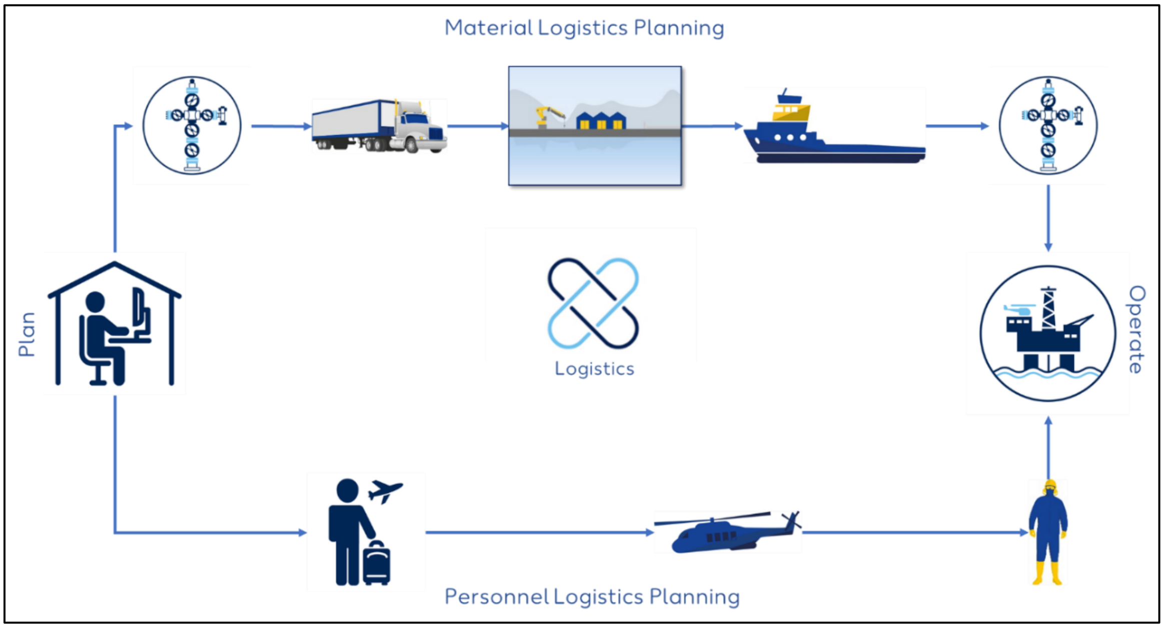

Figure 4 - Logistics Flow

The main activities are material transportation and personnel transportation. Within material transportation, there are two main scenarios: Material for operations, and material for drilling. These two scenarios have some main differences in that operations involve material planning, while drilling involves rental material. When adding the personnel transportation, have then have three main scenarios which will be described and analyzed in detail in the next sections:

- Material planning and transportation for operations and maintenance.
- Material planning and transportation for drilling operations.
- Personnel planning and transportation

6.2 Scenario 1: Material planning and transportation for operations and maintenance

In offshore activity, there is one important principle for all companies with activity on NCS. That principle is that they all need to have the "license to operate". To comply with this, the offshore installations need to be operational, and they need to be safe and secure. This is technical integrity, and it can be illustrated with James Reason's Swiss Cheese Model as in figure 5:

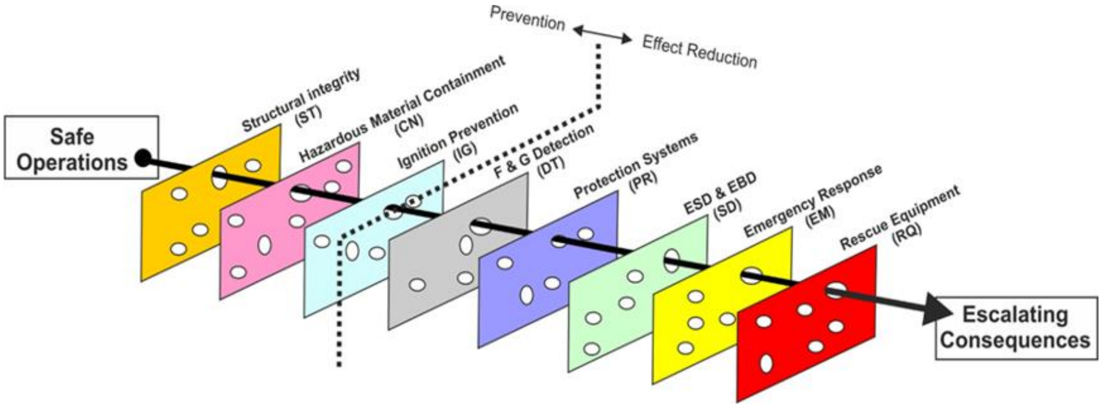

Figure 5 Asset integrity in offshore operations (Reason, Wintershall Dea)

The first step in the model to achieve technical integrity of the assets, is according to figure 5 to have structural integrity (ST). Let's compare the offshore installation with a car. If the brake pad is worn out and we continue driving, an accident will finally occur. Then there is a need to get spare brake parts at the workshop, and we are depending on that they have it on stock, since it is critical to get this fixed to cover the transportation demands. The importance of the brakes working, is a part of the car's structural integrity.

Returning to the offshore installations, they consist of complicated technical parts delivered for different suppliers, just as a car. And as the car, they also require spare parts on stock to comply with the required structural integrity. And the spare part process for offshore installations can be visualized as below in figure 6.

In the following chapters, a note like Fig 6:1.1 refers to Figure 6 process step 1.1.

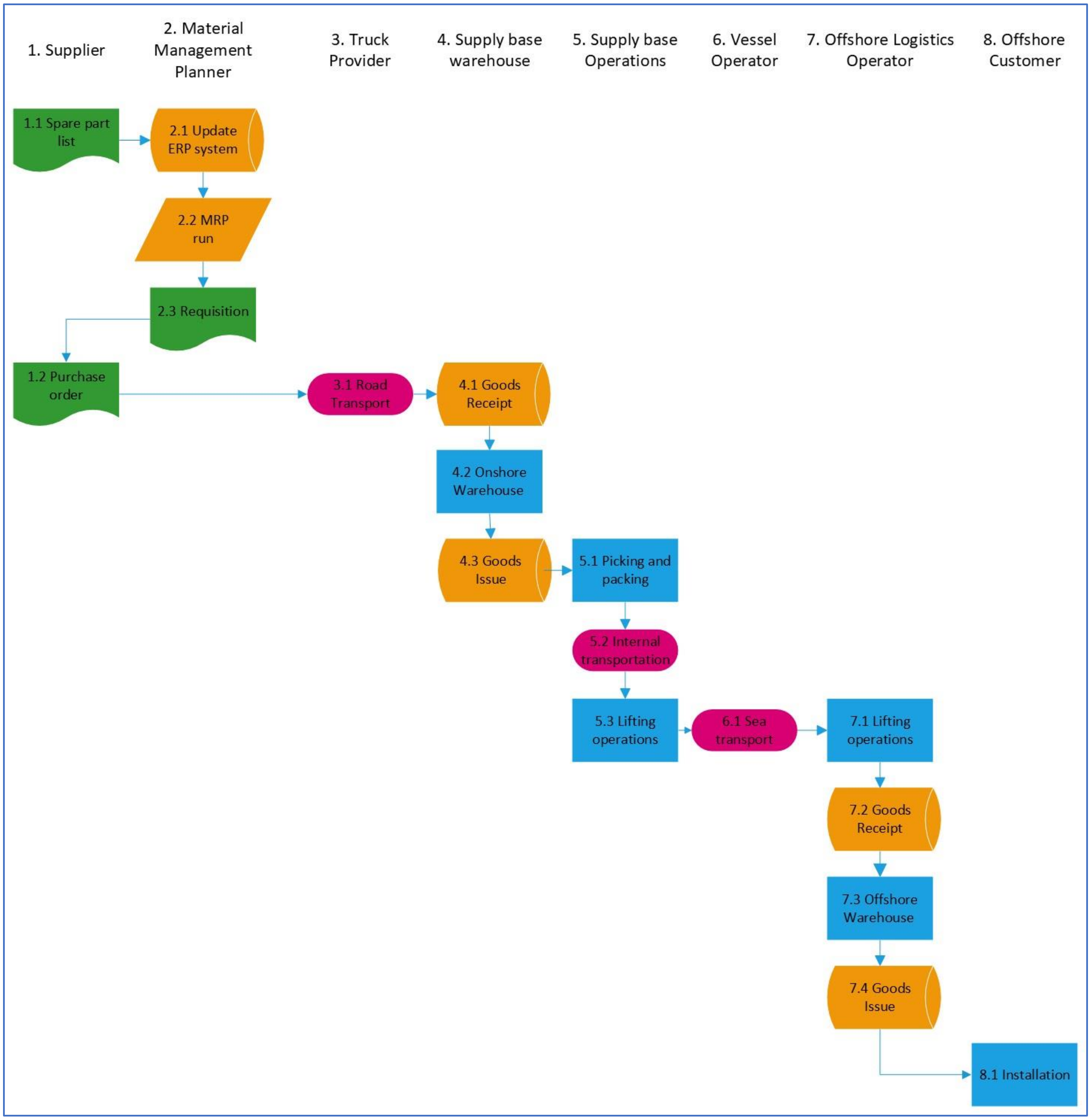

Figure 6 Scenario 1 Material Flow for spare parts. Ref. table 1 and 2

Initial proposal of which parts needed as spare parts on stock, is done by the supplier of the technical part via a spare part list with a criticality analysis (Fig 6:1.1). In some cases the supplier can hold the spare part, in other cases it is bought and stored by the operating company, either at the supply base warehouse or at the offshore warehouse at the offshore installation. This is depending on cost, size, delivery time and criticality for asset integrity if the part breaks down.

The technical discipline responsible for the assets is “owner” of these spare parts in the warehouse. Examples of technical disciplines are automation, electrical, rotating equipment and lifting equipment. The required spare parts and mandatory data are registered into the operators Enterprise Resource Planning (ERP) system (like SAP and STAR) (Fig 6:2.1). This contains data for re-order point and safety stock. That is, the required stock level to be able to secure the asset with spare part until new deliveries which will fill up the stock to max level are received. This stock leveling is done automatically by Material Requirement Planning (MRP) run (Fig 6:2.2). When MRP is run, a purchase requisition is automatically created (Fig 6:2.3). The purchase requisition is then converted to a purchase order by procurement. The purchase order is sent to the supplier together with the material specification description stored in the ERP system, to make sure that we get the correct quality and dimension of the spare part (Fig 6:1.2). The spare part is then packed according to Offshore Norge guideline 116 (Offshore Norge, 2018), required certificates is attached, and it is sent to the warehouse by road transportation (Fig 6:3.1).
At the warehouse it is then received, quality checked, unpacked, goods received is posted in the ERP system with reference to the purchase order, and the stock level increased accordingly (Fig 6:4.1).
When a critical part is needed at the offshore installation, in most cases the requirement comes from a workorder in the ERP system, requesting to issue spare part for a maintenance activity (Fig 6:4.1). According to criticality, the spare part is requested from own stock or directly from supplier. In either case, the part needs to be shipped offshore by supply vessel (if it is not already at the offshore warehouse. In these cases, it has already been shipped and placed into storage offshore). The ERP system will create a picklist to the onshore warehouse (Fig 6:5.1). The picking will be handled by the supply base personnel, and goods issue will be created in the ERP towards the workorder. The spare part will be packed according to Offshore Norge packing and marking guideline 116 (Offshore Norge, 2018), put into a suitable container and transported to the quayside (Fig 6:5.2). In most of these cases, the material is packed at the supply base on a pallet and put in a container, depending on size and weight of the material in question. If there are other deliveries to the installation on the same day, these will be packed together in the same container as far as possible, but in most cases, the container is half full when being sealed for security reasons. The security seal should not be broken before it has been lifted to the offshore

installation and handled by authorized logistics personnel offshore according to Offshore Norge guideline 091 for securing supplies (Offshore Norge, 2019).
From there, it will be lifted by the supply base operations personnel onboard the Platform Supply Vessel (PSV) (Fig 6:5.3), which will transport the container by sea to the offshore installation (Fig 6:6.1). When arriving the offshore installation, the offshore logistics operators will run the offshore crane and lift the container from the vessel (Fig 6:7.1). The container will be placed on the offshore cargo deck where it will be unpacked, controlled and goods received transaction run in the ERP system (Fig 6:7.2). The material is now placed in the offshore warehouse (Fig 6:7.3) The offshore customer will be noticed that the material is received, and the offshore logistics will perform a goods issue in the ERP system. Then the workorder will be updated with delivered flag and cost of the spare part accounted to the workorder (Fig 6:7.4). Now the spare part can be installed on its functional location at the installation (Fig 6:8.1)

6.2.1 Cause and consequences for Material planning and transportation for operations and maintenance

For further analysis, all the process steps in figure 6 have been put into a cause and consequence. I have then analyzed the challenges we have with each process step, and what is the consequence of each challenge if we do nothing. These consequences are then categorized and given a letter from A ->. All letters are then counted and weighted according to in which degree a cooperation initiative will give economical results. The weighted consequences are then reported graphically in a diagram, showing the consequence category according to frequency.
I have then in my analysis added one more dimension. I have analyzed the findings according to economic, environmental and societal dimensions (Montreuil, 2011). I have used the same methodology but changed the societal by health.

