Master's degree thesis

LOG953

Supply vessels in ensuring resilience within social ecosystems: a case of offshore field project development in the North Sea

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Preface

As the last step in my educational career at the Master's level, my Master's thesis has been the final mission. During the previous two years, I have grown as a person, both professionally and personally, after graduating from Molde University College.
The topic of the Master's thesis is of my personal interest. Foremost, all my respondents have my deepest gratitude that they participated and shared so much of their experience and knowledge with me and the Master's thesis.

I must express gratitude towards my wonderful supervisor Associate Professor Antonina Tsvetkova, for her patience, motivation, enthusiasm, and immense knowledge. Her excellent guidance helped me in the time of research and writing of this Master's thesis.
My family was much important for me in this challenging period of writing this Master's thesis. The unlimited support and faith in my abilities were of great help. I extend gratitude to my late mother, as I know she would have been proud and touched by my accomplishments. I would like to express my special thanks of gratitude to my wonderful friends, who understood me so much and gave me great support throughout the last two years.

Abstract

Supply chain operations are an essential part of the development of offshore oil and gas field projects. These projects are high-risk, and safety is a huge concern for all the actors involved. Emergencies may cause harm to the employees and pollute the natural environment only by one oil spill (Chang et al., 2014, Chiri et al., 2020, Ye et al., 2020). However, oil and gas companies strive to decrease their costs by reducing the number of resources involved (Ranum et al., 2018). This puts into question how oil and gas companies can ensure emergency preparedness by using a limited number of resources. Further, it remains underexplored how oil and gas companies ensure the resilience of these high-risk projects characterized by many possible disruptions and delays in operational performance (Ose et al., 2013, Tsvetkova, 2019).

Being motivated by mentioned above theoretical gaps, this Master's thesis aims to explore how offshore supply chain operations facilitate emergency preparedness and make the development of offshore oil and gas projects resilient on the Norwegian continental shelf. Three research questions have been formulated to make the journey to the overall purpose clearer; (1) What does emergency preparedness mean for offshore project development in the North Sea? (2) What kind of challenges affect offshore supply operations and emergency preparedness in the North Sea? (3) How do offshore supply operations facilitate emergency preparedness in the North Sea?

This Master's thesis is a descriptive exploratory study, which applies a single case study approach. The empirical case presents an offshore ecosystem located in the North Sea that includes an emergency preparedness area in order to serve five offshore projects at once. Data obtained from four semi-structured interviews and archival materials are interpreted through ecosystem and supply chain resilience concepts as theoretical lenses.

The findings have revealed that supply vessels contribute not only to cargo transportation but also to performing value-creating activities such as emergency preparedness operations. The findings have also identified that supply vessels adapt quickly to changes, such as reprioritizing and acting as a key link in facilitating integration between various actors, which are both collaborators and competitors within the offshore ecosystem. Further, it is emphasized that supply vessels actively participate in ensuring offshore oil and gas project development resilience.

In contrast to previous research on offshore operations that primarily focuses on vessel schedules and building theoretical models, this master's thesis is based on a case-study approach with insight into the real practice of offshore operations.

Terms and Definitions

Emergency preparedness - the knowledge, capacities, and organizational systems developed by governments, response and recovery organizations, communities, and individuals effectively to anticipate, respond to, and recover from the impacts of likely, imminent, emerging, or current emergencies

Emergency preparedness supply chain operations - Emergency supply chain operations are thus understood as the transfer and return of emergency resources and the cooperation between emergency operators in the event of an undesirable event

Resilience - Supply chain resilience is the capacity of a supply chain to persist, adapt or transformer in the face of change

Upstream supply chain – the delivery of all necessary products and services for operations to and from the offshore field.

Supply chain management – the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole

Supply Ecosystem - a community of organizations, institution, and individuals that impact the enterprise and the enterprise's customers and supplies

List of Abbreviations

MOB - Man overboard

nm - Nautical miles

NCS - Norwegian Continental shelf

SAR - Search and Rescue

SCM - Supply chain management

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1.0 Introduction

The introduction of this Master's thesis provides an overview of this study. First, the motivation for this study consists of key aspects that have driven the idea of research. Further, the problem statement is addressed with the overall purpose and three research questions. Finally, this chapter ends with an overview of the organization of the Master's thesis.

1.1 Motivation for the study

Supply chain operations are an essential part of the development of offshore oil and gas field projects. These operations primarily consist of the transportation of supplies, personnel, and equipment from the supply base to the offshore installation and returning waste, empty containers, personnel, and equipment no longer in use (Fahimnia et al., 2011, Milaković et al., 2014).