Table 1 Scenario 1, Process cause and consequence table part 1

Scenario 1: Process cause and consequence table

Process r	Process name	Process Description	Partner	Challenge	Consequence	Category	Incentive for chang	Cooperation possibiliti	Logistics Inefficiency and unsustainability mapping: Economical	Environmenta	Health
1.1	Spare Part List (SPIR)	Supplier proposes spare parts for the installed items on behalf of a criticality analysis	Supplier	Proposal is not revised or compared with other assets spare parts	Too many spare part items	A	Reduce spare parts, capital tie-up, reduce warehouse cost	Other Oil and Gas companies			
2.1	ERP System	Spare parts identification-, amount and ordering data is stored an managed in companies ERP system	Material management planner	Data must be consolidated throughout the company	Too many spare part items	A	Reduce spare parts, capital tie-up, reduce warehouse cost	Consolidate with other oil and gas companies			
2.2	MRP Run	Automatic reorder planning	Material management planner	Often run one-by-one for each installation. May be consollidated throug the company	Too many spare part items	A	Reduce spare parts, capital tie-up, reduce warehouse cost	Common max-min level on NCS for the same spare part			
2.3	Requisition	Requisition for materials from planning to procurement	Material management planner	Direct result of 2.2, gives input to what the company will ask the supplier to deliver	Too many spare part items	A	Reduce spare parts, capital tie-up, reduce warehouse cost	Consolidate with other oil and gas companies			
3.1	Road Transportation	The supplier packs requested materials and send them to the company by road	Truck Provider	Items are sent on pallets or in containers to the company, and shipments are not consolidated with other shipments to the same company from other suppliers, or to other companies on the same receiving supply base	Uneficcient container packing	B	Reduce number of trucks, GHG, transportation cost	Cooperate on transport from supplier to supply base			
4.1	Goods receipt	When the truck arrives supply base, goods will be unpacked, controlled and received in ERP system	Supply base warehouse	Unefficient process related to a lot of shipments that could be consilidated but are not	Manual work and follow-up	C	Reduce workload for supply base personnel	Common goods receive for several companies and assets			
4.2	Onshore Warehouse	After goods are received, they will be put on stock in warehouse	Supply base warehouse	Un-optimal warehouse location	Unefficient internal transportation	D					
4.3	Goods Issue	Goods will be issued from warehouse when required offshore	Supply base warehouse	-	Manual work and follow-up	C	-	-			

Table 2 Scenario 1, Process cause and consequence table part 2

Scenario 1: Process cause and consequence table									Logistics Inefficiency and unsustainability mapping		
Process r	Process name	Process Description	Partner	Challenge	Consequence	Category	Incentive for chang	Cooperation possibiliti	Economical	Environmenta	Health
5.1	Picking and packing	When goods are issued o be sendt offshore, they are picked and packed and put into suitable carrying units, like pallet or container	Supply base operation	Depending on amount of material to be sendt offshore, and type of material, it is put into a container. In most cases there is room for a lot more in the container.	Uneficcient container packing	B	Reduce number of container units, reduce lifts on supply base, reduce space required on vessel, reduce lifting operations offshore	Pack more items in same container for the same installation			
5.2	Internal transportation	Transport from warehouse to quay-side	Supply base operation	Internal transportation	Unefficient internal transportation	D	Optimise internal transportation with collaboration with other companies on supply base	Co-locate in same or nearby premises			
5.3	Lifting Operations	Lift cargo from quay to vessel	Supply base operation	Access to cranes	Poor utilization of vessels	E	Total resource availability planning	Supply base operator to have total activity picture to be able to plan			
6.1	Sea transport	Transport of cargo from supply base quay to offshore installation	Vessel operator	Half-full cargo decks	Poor utilization of vessels	E	Reduce number of vessels operating in the same seawaters	All companies having offshore activities out of same supplybase to cooperate and do route planning across offshore operators			
7.1	Lifting Operations	Lift cargo from vessel to offshore installtion	Offshore Logistics Operator	Many cargo units because of low utilization and lots of air causes increased number of lifting operations	Risk with lifting operations	E	Reduce number of lifting operations	If co-packing with other suppliers, cargo unit must be unpacked and returned in same operations, so limitet possibilities			
7.2	Goods Receipt	When lifted onboard offshore installation, goods will be unpacked, controlled and received in ERP system	Offshore Logistics Operator	More time consuming when number of cargo units is increased	Manual work and follow-up	C	Reduce workload for offshore logistics personnel	Limited			
7.3	Offshore warehouse	After goods are received, they will be put on stock in warehouse, or delivered to requisitioner/consumer	Offshore Logistics Operator	Shelf-space	Manual work and follow-up	C	Control number of items to be stored offshore	Awareness of equivalent units on installations or onshore warehouse that can be shared			
7.4	Goods Issue	Goods will be issued from warehouse when required for the asset	Offshore Logistics Operator	-	-	-	-	-			
8.1	Installation	Goods are located offshore in warehouse stock or consumed	Offshore Customer	-	-	-	-	-			

Grouping the consequences and the weighting gives the following table with the five main consequence categories:

Table 3 Scenario 1, Consequence category table

Consequence category description	Category	Frequency	Weight	Economic consequence	Economical	Environmental	Health
Too many spare part items	A	4	1	4	4		
Ineficcient container packing	B	3	2	6	2	2	1
Manual work and follow-up	C	4	2	8	3	1	2
Unefficient internal transportation	D	2	2	4	2	1	
Poor utilization of vessels	E	3	3	9	2	2	1

When placing the consequences in diagram, the following appears:

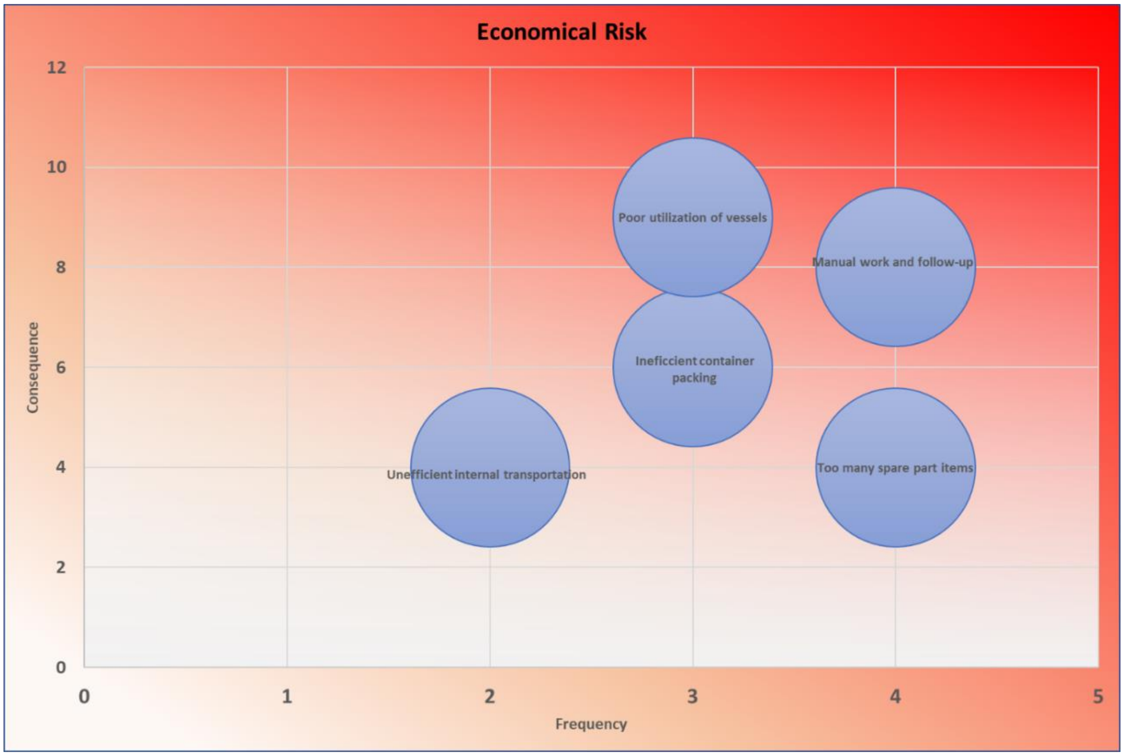

Figure 7 Scenario 1 Risk matrix - Material planning and transportation for operations and maintenance

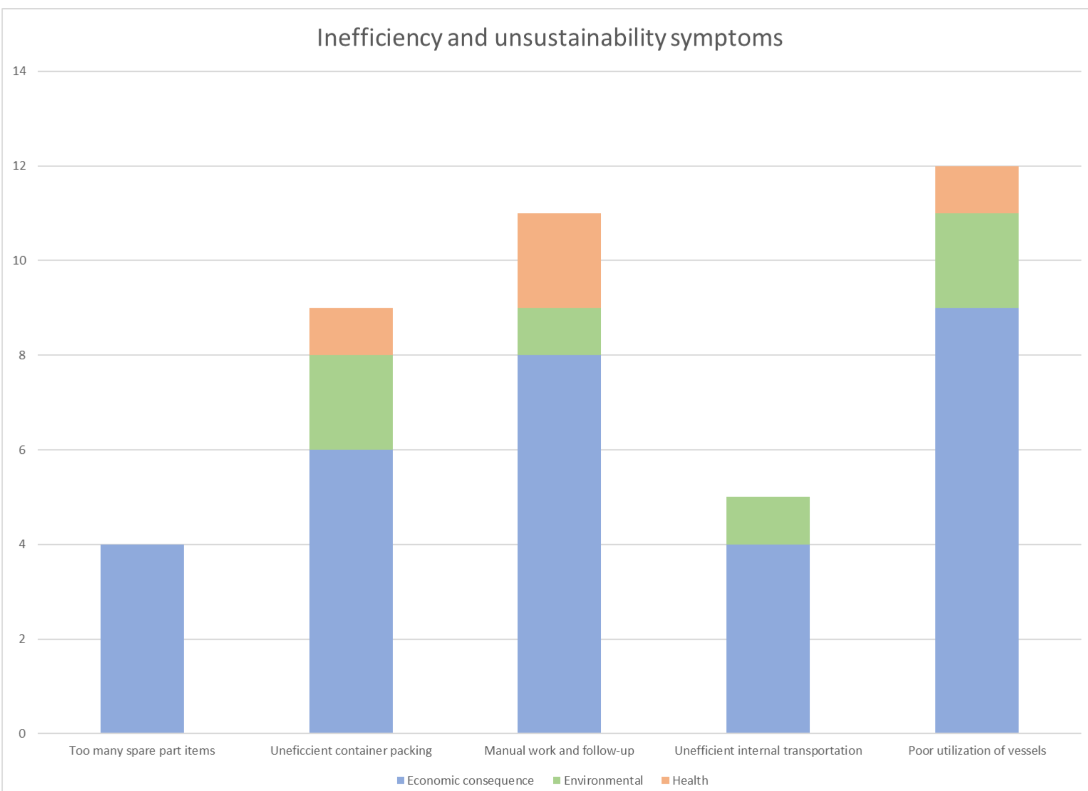

Figure 8 Scenario 1 Inefficiency and unsustainability symptoms - Material planning and transportation for operations and maintenance

The result of this analysis is that there are three consequence categories that is placed in the upper red area. These are Manual work and follow-up, Inefficient container packing and Poor utilization of vessels. We see that these three findings also have high score on unsustainability.

6.2.1.1 Manual work and follow-up

The category "Manual work and follow-up" receives a high score on the consequence table, both for economic consequences, but also for environmental, and some on health.

In a material handling environment, there is always some manual work to be performed. Goods needs to be handled when received and issued, and often the packaging sized are not uniformed so that the handling in each case will be different.

One fact, that may be unexpected to persons not familiar to the industry, is that digitalization and automation of warehouse functions is highly unmature in the oil and gas industry. In food and grocery business, all sales items have barcodes attached, so that you with a barcode scanner can get information on price, shelf life, item size, package size, producer and other relevant information. You pick the items by yourself, scan it before check-out, pay the items with payment card and tap function, get your payment receipt containing a barcode that you need to use for the exit gate to open.

In industry production, the suppliers get the refill orders directly into their own ERP systems, with amount and delivery time (day, hour and minute). Automatic order receipt and shipping notifications are digitally delivered back, and the ordered material are placed directly to the production line of the requesting production plant.

On the opposite side of digitalization within material management, is the Oil and Gas industry, especially the oil and gas operators. It is highly contradictory to the fact that an industry creating these large values, are so immature within this area. There is a saying from the supplier and transportation environment that when their goods on the truck arrives to the gate of the supply base, there is no more sign of the materials until it is paid or returned. The tracking stops when in hands of the oil and gas operators. The contradiction may be explained with that since the value creation in the industry is from the high commodity prices of the products produced, investments are done to achieve more production, and with this, support functions are less focused.

With close to zero use of bar-codes, no automatic shelf placement, manual picking and packing orders with keyboard entry of pick results, there is a lot of manual work. In addition, material management is still highly paper based with lack of use of handheld units, both onshore and offshore.

In this analysis "manual work and follow-up" are placed high on the Economical risk table, since all this manual work demands a lot of personnel. It is also known that the consequence of missing spare parts can have high economic consequences, with a worst case consequence of production shut down. Higher degree of automation and digitalization will reduce personnel demand. There is also an environmental risk, since this manual work creates a lot of paper, good handling with trucks and unnecessary internal- and road transportation. The health aspect has a high risk as it creates low motivation and stress for the people that needs to do manual entries and data handling when there are ways of securing data quality in much more digitalized ways.

6.2.1.2 Inefficient container packing

Container packing and handling has been challenging in the oil and gas industry. There are several reasons for this. One reason is access and availability to CCU's (Container Carriage Units). When times are good, number of drilling operations are high, and maintenance and modification programs run on full speed, there is a high demand for CCU's. This result in lack of availability. To secure capacity, many of the oil and gas operators have entered into commercial agreements with the CCU suppliers. This means that each of these operators have their own pool of CCU in different sizes, dimensions, and types, where the supplier is obligated to keep the agreed pool size up and running (see figure 9 below).

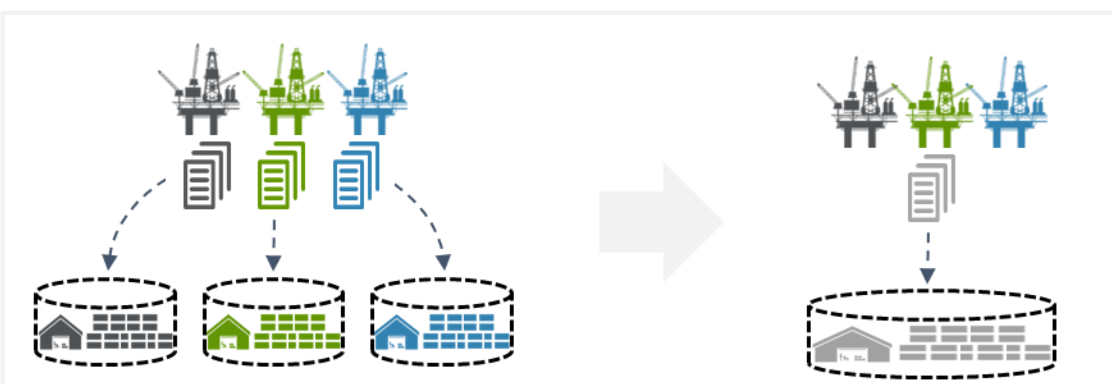

Figure 9 Container Pool solutions (Source: NCS Logistics Collaboration Report 2020)

The advantage of such pool solutions is that the operators with sufficient pool will have sufficient capacity. The disadvantage is that this creates a sub-optimization in the CCU marked. All these small pools consist of the same CCU types, and since the operations is not equal from operator to operator, there will be an over-capacity all together. This also means that an operator without a pool solution and who have an on-demand rental agreement with the CCU supplier directly, will be down-prioritized if a CCU type in question is allocated to the different pools. Explained as an example: If an operator without pool solution has a requirement for two 10 foot containers, he might get one that is available at the suppliers warehouse. But the second one will not be delivered, even if there are a lot of them available in the different pools. So in total there is over-capacity, but it is locked in the different pools.

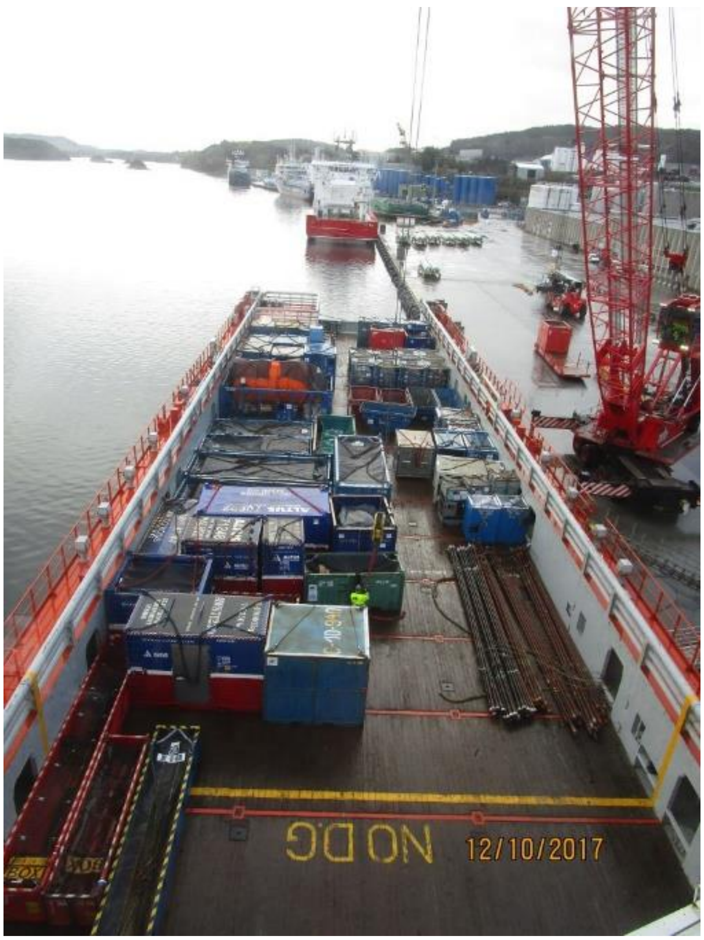

Figure 10 Cargo lifting operation from supply base on to PSV Deck (Photo: Arne Kjetil Nilsen)

Another challenge with containers and packing, is the filling-level of the containers as they are shipped offshore. Some of the material for operation and maintenance arrives the supply base packed and sealed in containers, while other arrives on pallet or is picked from the warehouse shelf and put in a container. According to the instructions in Offshore Norge guideline 116, 5% of the sealed containers must be checked and re-sealed on supply base. So in worst case, one small valve can be shipped in one big container. The material that is picked in own warehouse is also placed in a container and sealed before shipping. In this case there are room for more optimal packaging, but often there is also much space left. So – a lot of air is transported offshore in expensive containers by high-cost vessels which are not environmentally friendly.

6.2.1.3 Poor utilization of vessels

Along the Norwegian coastline, there are have several bases used to supply the oil and gas industry with food, laundry, fluids, steel and equipment. Starting from south and going north, the sites are Stavanger (Dusavik and Tananger), Bergen (Ågotnes and Mongstad), Florø, Kristiansund, Sandnessjøen, Hammerfest and Kirkenes. These supply bases have on and off supply for drilling operations and exploration campaigns, and most them have in addition continuous supply for installations that are producing oil and gas, like Johan Sverdrup, Statfjord, Brage, Draugen, Aasta Hansteen and Goliat. Each of these fixed installations and mobile drilling installations require continuous supplies, delivered by Plattform Supply Vessels (PSV's).

Figure 11 PSV and Mobile Drilling Installation (Photo: Golden Energy Offshore)

This means, that from one supply base, there may be supply for two fixed installation and three mobile drilling installations at the same time, so together five installation all together. Normally, one fixed installation with running production requires 1-2 arrivals each week. A drilling rig may require 3-4 arrivals each week, all depending on production phase, drilling phase and distance from shore. So, the potential for sharing vessels to cover all five installations is certainly in place. What is often the case, is the opposite of vessel sharing. If these installations are not run by the same operator, the main scenario is that each operator calls of their own supply vessels to cover its own operation. In cases of distance from shore and busy time schedules, often two vessels are placed in operation for one drilling operation. The fact is then that the vessels pass by each other and installations in the sea on its way to its location, and then wait for quay capacity when back on shore at the supply base. PSVs are cost demanding assets. The day rates for PSVs can vary based on various factors, including market conditions, vessel specifications, contract duration, and specific requirements of the project they are going to support. As of 2022, the average day rate on NCS was 220.000 NOK (Wintershall Dea, personal communication, 2022). In addition to the high day rates comes fuel cost and environmental footprint. The common fuel type for PSVs are still diesel, and with the energy prices today (2023) the energy cost per day is on the level of the rental cost (Wintershall Dea, personal communication, 2023).
Another fact that makes the utilization of the vessels poor, is the filling level of containers. As mentioned in the chapter regarding inefficient container packing, clearly higher filling degree of containers would help on the footprint of the cargo deck on the PSV's. A PSV deck is normally between 800 and 1000 m2 (Aas et.al, 2009, s. 312) and deck capacity is high on the planners list when they calculate number of vessels and arrivals to installation.

6.3 Scenario 2: Material planning and transportation for drilling operations

Drilling of exploration and production wells is one of the most capital-intensive activities in the oil and gas industry. In addition to rental of the drilling rig, also drilling equipment needs to be rented for all possible phases of a drilling campaign. In addition to the drilling activity, there are logging equipment to analyze the outcome of a well, phishing equipment if something is lost in the well, cementing devices and completion equipment, to mention some. Most of this is special equipment which the offshore operators rent from drilling companies for specific drilling campaigns. The equipment is often allocated to sections of the drilling string and is mobilized some days before it is required on the drilling installation. In such type of operations, it is normal to have between one and two dedicated supply vessels, depending on type and size of drilling rig, distance to shore, distance other installations and maturity of cooperation agreement with other operators.

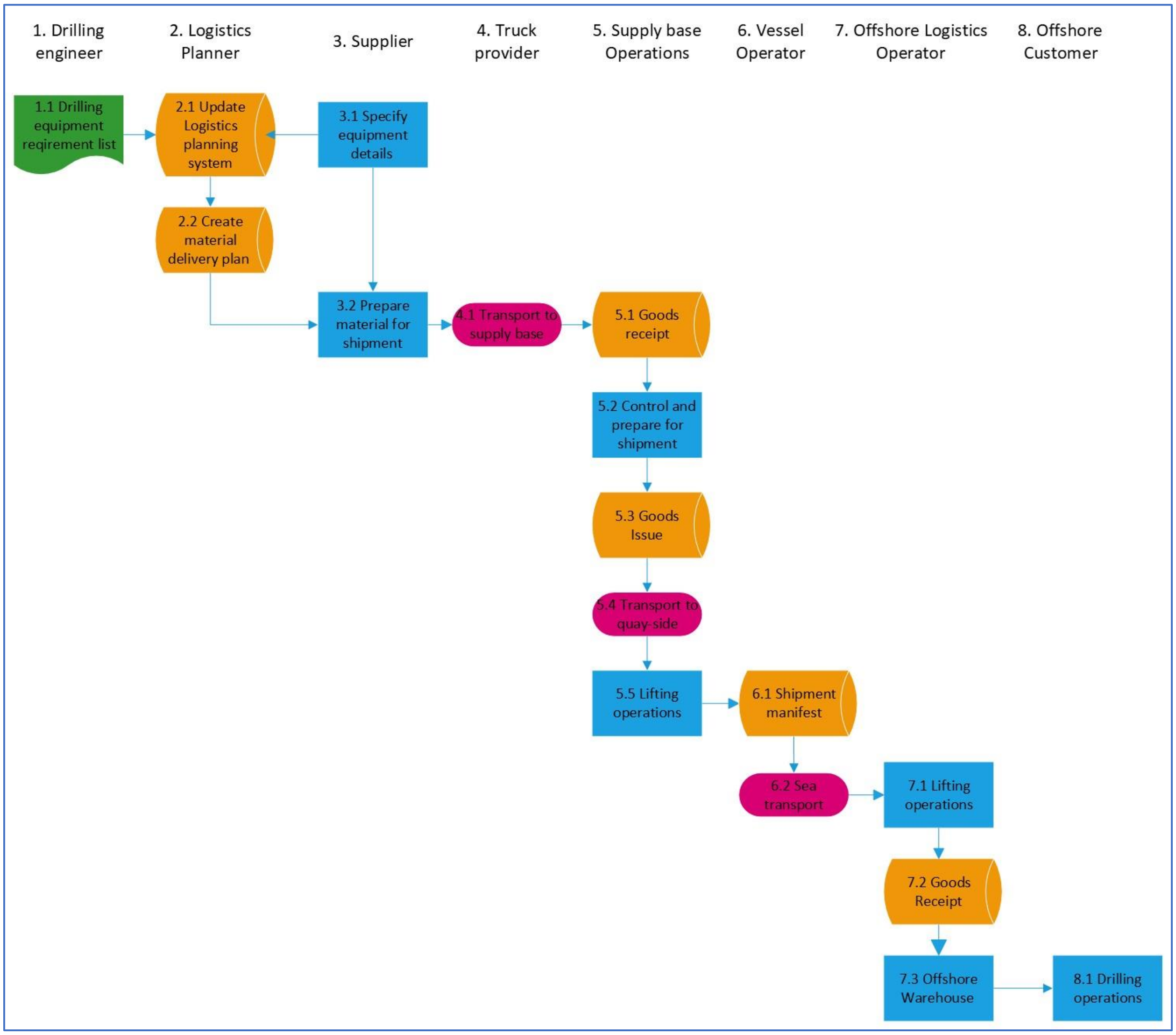

Figure 12 Scenario 2 Material flow for drilling equipment. Ref. table 4 and 5

With reference to figure 12, when planning a well, the drilling engineer will split the well into phases and plan each phase accordingly. Each phase requires different type of equipment, and the engineer will put the required equipment into the planning system (Fig. 12:1.1). The