Safety is a huge concern for all the actors involved in the development of offshore oil and gas field projects. Emergencies may cause harm to the employees and pollute the natural environment only by one oil spill (Chang et al., 2014, Chiri et al., 2020, Ye et al., 2020).
There is a common practice on the (NCS) when oil and gas companies organize a single emergency preparedness area. It often includes one standby vessel and one SAR helicopter, which serves the platforms within the emergency preparedness area. As Ranum et al. (2018) revealed, oil and gas companies strive to decrease their costs by reducing the number of resources for emergency preparedness. There seems to be a lack of understanding of how oil and gas companies can ensure emergency preparedness by using a limited number of resources (particularly within a unified emergency preparedness area).

At the same time, offshore oil and gas projects can be viewed as special ecosystems where actors are competitors and collaborators simultaneously (Jacobides et al., 2018). These projects are high-risk and complicated projects where supply chain operations are characterized by a number of challenges such as often bad weather conditions, many actors involved, and frequent changes in operational schedules. A number of researchers have also viewed supply bases as the bottlenecks of the supply chain. They serve multiple shipping companies simultaneously and are the stage in the supply chain where the operations take the longest time. All of these make the planning of supply chain operations time-consuming and complex (Aas et al., 2008b, Vinnem, 2011) and may cause possible disruptions and delays in operational performance. Any delays and disruptions are very costly in these projects and make further development unpredictable. It refers us to resilience in offshore supply chain management (SCM) that is the ability to adapt when disruptions or unexpected events occur. According to Krajewski et al. (2016), SCM connects the actors within the supply chain and directly impacts the overall performance of the actors involved. A number of researchers have also revealed that the actors need to constantly be alert for changes in the operations to ensure supply chain resilience within oil and gas projects (Ose et al., 2013, Tsvetkova, 2019). It means that it takes a lot of time to ensure emergency preparedness and reallocate all the supply resources quickly if an emergency happens. Thus, it remains underexplored how oil and gas companies ensure the resilience of these high-risk projects within ecosystems.

As emphasized by Turkulainen et al. (2017), integrated mechanisms in SCM serve as a tool for companies to collect all the supply chain activities into a single vision to ensure a close working relationship. There is a call in the literature to examine how integrations occur in different contexts, such as upstream supply ecosystems (Turkulainen et al., 2017).

For the last three decades, SCM being explored in various businesses and industries has received little attention in research on offshore oil and gas activities. In addition, there is a lack of knowledge about how actors can ensure that all operations are performed in coherence when there are many delays and actors are both competitors and collaborators within an offshore ecosystem.

1.2 Problem statement

Being motivated by the mentioned above gaps in the literature, this Master's thesis aims ***to explore how offshore supply chain operations facilitate emergency preparedness and make the development of offshore oil and gas projects resilient on the Norwegian continental shelf.***

This master’s thesis applies a single case study approach. The empirical case presents an offshore ecosystem located in the North Sea that includes an emergency preparedness area in order to serve five offshore projects at once. The investigation focuses on the SCM practices within offshore ecosystems, including this emergency preparedness area.

Three research questions have been formulated to make the empirical case presentation more understandable and the journey to the overall purpose clearer.

Offshore operations constitute a considerable risk for both the employees on board the platforms and the surrounding environment. As offshore activities are complicated projects, they can cause many different emergencies like an oil spill, collision between supply vessels and the platform, fire, and outbreaks of Covid-19 virus cases (Vinnem, 2011). Vinnem et al. (2010) have emphasized that the platforms need to be self-sufficient with everything they need in case of an emergency and predict possible emergencies because of the remoteness of the platforms. It looks like oil and gas companies should have a good plan for handling an incident at installations as time is crusial to reduce the consequences of an emergency. With this in mind, the first research question is

RQ 1: ***What does emergency preparedness mean for offshore project development in the North Sea?***

In the North Sea, the oil and gas installations are located far away from the supply base, making them resource-dependent if an emergency happens (Vinnem, 2011). This derives due to a number of challenges, such as long distances and weather conditions (Mujeeb-Ahmed and Paik, 2021, Sætrevik et al., 2018). At the same time, when we talk about offshore ecosystems that involve a uniform emergency preparedness area to serve several platforms at once, we can expect some new challenges and factors that affect offshore supply chain operations and oil and gas activities. Here comes the next research question:

RQ 2: ***What kind of challenges affect offshore supply operations and emergency preparedness in the North Sea?***