equipment supplier will further detail the equipment into the same system (Fig. 12:3.1). The logistics planner then takes over the plan and will communicate directly with the supplier on when the equipment is to be mobilized and planned to be sent to the supply base (Fig. 12:2.1). Often a cloud-based system is used, so that all suppliers and partners in the drilling campaign have access to the system and can input and read-out relevant information (Fig. 12:2.2).
The equipment is then called off from the supplier, who will prepare the material for shipment (Fig. 12:3.2). The equipment is then sent to the supply base with the transportation method that is agreed between operator and supplier. Sometimes the supplier uses their own transport agreement, sometimes they use the operator's agreement, and sometimes the supply base provides transport. This can also differ between suppliers for the same drilling campaign. This creates some challenge for the supply base, since they have few detail on when goods will arrive, they only have the information from the planning system that some equipment is mobilized and, on its way (Fig. 12:4.1).
When the truck arrives the supply base, the equipment is offloaded and checked, and the system is updated so that all participants can monitor that is has been received (Fig. 12:5.1). Since most of the rental equipment is delivered as one package, the equipment is already packed and sealed from the supplier, according to the instructions Offshore Norge guideline 091. In such cases, NOG-091 in ordinary circumstances requires that 5% of the containers are controlled and re-sealed (Fig. 12:5.2). This meaning that 95% of the containers are not opened and re-filled unless the operator has given instructions to the supply base personnel to do so. The risk for transporting half-empty containers onshore and offshore is in place since there is no incentive for re-packing at the supply base. When the control is done, the system is updated so that all participants in the logistics chain can see that the equipment has been issued from the warehouse at the supply base. The container with the equipment is then transported to the quayside (Fig. 12:5.4) and lifted onboard to the supply vessel (Fig. 12:5.5), and the shipment manifest is created from the system so that the captain have information of what he is carrying (Fig. 12:6.1). The vessel then sails to the destination offshore, where the drilling crew is aware what is on its way because of the system updates along the material flow (Fig. 12:6.2). When arriving, the offshore logistics operators lift the equipment container off from the vessel (Fig. 12:7.1). Now the system is updated with goods received status it in the system (Fig. 12:7.2) and placed in the warehouse

or directly on drilling deck (Fig. 12:7.3). The last step is to notify the drilling crew that the equipment has arrived, hopefully in time (Fig. 12:8.1).

6.3.1 Cause and consequences for Material planning and transportation for drilling operations

All actions in the flowchart in figure 7 are now analyzed to find cause and consequences with missing cooperation:

Table 4 Scenario 2, Process cause and consequence table part 1

Scenario 2: Process cause and consequence table									Logistics Inefficiency and unsustainability mapping		
Process r	Process name	Process Description	Partner	Challenge	Consequence	Category	Incentive for chang	Cooperation possibiliti	Economical	Environmenta	Health
1.1	Drilling equipment reqirement list	The Drilling engineer gives input to the requirement list on what is required, and when	Drilling engineer	Dynamic list with lots of changes. Difficult to have standardized material	Manual work and follow-up	A	Manual work, low integration between technical systems and logistics systems	Standardisation			
2.1	Update Logistics planning system	Equipment requirements is used as a basis for the logistics planning and fundament for transporation	Logistics planner	Manual creation of logistics plan	Manual work and follow-up	A	Manual work, low integration between technical systems and logistics systems	Standardisation			
2.2	Create material delivery plan	On basis of the equipment requirements, a delivery plan is created	Logistics planner	Complex communication with all stakeholders in the logistics flow. Large amount of changes, difficult to keep track	Delivery delays	B	Track and trace system	Standardisation			
3.1	Specify equipment details	Supplier specifies equipment to secure correkt deliveries	Supplier	Availability of equipment when needed	Delivery delays	B	Track and trace system	Cooperate between operators for critical equipment			
3.2	Prepare material for shipment	When time of delivery is reached, supplier have to call for transporation and mobilize equipment to be delivered to supply base	Supplier	Access to equipment in case of sudden changes to plan	Delivery delays	B	Track and trace system				
4.1	Transport to supply base	Supplier creates transport request to supply base. Truck Provider have contractual obligations on when to be at site for pick-up	Truck provider	Low standardization on transportaion contracts and delivery terms. Transport requirements can be contracted directly to truck provider from operator, or via equipment supplier. This creates sub-optimalisation	Poor utilization of road transport	C	Reduce number of trucks on road and to supply bases	Standardize on pick-up times and opening hours at supply base			
5.1	Goods receipt	When the truck arrives with the equipment, supply base personnel receives the goods and register goods receipt in the logistics system. Delivery status on the equipment changes	Supply base operations	Low coordination between equipment supplier, truck provider and supply base creates challenges on receiving time for equipment. Truck driver may have to wait at the gate until supply base opening hours. Each operator have their own goods receipt area which creates a lot of demand for personel and facilities	Delivery delays	B	Reduce number of trucks on road and to supply bases. Reduce facility requirement and personnel on duty	Standardize on pick-up times and opening hours at supply base. Common goods receipt area across operators to reduce area requirement and number of personnel			
					Poor utilization of road transport	C					
					Poor utilization of facilities and personnel	D					
5.2	Control and prepare for shipment	Equipment will be controlled according to proceduces, and container will be placed in outbound area	Supply base operations								
5.3	Goods Issue	When equipment is ready for shipment, goods issue is registered in the system and delivery status changes	Supply base operations								

Table 5 Scenario 2, Process cause and consequence table part 2

Scenario 2: Process cause and consequence table

Process n	Process name	Process Description	Partner	Challenge	Consequence	Category	Incentive for chang	Cooperation possibiliti	Logistics Inefficiency and unsustainability mapping		
									Economical	Environmenta	Health
5.4	Transport to quay-side	The equipment is transported to quey to be ready for shipment	Supply base operations	Operator-spesific issue areas	Poor utilization of facilities and personnel	D	Reduce facility requirement and personnel on duty	Cooperate on common pick-up location for equipment to quay			
5.5	Lifting operations	When the equipment arrives the quay side, it is lifted onboard the vessel to be transported to offshore location	Supply base operations	Bottle-neck on crane access when number of vessels are high	Operational delays	B	Reduce number of vessels at the same time	Plan departure cross-operator, and share vessels when possible			
					Poor utilization of vessels	E					
6.1	Shipment manifest	Vessel operator requires shipement manifest to be delivered	Vessel operator	If several systems are in use and vessel do not have access, the manifests is delivered on paper og by mail	Manual work and follow-up	A	Standardize on logistics systems	Agree on common system for logisics follow-up across operators			
6.2	Sea transport	When all equipment is on deck, vessel leaves the supply base and sailes to offshore location(s)	Vessel operator	Poor utilization of vessel capasity. Over-capasity on deck space and bulk tanks	Poor utilization of vessels	E	Reduce number of vessels operating in the same seawaters	All companies having offshore activities out of same supplybase to cooperate and do route planning across offshore operators			
7.1	Lifting operations	Lift cargo from vessel to offshore installtion	Offshore Logistics Operator	Many cargo units because of low utilization and lots of air causes increased number of lifting operations	Poor utilization of vessels	E	Reduce number of lifting operations	If co-packing with other suppliers, cargo unit must be unpacked and returned in same operations, so limited possibilities			
					Risk with lifting operations	F					
7.2	Goods Receipt	When lifted onboard offshore installation, goods will be unpacked, controlled and received in logistics system	Offshore Logistics Operator	More time consuming when number of cargo units is increased	Manual work and follow-up	A	Reduce workload for offshore logistics personnel	Standardization			
7.3	Offshore Warehouse	After goods are received, they will be delivered to requisitioner/consumer. Logistics system will be updated accordingly	Offshore Logistics Operator	Lots of cargo units gives challenges regarding deck space offshore. High amount of internal movement of cargo units with crane	Manual work and follow-up	A	Plan deliveries from start of the supply chain, and consider co-packing on supply base to reduce number of CCU's	Standardization			
					Risk with lifting operations	F					
8.1	Drilling operations	When drilling operations receive the equipment, containers are opened and equipment put in operation	Offshore Customer								

Grouping the consequences and the weighting gives the following table with the six main consequence categories:

Table 6 Scenario 2, Consequence category table

Consequence category description	Category	Frequency	Weight	Economic consequence	Economical	Environmental	Health
Manual work and follow-up	A	5	1	5	5		
Operational delays	B	5	2	10	5	1	1
Poor utilization of road transport	C	2	2	4	2	2	1
Poor utilization of facilities and personnel	D	2	2	4	2		2
Poor utilization of vessels	E	3	3	9	3	3	3
Risk with lifting operations	F	2	2	4	2		2

When placing the consequences in diagram, the following appears:

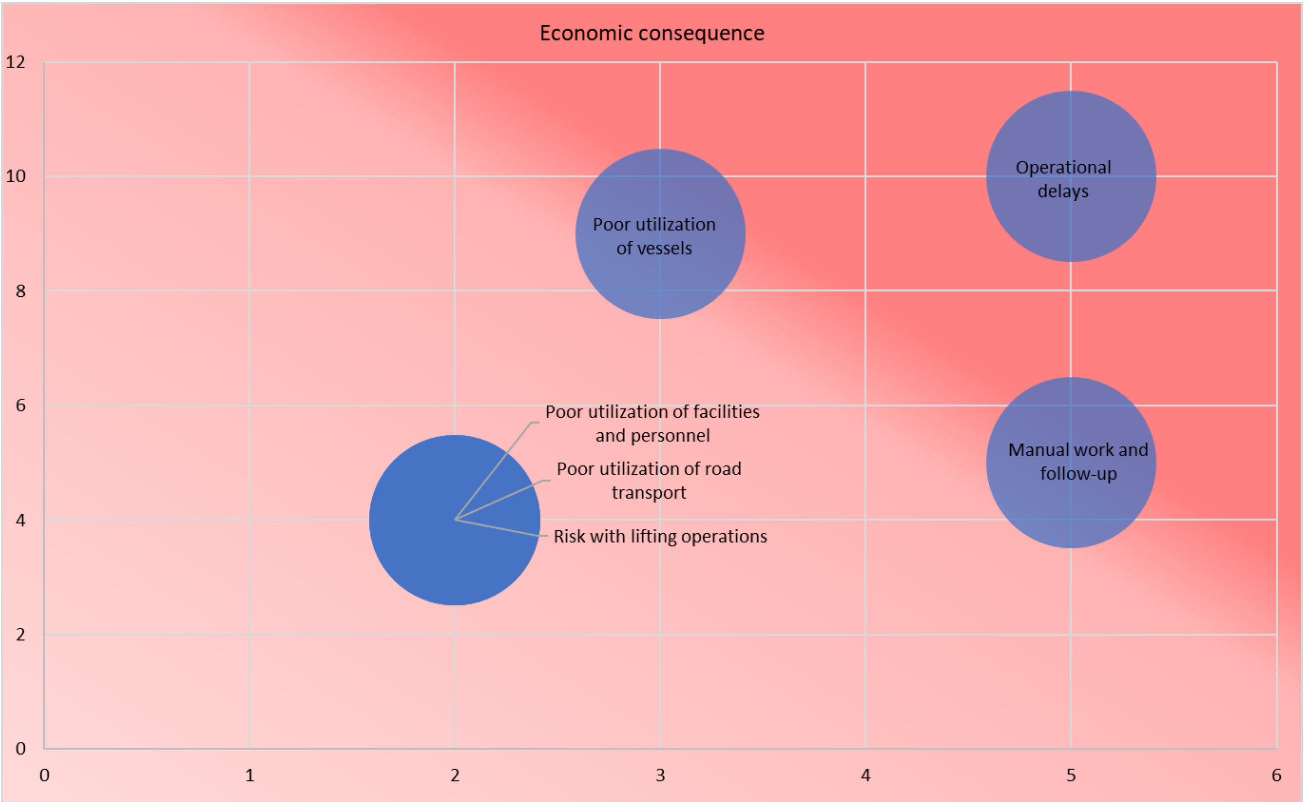

Figure 13 – Scenario 2 Economic consequence - Material planning and transportation for drilling operations

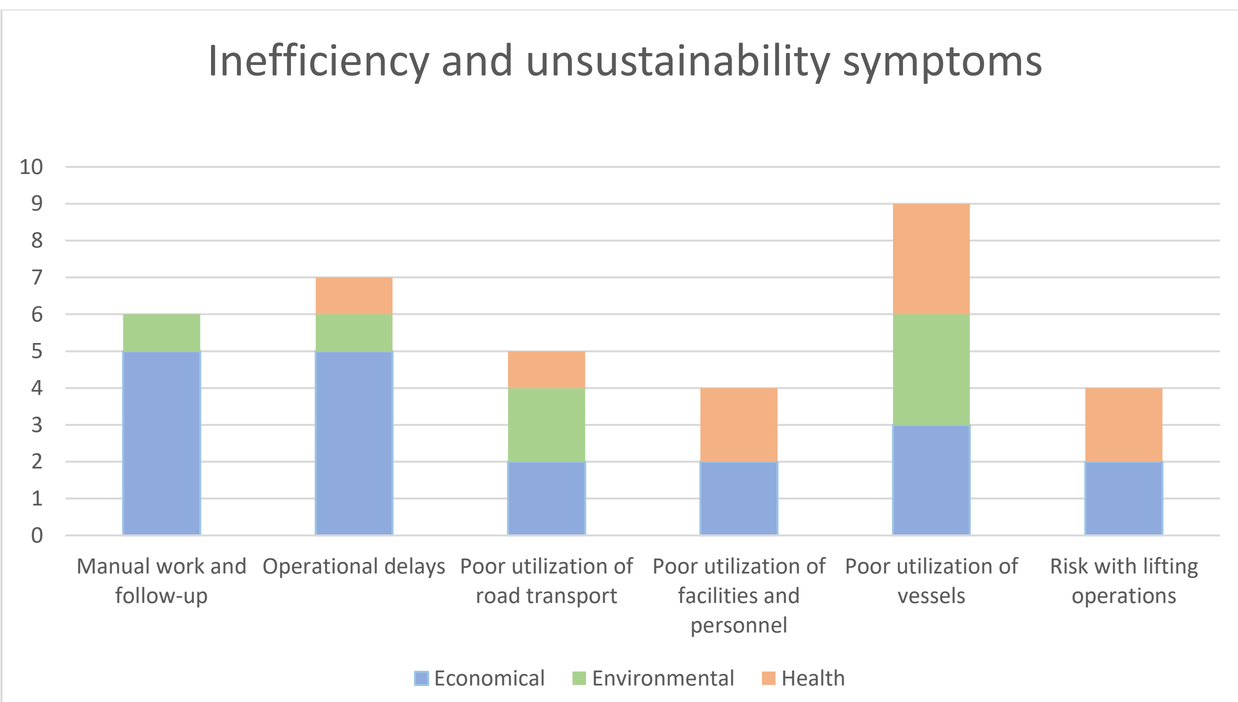

Figure 14 – Scenario 2 Inefficiency and unsustainability symptoms - Material planning and transportation for drilling operations

The result of this analysis is that there are three consequence categories that is placed in the upper red area. These are Manual work and follow-up, Delivery delays and Poor utilization of vessels. Two of these findings also have high score on unsustainability, while manual work and follow-up have several findings on the economical side.

6.3.1.1 Manual work and follow-up

As for the material planning and transportation scenario, manual work and follow-up gives a high economical consequence when cooperation initiatives are missing. The reasons are much the same for the drilling scenario, even though the systems in use are not the same, there is a lack of digitalization that makes it cumbersome to handle and creates a lot of unnecessary use of paper.

6.3.1.2 Operational delays

Operational delays are often related to logistics, and one of the main challenges in logistics are to avoid delays. In the oil and gas industry, delays can have quite large consequences. In the context of drilling operations, the worst-case scenario for operation effectiveness is if the delay causes drilling operations to stop, and even create extra rental days for the drilling rig. For the environment, the delay may cause pollution and spill if parts to avoid such happenings are not delivered on time. For health, delivery delay can cause serious incidents to take place for personnel working offshore.

6.3.1.3 Poor utilization of vessels

As for the material planning and transportation scenario, poor utilization of vessels gives a high economical consequence. It has the highest score and gives the largest consequence when cooperation is missing. We also see that it has a large inefficiency and sustainability consequence. The reasons are much the same for the drilling scenario as it is for the material planning scenario. The different may be that for the drilling scenario, the urgency is often higher since both the economic and environmental risk is higher for drilling than it is for operations.

6.4 Scenario 3: Personnel planning and transportation

Offshore helicopter operations are a critical component of the oil and gas industry. These operations involve transporting personnel to and from offshore oil and gas platforms and mobile installations. The use of helicopters is necessary because these platforms are in remote areas that are difficult for personnel to enter by other means of transportation.

These operations require specialized training, equipment, and procedures to ensure that they can be conducted safely and effectively in the challenging offshore environment. Helicopters used for offshore oil and gas operations are specially designed to meet the industry's stringent safety and operational requirements. They are equipped with advanced navigational and communication systems, including GPS, radar, and satellite communication, to ensure that they can safely and efficiently transport personnel and cargo to and from offshore locations.

Personnel changeovers involve transporting workers to and from the offshore installations on a regular basis. The regularity for fixed offshore installations is for most personnel a rotation of 2:4, that is 2 weeks on and 4 weeks off. All human resource regulations are built around this rotation, and penalties for the operators start running as soon as there are deviations.

The other group of offshore crew are personnel dedicated to drilling. These are often contracted from a specialized drilling company to an oil and gas company to perform a dedicated drilling operation. The personnel can be allocated to a fixed installation containing a drilling unit, or to a movable drilling facility like a rig or vessel. For these personnel, there will be a mix between 2:4, 2:3 or on-demand schedule. One important planning task for optimal drilling operation and cost control, is to plan personnel and equipment together. In most cases, 3rd party drilling equipment is operated by personnel from the same supplier. This requires good planning tools to cover equipment, individuals to operate the equipment, road transport, supply base operations, supply vessels, lifting operations when goods are received offshore and helicopter flights to secure that personnel are onboard the rig in due time before the equipment are received.

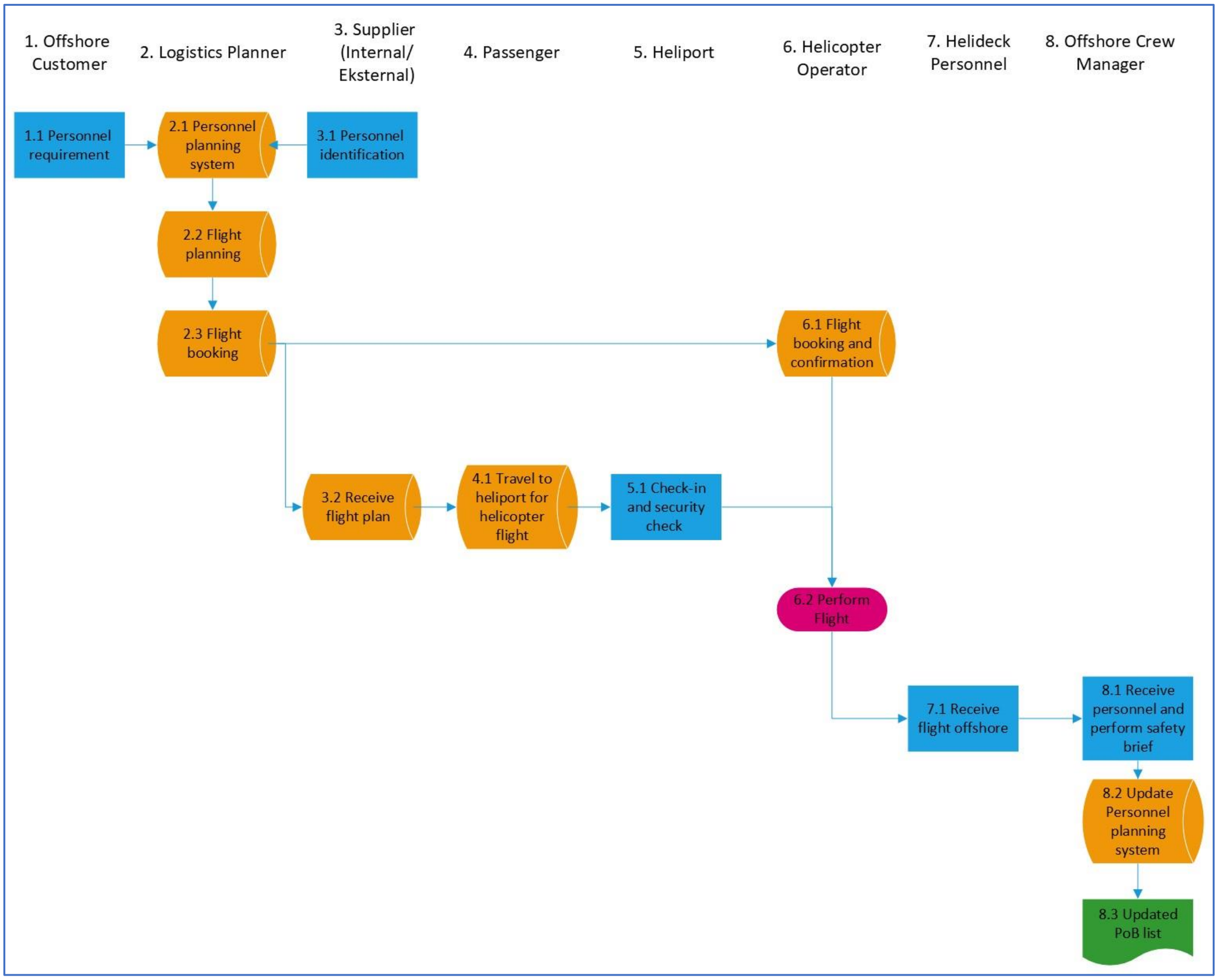

Figure 15 Scenario 3 Personnel planning and transportation flow. Ref. table 7 and 8

With reference to figure 15, the offshore customer, like Drilling Supervisor or Offshore Installation Manager that gives input to the Logistics Planner on which type of personnel is required for the current operations (Fig. 15:1.1). The demand is then input to a planning system (Fig. 15:2.1). This planning system is typically Kabal (www.kabal.no) or other personnel planning software. The supplier receives the information of the personnel demand, identifies the individual to cover the demand, and gives the information back to the logistics planner (Fig. 15:3.1). In Kabal, the logistics planner now has an overview of the personnel demand for the operation.

Now, the personnel plan will be transferred to the flight planning system, daWinci (Dawinci, Personnel and Cargo Logistics Management (quorumsoftware.com))(Fig. 15:2.2). daWinci is a tool originally developed by the Norwegian oil and gas industry to be a common tool for

offshore helicopter booking, and still have monopoly status as the one system used for these operations. The system contains a lot of personal information regarding offshore personnel and is highly governed according to GDPR. With monopoly status and GDPR governance as a backbone, system integration between systems like Kabal and daWinci have shown to be difficult to develop. Therefore, the update between these two personnel planning systems have to be done manually even though it is much of the same information that has to be updated.
In daWinci, personnel information like health declaration, next of kin, home address and emergency role is listed.
After the flight is planned and all data has been given as input for the flight, the flight is booked according to pre-defined flight schedule agreed between the oil and gas operator and the helicopter operator (Fig. 15:2.3). This is a contractual agreement between the parties and involves fixed flight schedule with number of flights each week and time for the flights. For the large oil and gas companies, this agreement often even includes identification on the aircraft, called tail number. All relevant parties involved in the helicopter operation have access to daWinci. This means that when the passenger list is ready and the passengers are planned into the flight program, the helicopter operator like Bristow and CHC can start preparing the flight (Fig. 15:6.1). Also, the supplier of the personnel gets the relevant information and updates together with the passenger (Fig. 15:3.2).
The passenger now starts to prepare the journey to the heliport. The offshore crew is located all around the country, and in some cases also outside Norway. In most cases the travel needs to take place the day before, to be ready for helicopter check-in at time of departure. According to contract with the oil and gas company, commercial or work salary related, delays for outgoing personnel comes with a high cost. And the delay cost is not only direct cost because of accommodation and salary, but also for activities offshore that may need to be delayed. Worst case scenario is delay in rental days for a drilling rig. If the result of a delay for critical personnel results in one additional rental day for the drilling rig, this gives a cost of around 3-5 MNOK (Wintershall Dea, personal communication, 2022), depending on the rig type, the location of the rig, the length of the contract, and the current market conditions.
The heliport is manned with crew to support the helicopter operators with security check and check-in. The oil and gas operators are having common contracts with security service suppliers who is manning the heliport, along with personnel from Avinor and from the helicopter

operators. To be able to travel to an offshore installation, each person must have a valid health certificate and safety course. The status of this is stored in daWinci, and an alarm will show if this is not in order. Each oil and gas company have agreement with the supplier of safety-suits, which is Hansen Protection, either as direct contract or via the helicopter operator. Delivery of safety-suit is a part of the check-in procedure (Fig. 15:5.1).

When all personnel are checked in, the flight is ready to be performed (Fig. 15:6.2). The flight routing is already decided and registered in daWinci, but it is possible to deviate in last minute if the owner of the flight (the oil and gas company which have booked the flight) agrees. This means that it is possible to make one or more additional offshore landings during the trip, called split flights. The owner of the flight then sells available seats, outgoing or incoming, to some other oil and gas companies. It is often less expensive than setting up a separate flight, and is mostly used in case of emergencies or operational issues.

When the helicopter is approaching the offshore installation, the helideck crew is assembled to receive the flight and secure the helideck for embarking and disembarking passengers. The helideck crew also have important roles in case of accidents or fire on the helideck. They are guiding the passengers to the right escape route on the helideck and perform loading and unloading of luggage to and from the aircraft (Fig. 15:7.1).