Aas et al. (2008b) argue that the offshore oil and gas industry has wide experience and deep knowledge that has not been shared with the academic world. In the middle of the 2000s, the Norwegian government suggested a guideline according to which oil and gas companies could choose if they engage only one standby vessel to serve several installations. Each project had to have its own standby vessel. While this guideline is not a strict norm but voluntary, it looks like oil and gas companies can organize emergency preparedness in a proper way by using a limited number of resources (Ranum et al., 2018). It seems there is a lack of understanding of how oil and gas ensure emergency preparedness by using a limited number of resources. Several researchers have emphasized the role of supply chain operators in this. It comes to the third research question:

RQ 3: ***How do offshore supply operations facilitate emergency preparedness in the North Sea?***

1.3 Organization of the Master's thesis

This master thesis consists of eight chapters:

Chapter 1 – presents an overview of the motivation of this master's thesis and the overall purpose and the connecting research questions that serve as a roadmap to reach the destination of this master's thesis.

Chapter 2 - presents an overview of the state-of-the-art knowledge in the literature on the upstream supply chain in the oil and gas industry and emergency preparedness and its aspects within the supply chain and the resources involved in the preparedness operations.

Chapter 3 – announces the theoretical framework of this master's thesis, which focuses on the ecosystem within the supply chain and supply chain resilience

Chapter 4 –gives an overview of the methodology used in this master's thesis, including; the philosophical position, research design, data collection, and analysis. In addition, to the quality of the research and its ethical consideration.

Chapter 5 – presents the context description for this aster's thesis, which consists of the development of offshore oil and gas projects on the (NCS). Including history on the emergency preparedness area and the guidelines given by the Norwegian government on how to operate safely within the area.

Chapter 6 – presents the empirical findings from the research, where quotes from the conducted interviews will be used to support the overall findings and connect the ecosystem and its many actors.

Chapter 7 – presents the discussion of the empirical findings and whether or not they support or disproves previous research and theories.

Chapter 8 – presents an overview of the concluding results from the discussion and will include what implementation in practice and theory this research is providing. The outline will end with the limitation of this master's thesis and suggestions for future research.

2.0 Literature Review

This chapter acknowledges the main concepts for this master's thesis, including SCM, upstream supply chain operations, emergency preparedness, offshore resources, and supply chain resilience. This literature review pays attention to the state-of-the-art knowledge in the literature on the above concepts to identify theoretical gaps on what remains unexplored.

2.1 Supply Chain Management

For the last four decades, extensive research has been done on the term SCM. The focus in the increasingly voluminous literature on SCM is aimed at meaning-making of SCM's core. SCM serves as a tool for companies to collect all the activities in the supply chain into a single vision(Storey et al., 2006).

Cooper et al. (1997, p. 2) have determined SCM as:

> *"the integration of business processes from end-user through original suppliers that provide products services and information that add value for customers"*

According to Mentzer et al. (2001, p. 6) SCM can be veiwed as:

> *"the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole"*

It is worth presenting one more definition provided by Krajewski et al. (2016, p. 640):

> *"The synchronization of firm's process with those of its supplier and customer to match the flow of materials, service and information with customer demand"*

All of the three definitions of SCM have some elements of similarity. They view SCM as an aid to control the process flow the whole way from raw material to finished product at the end-user.

An integrated mechanism within SCM practice is essential to connect the supply chain systems. SCM integration mechanisms are a great feature that connects the network of actors into a closer working relationship, where the goal is to improve the response time and reduce costs and amount of waste (Krajewski et al., 2016, Storey et al., 2006).

Turkulainen et al. (2017) refer to integration in the supply chain as the degree of collaboration and coordination between the actors involved both inside and outside of a company's boundaries to create value for the customers and stakeholders.
Several research has called for more research about integrated mechanisms to develop a deeper understanding of integration. Research needs to move beyond efficiency and need to examine the context in how and where integrations occur (Turkulainen et al., 2017).

2.2 Upstream supply chain operations

Offshore supply chain operations are built together through a logistics system, which is a network of involved organizations, people, activities, information, and resources in the process flow of products and services from supplier to the customers. Further, supply chain operations consist of the structure and processes needed to plan and execute the flow of goods (Fahimnia et al., 2011). Offshore supply chain operations include different actors such as the supply bases, oil and gas platforms, oil companies as operators, shipping companies, and employees onboard vessels and offshore platforms.

SCM of offshore supply chain operations are divided into -upstream and downstream. Milaković et al. (2014) and (Aas et al., 2008b) have defined upstream supply chain as delivery of all necessary products and services for operations to and from the offshore field. A downstream supply chain involves the activities which aim to bring the oil and gas out to the customers (Aas et al., 2008b). This master's thesis focuses only on upstream supply chain operations.