The incoming personnel are then received at the air lodge on the installation and met and briefed on the production status and plan by the Offshore Installation Manager (OIM) and Drilling Supervisor. New personnel on the installation get a safety briefing by HSEQ responsible and a get-to-know tour before they are shown their cabin (Fig. 15:8.1).

Now, the personnel planning system and daWinci are updated with arriving and departing personnel (Fig. 15:8.2). This is to be sure that the Personnel on Board (PoB) status is updated. This is of most vital knowledge in case of emergency and need for escape with lifeboat. The official system for this is daWinci. Since daWinci is open for many users across a lot of companies and suppliers, there is a functionality to “lock” the PoB in case of such situations. The reason for this is that personal information shall not get out of control (Fig. 15:8.3).

6.4.1 Cause and consequences for Personnel planning and transportation

All actions in the flowchart in figure 8 are now analyzed to find cause and consequences with missing cooperation:

Table 7 Scenario 3, Process cause and consequence table part 1

									Logistics Inefficiency and unsustainability mapping		
Process r	Process name	Process Description	Partner	Challenge	Consequence	Category	Incentive for chang	Cooperation possibiliti	Economical	Environmenta	Health
1.1	Personnel requirement	The offshore customer have reqirement for personnel to support operations	Offshore Customer								
2.1	Personnel planning system	Personnel reqirement is registered as demand in the personnel planning system	Logistics planner	Personnel planning system is different than the personnel booking system	Double registration	A	One common planning system for equipment, personnel and booking	Common system will give same information for cooperative planning			
2.2	Flight planning	Logistics planner plans flights according to fixed schedule and confirms the booking	Logistics planner	The planner must manually transfer the data from the personnel planning system to the flight planning system/booking system.	Double registration	A	One common planning system for equipment, personnel and booking	Common system will give same information for cooperative planning			
2.3	Flight booking	The flight is confirmed and booked according to fixed schedule	Logistics planner	The booking is done according to pre-defined schedule agreed with the helicopter operator and contractual agreements	Helicopter capasity not utilized	C	Limitations in combining flights because that each company have their own contract with helicopter operator without any incentives for cooperation	Sharing of helicopter resources between operators			
3.1	Personnel identification	Supplier gives input on which personnel will cover the demand	Supplier	GDPR	Double registration	A	The same data is registered in two systems, and personnel data have high degree on data security	Common system will give same information for cooperative planning			
3.2	Receive flight plan	Supplier receives flight plan from the logistics planner, with information of passengers, and keep their personnel informed	Supplier								
4.1	Travel to heliport for helicopter flight	The passenger also receives flight plan, and then needs to prepare the travel to heliport by car, airplane or other transportation	Passenger	Changes to offshore operations and waiting for weather can result in delays. Waiting for flight is challenging for personnel	Operational delays	B	Prioritize urgencies. Reduce waiting time and possible downtime in cases of back-load	Sharing of helicopter resources between oil and gas companies Common booking of travel from home to work			

Table 8 Scenario 3, Process cause and consequence table part 2

									Logistics Inefficiency and unsustainability mapping		
Process r	Process name	Process Description	Partner	Challenge	Consequence	Category	Incentive for chan	Cooperation possibilitie	Economical	Environmenta	Health
5.1	Check-in and security check	At the heliport, passengers need to check in before going through security check and safety video	Heliport								
6.1	Flight booking and confirmation	The helicopter operator receives passenger list and flight plan, and confirms booking in the system	Helicopter operator	The helicopter operator have no possibilities to combine flights and installations since O&G operators "own" their own flights. Creates more waiting for passengers	Helicopter capasity not utilized	C	Fill helicopter to reduce number of aircrafts	Sharing of helicopter resources between oil and gas companies			
6.2	Perform Flight	When passengers are briefed and security check finished, the flight is performed	Helicopter operator	Most of the flights are performed as one landing flights, so the potential for filling seats are not utilized. Creates more waiting for passengers	Helicopter capasity not utilized	C	Fill helicopter to reduce number of aircrafts	Sharing of helicopter resources between oil and gas companies			
7.1	Receive flight offshore	When flight approaches the offshore installation, heldideck personnel is ready to receive the flight according to guidelines	Helideck personnel	Helideck personnel usually have other tasks as well on the installation, and when flight schedule changes, planning other tasks will be difficult							
8.1	Receive personnel and perform safety brief	When personnel have arrived, offshore installation manager or drilling manager briefs the newcomers of status and activity offshore	Offshore crew manager								
8.2	Update Personnel planning system	The arrival of personnel is updated in the personnel planning system	Offshore crew manager	Personnel status needs to be updated in two systems because of missing integration possibilities between systems	Double registration	A	The same data is registered in two systems, and personnel data have high degree on data security	Common system will give same information for cooperative planning			
8.3	Updated PoB list	The personnel planning system is the main system for keeping track of the Personnel on Board (PoB)	Offshore crew manager								

Grouping the consequences and the weighting gives the following table with the tree main consequence categories:

Table 9 Scenario 3, Consequence category table

Consequence category description	Category	Frequency	Weight	Economic consequence	Economical	Environmental	Health
Double registration	A	4	1	4	4		4
Operational delays	B	1	3	3	1	1	1
Helicopter capasity not utilized	C	3	3	9	3	3	2

When placing the consequences in diagram, the following appears:

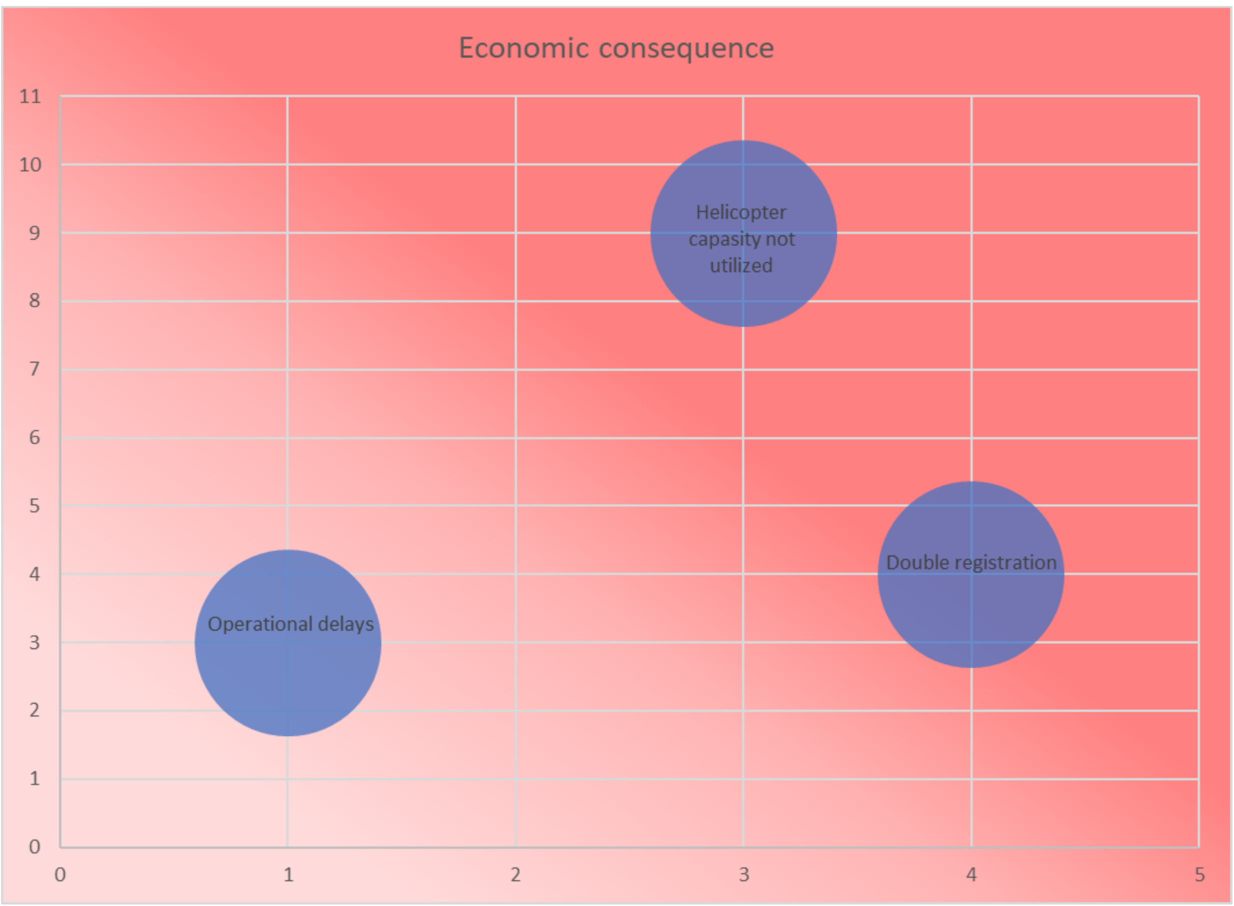

Figure 16 Scenario 3 Economic consequence - Personnel planning and transportation

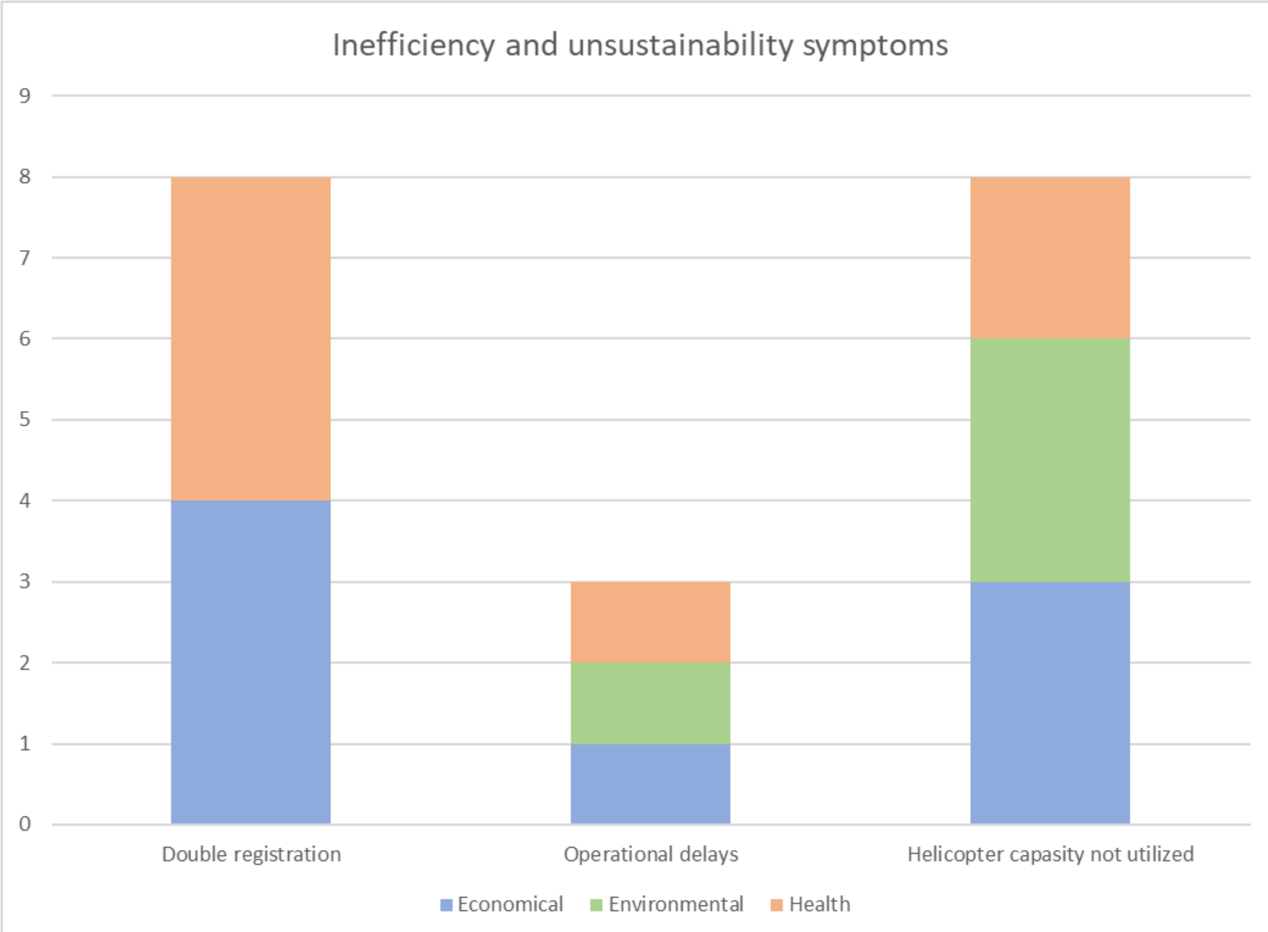

Figure 17 Scenario 3 Inefficiency and unsustainability symptoms - Personnel planning and transportation

6.4.1.1 Double registration

The Personnel planning system daWinci is a "personnel logistics management software solution designed to accommodate the international oil and gas industry's critical business requirements and diverse needs". The system was developed by Norwegian oil and gas companies and was deployed on cloud already in 2001 (Quorum Software, 2023). From that time of, it has been the industry standard for personnel planning to and from the offshore installations. All participants in the personnel logistics chain have access to the system. The combination of industry standard, access for all participants and high amount of personal information governed according to GPRS, have created a monopoly situation for the system supplier. This has both upsides and downsides. Upsides are that the supplier is open for changes and further developments, and the commercial

model is that all cost is shared between the users in the community. The downsides are that the supplier is very protective and reluctant to integration to other systems and to data exchange.
To be able to secure that personnel is going offshore at the time receival of the equipment they are going to perform work on, there is a need for an integrated solution that plans both equipment and personnel. There are several solutions on the market for doing this, and the most commonly used solution on the NCS is the cloud-based Kabal solution, formerly called Wels (www.kabal.no). Kabal has a personnel planning solution used to collect input from the drilling management to connect personnel with required equipment. This personnel list has names and communication data to the offshore personnel and to supplier contacts, so messages of mobilization can easily be transmitted to relevant people. In these days of digitalization, one should believe that it also had connection to daWinci, where the connection between personnel and helicopter flight is done. But because of the special situation of daWinci as described above, such a connection does not exist. This is the reason why "Double Registration" appears and scores high as a consequence for missing cooperation. In the further analysis, the weight factor equals 1. The reason for this is that the economical consequence is not very high, but we see that the finding "Double Registration" appears in many process steps. We also see that is scores high on health cost. The reason for this is that all this manual registration is frustrating for a lot of persons in the value chain and seems unnecessary and time consuming in a stressful work environment.

To change some of this waste in process handling, the oil and gas companies probably need to do some restructuring and reduce number of actors in the personnel logistics chain. There are a lot of actors that have a stake in the helicopter booking process. Let's take an example from WintershallDea (2022), where the need is to buy capacity from another oil and gas operator. Wintershall Dea's own logistics planner contacts its 3rd party booking agency, which asks the helicopter operator for availability, who passes the request over to the other oil and gas operator for approval, which approves and informs the helicopter operator, which then informs the 3rd party and in the end the logistics planner receives the confirmation. If the oil and gas companies gave this task to the helicopter operator, time and cost consumption would be reduced, and with digitalization effort, also the health aspect of the finding would be reduced.

6.4.1.2 Operational delays

Another result of the analysis is Delay Cost. In the personnel process, this result appears once, but we know from the previous analysis on the other processes, that delays can create really high cost for the offshore operations.

The delay cost in scope here is the cost of personnel waiting on weather or because of poor utilization of helicopters. Sharing of resources when backlog appears can reduce cost of personnel waiting for flights to take them to work.

The reason for weight factor equals 3 is that in worst case, a delay can cause addition rental days for a rig or vessel, which earlier mentioned in chapter 6.4 counts for 3-5 MNOK.

6.4.1.3 Helicopter capacity not utilized.

The analysis result that helicopter capacity is not utilized, is getting a high score on the consequence of missing collaboration between oil and gas operators. The weight factor is 3, and the reason is that a collaboration has high potential for reducing cost for the operators on NCS. The cost of mobilizing and leasing an aircraft is high. If an oil and gas operator can buy free capacity and then reduce the number of aircrafts in operation, this will have a positive influence on all actors in the collaboration. There is a lot of factors driving the cost for helicopter transport. The largest cost is of course the leasing cost of the aircraft. The helicopter operator is the lessor, but the cost of leasing is allocated to the oil and gas companies in the commercial agreements. And the aircraft needs maintenance, tools, hangar and crew. The crew need training a simulator hour, and often the simulator is not located close by, so travel and stay is needed.

The way helicopter operations on NCS are set up as of now is that each oil and gas company have their own commercial agreement with the operator. This agreement is often connected to a full aircraft or part of an aircraft, so 30, 50 or 100%. But even if you contract a 100% aircraft, it is not necessarily utilized 100%. This only means that the contractor has the right to the fixed flight schedule, and the crew that follows that schedule. Normally for distances up to one hour flight, you get 3 flight each weekday with one full crew. The chosen schedule is then between 08.00 and 16.00, also called “the golden hours”. These “golden” hours are the most favorable for the operating companies and for the passengers because most of the passengers are able to travel to the heliport the same day as the helicopter flight is performed and then don’t need to travel the day before. But the aircraft can operate in many hours before and after these “golden hours”, only limited by daylight and noise limitation in nearby areas of heliport, but it needs one additional crew. There is also other capacity that can be utilized, and that is free seats in the aircraft. The seating capacity for normal distance flights with a Sikorsky S-92, the only helicopter type currently in operation on NCS (2023), is 19 passengers. The average passenger number for flights is 15 (WintershallDea, personal communication, 2021). This means that if the oil and gas companies can agree to collaborate on flight schedule and increase use of split flights and schedules outside the "golden hours", they are able to reduce number of aircrafts in operation. Even the helicopter operator could potentially gain on this, since they can utilize their crew and facilities in a better way, and possibly reduce number of maintenance objects.

6.5 Research results from the three scenarios

If we now sum up from the three scenarios, the consequences of missing collaboration that gives the highest economical and sustainability consequences, we get the following:

Table 10 Consequence sum-up

Consequence of missing collaboration	**Scenario**
Manual work and follow-up	1, 2
Unefficient container packing	1
Poor utilization of vessels	1, 2
Operational delays	2, 3
Double registration	3
Helicopter capacity not utilized	3

In the next section the research results are analyzed against the three research questions.

6.5.1 Research results within Manual work and follow-up

These challenges are not new to the industry. Already before 2013 Norwegian Oil and Gas Association initiated a work on a common event database for cargo carriaging units leading to the first business case in 2013 (EPIM, 2022, s. 23). The database was called LogisticsHub, and the first task was to track containers by RFID tags throughout the delivery chain from supplier to supply base. RFID tags were placed on the containers, and readers on the supply base entry gate. The technology had some challenges, and also the isolated tracking of containers was not sufficient to get the information requested.

Later on, in 2018, Wintershall Dea took the initiative to test the solution, now with new technology consisting of event tracking by GPS and GeoFencing (EPIM, 2022, s. 26). The tracking object was still the containers, but the tracking path was extended to cover supplier, road transportation, supply base handling, port departure and offshore arrival. The project was done in close performance with suppliers in the logistics chain. A schematic can be found in the figure below.

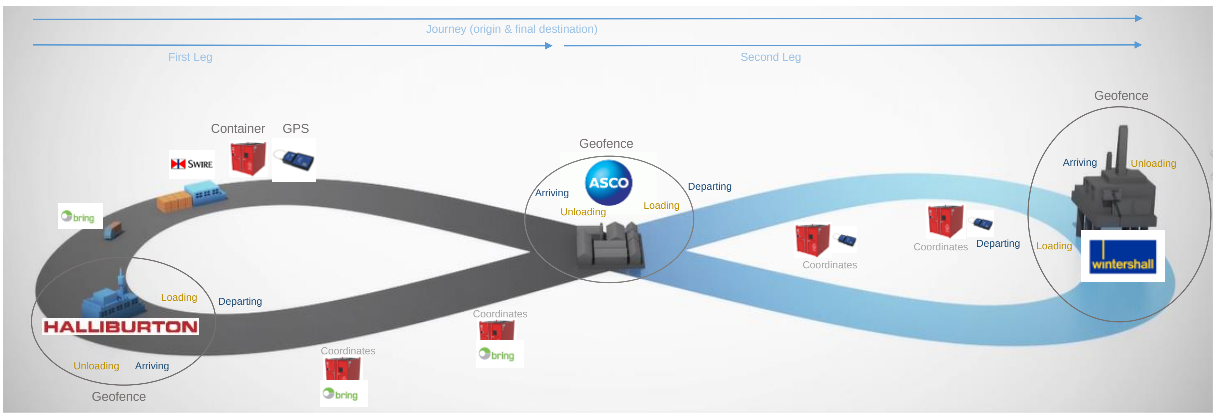

Figure 18 LogisicsHub Pilot Project. Wintershall Dea 2018

This test was closely supporting the recommendations from the Konkraft report (2018), and it was an important input to the NCS Logistics Collaboration Projects in the aftermath of Konkraft. Even though this project was linked to container tracking, it was a part of reducing manual work and follow up and with that supporting results in the analysis of this master thesis.

The Manual work and follow-up consequence is a lot about digitalization. Going to the proposals in the Offshore Norge logistics improvement report, pilot projects that can be connected the this are of the following two pilots within Plan, Master and Tracking data, namely “Start exploring EPIM Logistics Hub” and “Assess Further Development of Logisics Hub to handle Cargo Unit”, (Norsk Olje og Gass, 2020).

So, how have the development of these projects performed, and how can they answer the research question in this thesis?

Regarding Logistics Hub, the largest oil and gas company on NCS, Equinor, recommended in 2019 to initiate implementation of EPIM Logistics Hub's CCU tracking solution (Equinor, 2019, s. 35). This finally gave the start-kick for the tracking solution which had been developed since 2012 and supported the NCS Logistics Collaboration Report. Then, some months later, Equinor turned around and decided not to go for Logistics Hub as a tracking solution. One reason for this was that the second pilot mentioned above, "Assess Further Development of Logistics Hub to handle Cargo Unit", were connected to sharing tracking information on purchase order items. This was shown to be challenging with the architecture and technology behind Logistics Hub. In Q2, 2021, the members of Executive Operations Committee in Offshore Norge decided to stop support and develop LogisticsHub as a service (T. Tønnesen, personal communication, 28th of May 2023).

Offshore Norge, Equinor and other Oil and Gas companies, decided to explore Open Peppol (www.peppol.org) as an international standard. A project was then started in Offshore Norge in cooperation with BEAst, the Swedish construction industry's electronic business standard cooperation (www.beast.se). The reason for this cooperation is that these to industries, even though rather different type of industry, have the common requirement for tracking logistics event. So, the status of digitalization projects within oil and gas logistics is that there is now a completely new service domain in Peppol to be developed, called Peppol Logistics (Peppol Logistics – A new service domain that will enable more efficient logistics – OpenPeppol). Since this collaboration initiative is different from the original pilot covered by the NCS Collaboration Project, this can be seen as a spin-off initiative with reference to research question 3. It will be interesting to see how this project develops, and hopefully the oil and gas industry can agree on a standard to avoid manual work and follow-up, 11 years after LogisticsHub birth.

6.5.2 Research results within Inefficient container packing

For the Scenario 1, Material planning and transportation process, inefficient container packing have a high score as an economical consequence for lack of cooperation, as well as for the unsustainability consequences. The main reason for this is low degree of container filling, meaning the amount of air that is transported, and the individual pool solutions existing at each of the oil and gas operators.

From the Offshore Norge logistics improvement report, there is a recommendation to standardize the use of container carrying units (CCU) at each supply base location by unifying carries in a common pool. There is also a recommendation to give the supplier control of the resources.
For some operators, this have been done, in cutting the pool solution and letting the supply base operator handling the pool with direct contact with the CCU supplier. Still, it is not the CCU supplier that controls the pool, but it is a step closer to the recommendation. For the larger oil and gas operators, pool solutions still exist.
When it comes to the amount of air that is transported, this is still an issue, even though it is on the compass of the operators and supply bases. As a spin-off to the logistics improvement report, ref. RQ3, it became clear that to make the industry more efficient in the area of container packing and handling, you have to begin from the start with the information of each CCU and standardize the information and then make it digital. So, linked to the consequence described above regarding manual work and follow-up, a project was started to create a guideline for exchange of logistics data, resulting in Offshore Norge Guildeline 146 – Recommended guidelines for exchange of logistics data (Offshore Norge, 2021). Still, it only contains information to cover container data, but it is a start and will be useful when continuing to digitalize the logistics flow and making container packing more efficient.

6.5.3 Research results within Poor utilization of vessels

For both scenario 1 and 2, poor utilization of vessels can give economical and unsustainability consequences if the oil and gas operators fail to cooperate in utilizing vessels in the fleet.
There is over-capacity in the total fleet today, and most oil and gas companies strive to have priority over the vessel assets in case of emergency that can cause production stop or delays.
In the Offshore Norge logistics improvement report, vessel planning- and operation was high on the agenda. There was outlined a pilot for «Common offshore marine transport – Stavanger area”, covering the fields in operations that were supplied from Dusavik and Tananger. The aim was that logistics provider(s) should be given responsibility to aggregated logistics needs across operators, and from that plan and manage vessel routes in a manner that was optimal for all.
In addition, there was a recommendation to start working on standardizing timelines and key information for handover of vessels to increase efficiency and optimize planning.

Today there is still no vessel cooperation from Stavanger area driven by logistics provider. The cooperation that are existing is still on an ad-hoc basis.

In Florø, there was a pilot initiative to share end-to-end services between operators. During the last years, Neptune, Shell and Equinor entered into an agreement on utilizing the vessels out of Florø in a common route pattern covering installations from three different oil and gas operators (Wintershall Dea, personal communication, 2022). This cooperation has been successful. The challenge with this kind of cooperations is that it is challenging to get other operators to enter the cooperation when running ad-hoc drilling operations. The reason is that the complexity of the cooperation and planning to get it running, and the challenge it is when a new operator enters in a relatively short period of time. Then the result often becomes that the new operator runs its own vessels and routes.

On the standardization side, there is an initiative to standardize sharing of planning data in logistics, Integrated life cycle Asset Planning (ILAP), based on ISO 15926-13 (Nesheim et.al, 2020), The aim of implementing this standard is to use it in sharing of logistics data between all actors in the logistics chain. As time of writing this master thesis, ILAP Data Exchange Service is under development, and Offshore Norge will participate in a pilot for new cloud solution in the autumn 2023 (Offshore Norge, personal communication, 25th of May 2023).

With reference to RQ3 and spin-offs from NCS Logistics Collaboration Project within vessels, there is one project worth mention. From the supply base on Mongstad, two operators had fixed operations. This was Equinor supplying their installations with 6 vessels, and Wintershall Dea supplying their only operated topside, Brage, with one vessel. The cooperation on ad-hoc basis worked fine, but even with quite some effort, it has proven difficult to get a fixed vessel sharing agreement to be signed. Equinor then created an own business area for late-life production facilities, called Field Life Extension (FLX). The aim with this business area is to operate the late life installations according to Lean methodology and reduce waste (Equinor, personal communication, 2020). This was a good match for the way that Wintershall Dea was running Brage. In May 2021, the vessel Energy Swan, during one day, extended its route pattern from one to five installations, becoming the vessel on the NCS with the highest deck space utilization and lowest waiting time on quay side (Wintershall Dea, personal communication, 2021). The total vessels operating from Mongstad was reduced from 7 to 6, close to 15% reduction (WintershallDea, personal communication, 2021).

6.5.4 Research results within Operational delays

Because of missing cooperation with logistics operations in the oil and gas industry, the analysis show that operational delays can occur. This is valid both for material and equipment, and for personnel.

Delivery delays in the sense of this paper is a direct consequence, but it can also be a result of the other consequences found.

In the NCS Logistics Collaboration Project report, there are no direct pilots covering delivery delays, but there is indirect action that could influence the delivery security. Some of these actions are within standardization, more concrete to standardize the operator specific requirements on deadlines. This is also listed as a challenge and cooperation possibility in process Fig 12:4.1 for scenario 2. When the operators have different deadlines for pickup of material at supplier, and the opening hours at supply base is not corresponding, the truck may meet a closed gate at arrival. If the transport in addition have been called-off as express, both personnel and environment have been challenged and the result is delayed delivery to the end customer – the offshore installation.

Offshore Norge have a project running called Standardized Supply Chain Behavior, which is a joint industry improvement arena. The project was started in 2019 after the Konkraft report and in parallel with the NCS Logistics Collaboration Project. In the annual report in 2020 (Offshore Norge, 2020), it is stated that one of the main areas for improvement is to increase the use of standard deliveries. As delivery deadlines are a part of the contract between the operator and the supplier, this could be a part of the improvements to be handled in the Supply Chain Behavior project.

Also worth mentioning, and which is more linked to Scenario 1, is a project facilitated by Offshore Norge have called Virtual Inventory (Virtual Inventory – Collabor8), where the aim is to gather information of material on stock from all oil and gas operators in Norway, and analyze which items are identical and stored on several locations for several installations, to be able to reduce total stock and share spare parts in case of emergency for operational issues. This have been a great success and is a proof that cooperation between the different companies can give great results. In addition to achieving sharing of material and avoiding surplus and waste, the companies have reduced capex and opex, reduced down-time of the overtaking facility because of available spare parts, and increased digitalization-level and data quality (Offshore Norge, 2023).

6.5.5 Research results within Double registration

The consequence for having different systems for personnel planning is double registration. Normally, one can have several system with integration via API's or other technology. It has proven difficult to integrate the personnel module from daWinci with other systems. One of the reasons is the General Data Protection Regulation (GDPR), which is really strong in the agreement the supplier of daWinci have with the customers (which are the oil and gas operators). But in addition to this, it is valid to think that since the daWinci system have a monopoly situation, the power of data is strong, and that giving access for other system suppliers to these valuable data is a threat for this monopoly situation.

As to activities outside the NCS Collaboration Project to reduce the double registration, Offshore Norge did a check two years ago to see what possibilities were available. The oil and gas companies however did not approve to implement any changes at that time (Offshore Norge, T.Tønnesen, personal communication 28th of May 2023). There are currently no common initiatives.

6.5.6 Research results within Helicopter capacity not utilized.

Helicopter is, together with vessels, the most cost intensive asset in the offshore logistics value chain. As mentioned in the previous chapter, the setup for helicopter operations is complex, and it is ready for evaluation and change. In the NCS Logistics Collaboration Project report, there is listed a potential pilot for Helicopter Transportation as a service. The aim of this pilot was to test out new service models, where the helicopter operator takes on more responsibility of the total service offerings than what has been the case.

Helicopter services are one of the key deliveries to the oil and gas industry. The service is associated with great attention and sensitivity, partly due to the requirements for delivery accuracy and safety in connection with personnel transport.

The supplier industry within helicopter services for the oil and gas industry has long been facing a very strained financial situation, which has led both suppliers on the Norwegian Continental Shelf to undergo Chapter 11 bankruptcy proceedings in the United States in recent years.

The reasons for the strained economy are complex. The contract regime within personnel transport on the Norwegian Continental Shelf is complicated. A complicating factor is long-term leasing contracts on the operators' assets, namely the helicopters, where the contractual obligations are time-based and independent of the market situation. This means that these contracts do not consider the downturn in the oil industry, let alone the large fluctuations in oil prices that result in significant changes in the activity levels of oil companies and therefore also for helicopter operators. As a result, they are left with financial commitments for expensive helicopters that remain on the ground with full leasing costs.

As to service model, this is linked to how the contract model is set up.

The traditional model is characterized by a leasing company being responsible for the financing of the fleet. The leasing company owns the helicopters and has an established leasing contract with the helicopter operator. The helicopter operator then leases its fleet to oil companies using various compensation models. Additionally, the helicopter operator must maintain close contact with the manufacturer, as requirements for training and knowledge, technical manuals, spare parts, and tools necessitate a close collaboration between these two entities.

The oil company, as the customer, only has a relationship with the helicopter operator as the supplier.

When it comes to extended services, the process today is that when a passenger is traveling from one airport to another to catch a helicopter to an installation, the individual book his own flight tickets online and choose the price and time that is the best suit. After that, the oil company takes over completely with their own processes and routines to transport the person to the installation.

In a model proposed piloted in the NCS Logistics collaboration project, the thought is to look at the possibility to have a service provider to book the entire journey from home to the final destination (similar to what is done in the civil aviation industry today) because then all the value chain resources are integrated, and there will be mechanisms for control, trust, and complementary relationships in place. The setup will then be like an alliance model between service provider (which can be the helicopter operator) and the oil and gas companies.

The concrete pilot mentioned has not been utilized. But, as a spin-off, there has been several initiatives.

The most recent and that is still in operation, is a cooperation started between Equinor FLX and Wintershall Dea (also mentioned for vessel cooperation in chapter 6.5.3). The aim was to take

the same model as the one used for vessel cooperation, and mirror this for helicopter. One aircraft was dedicated for this cooperation, and a flight plan was set up, covering 5 installations. The operating window was extended from the norm, and the installations had to adjust their operations and agree on receiving flights at more inconvenient hours than before, because all installations could no longer have the “golden hours”. The result was that the price per seat on helicopter was significantly reduced and the flexibility for split flights and extra trips was improved (Wintershall Dea, personal communication, 2022).
On the other hand, there is still a way to go on having the extended services offered from a professional service provider, since the oil and gas operators still perform most of the services with own resources.

In parallel with the startup of the NCS Collaboration Project, another project which is worth mentioning is a project that Wintershall Dea run together with Bell helicopters as manufacturer and CHC as helicopter operator. In January 2020, Wintershall Dea entered a memorandum of understanding with Bell Helicopters to collaborate on a 24-month soft launch of the Bell 525 on the Norwegian Continental Shelf. The memorandum of understanding was intended to be followed by a binding partnership agreement, outlining the commitments and commercial aspects between the parties. The project has placed a strong emphasis on employee involvement with a high focus on safety aspects. The context of this agreement was the Turøy accident, where an Airbus H225 helicopter crashed off the coast of Bergen. Thirteen people lost their lives in the accident. As a result, the H225 helicopter will no longer be used on the Norwegian Continental Shelf. Currently, the oil industry relies solely on the Sikorsky S-92 helicopter for personnel transportation. If an accident were to happen involving the S-92 in Norway or elsewhere in the world, it would put the entire oil industry in a very challenging situation, as we would be unable to transport personnel to our installations for a period. Therefore, Wintershall Dea stated that it was time to explore the possibilities of introducing a new helicopter type on the Norwegian Continental Shelf as an addition to the S-92. This project fits good with the goals of the above-mentioned pilot. It challenges the current setup of the relation between helicopter operator, leasing company and oil and gas operator, in addition to looking at the total concept of helicopter transportation as a service. This current project was stopped due to the fact that Wintershall Dea sold the only fixed topside asset Brage, but the work that was done together with safety delegates and unions is a good foundation when a new helicopter type is launched on the Norwegian Continental Shelf to transport offshore personnel to their work.

7 Validation

According to Johannessen et al. (2010), validation in qualitative research refers to the process of assessing whether the researcher’s methods and findings align with the intended objectives of the study and whether they can be applied or generalized to real-life situations.

The theory part is taken from Norwegian Petroleum Directorate (NPD), and the source of this information is part of what my own company reports.

The analysis is based on process and risk analysis method, and on my own know-how after a lot of years as a leader and project manager within logistics, in addition to knowledge transfer from sources in the industry. The assessment of the consequences of lacking cooperation between oil and gas companies are based on process knowledge and own interpretation and could possibly be described with different wording if done by another person. The findings though are directly comparable to pilots or recommendations in the NCS Logistics Collaboration Project report, which shows that the process described in this thesis adheres to the process that is used in the report, and that the results support the research questions.

8 Conclusion

The analysis in this master thesis have shown how the main logistics processes are set up, and shown the challenges, according to RQ1. The process challenges leads to financial and sustainable consequences when cooperation between the parties are missing. These consequences are found using risk methodology, and the sum of these are as presented in table 10. Next step of the analysis has been to look into the NCS Collaboration Project Report and check how the process challenges have been handled and which actions have been taken after the NCS Collaboration Project Report, according to RQ2. To reduce manual work and follow-up, this must be done with digitalization. LogisticsHub was in the report pointed out as the digitalization platform for sharing tracking data in the logistics chain. After 9 years of development and test of different technologies, it was never put into live operation by any companies and shut down. The Peppol standard has taken over the digitalization task with the development of Peppol Logistics Domene.

There is still work to be done regarding container handling. The industry still transports a lot of air, and local container pools exists. This has direct impact on deck capacity, as each container have a footprint on the cargo deck. Physical internet approach is still a long way to go, but perhaps some ideas can be adopted if the CCU suppliers get more responsibility.

Deck capacity is a part of vessel utilization. There are over capacity of vessels in operation on the NCS, and still room for cooperation. The recommendations from the NCS Collaboration Project have not failed, and some of it has been operationalized in another form than proposed, as spin off effects from the project, answering to RQ3.

Helicopter and system handling is important and complex. The project pointed out many recommendations, most of them was on giving more responsibility to service providers. Still, most of the administration is done by the oil and gas companies own resources. It is worth asking if this is better performed by experts on helicopter operations or external companies who can specialize on such activities. Then it could be easier to also come to a solution on the double registration problematics on personnel data. To RQ2, for this process challenge there is still room for improvement.

As to the personnel transportation process and RQ3, cooperations has been started with success as spin-off to the NCS collaboration project.

The overall task for logistics is to deliver quality on time, in a sustainable manner, and avoid delays. The findings and recommendations above are building up on this.

8.1 Further recommendations

As additional remarks, not directly linked to the research questions, but important for future work, the following can be added:

For the digitalization topic and the future Peppol Logistics Domene development, a recommendation for the industry is to be active in the development, put on resources and have an agile approach to the execution so that it comes into production as soon as possible, to avoid a new LogisticsHub case.

It has been 7 years since the Turøy accident, and still only one helicopter type is in operation on the NCS. This is not sustainable for the logistics operations. A recommendation is that the industry join forces through Offshore Norge Aviation forum to work in a common initiative to introduce an additional helicopter type on the NCS.

In the NCS Logistics Collaboration report, it is stated that "Close collaboration between Operators and Logistics Suppliers in different forms, has been key for scoping ambitious and realistic Pilot recommendations". On another occasion than this master thesis, it would be interesting to investigate if the suppliers really was involved sufficiently throughout the whole scoping process, or if the focus was high in the start of the project and then faded along the timeline, then to be taken by surprise when the pilot cases was presented as a finished product.

8.2 Closing remarks

The research questions in this master thesis have been focused on offshore operations and logistics. The offshore industry is in a changing environment. Oil and gas are on decline, and other forms of energy production takes over. The offshore operations will continue anyways, converting to the form of offshore windmills. It is a new type of offshore operations, but it has a lot in common with oil and gas production. You need to supply spare parts, and you need to be able to get personnel offshore to perform maintenance work. This will create a lot of the same challenges that has been discussed in this master thesis. It will be interesting to follow the development of the industry and the growing focus on logistics in the years to come.

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