Figure 1 shows the three main stages in the offshore upstream supply chain; supply base, offshore support vessels, and the offshore oil and gas installations. The offshore support vessels serve as a connecting link between the onshore supply base and the offshore installations. Within the offshore upstream supply chain, cargo transportation and services to offshore fields are generally done using offshore supply vessels.

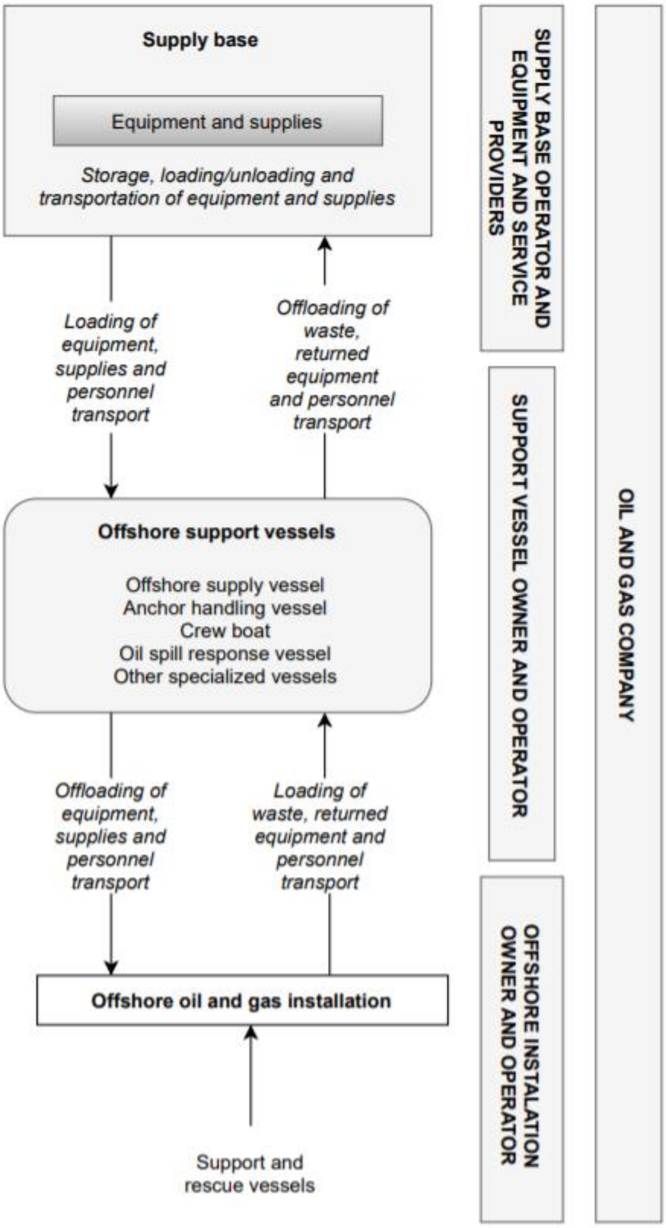

Figure 1: Overview of an offshore upstream supply chain (Adapted from Milaković et al. 2014)

Illustrated in Figure 1, there are equipment and supplies at the supply base, and these supplies are stored and transported to the loading/offloading area of the base. The supply base is located onshore for practical reasons as it is connected to the onshore infrastructure. The actors involved in this phase are the supply base operator and the provider of service, goods, and equipment. The next stage of the supply chain is offshore support vessels, which consist of different vessels such as offshore supply vessels, anchor handling vessels, crew boats, oil spill response vessels, and other vessels with specializations. The main activities that take place between the supply base and the offshore supply vessels are the loading of equipment, supplies, and personnel from the supply base. And offloading of waste, returned equipment and returned personnel from the offshore supply vessels. The actors involved in offshore support vessels are the owners of the vessels and operators of them. The next stages are the offshore oil and gas installation; the operations here are much similar to the operations between supply base and offshore supply vessels. The vessels loading off equipment, supply, and personnel from the base, and returning vessels are loaded with waste, equipment, and returning personnel. Also, offshore installations have ongoing operations of support and rescue vessels close by. The actors involved in these activities are the owner of the offshore installation and its operators.

For the last decades, a number of researchers have emphasized the role of supply vessels in upstream operations. Some contributions are the research of Aas et al. (2008b), which provides an insight into how to plan upstream supply chain operations. With great attention to offshore supply vessels and their role in the supply chain as a means of transportation. Aas et al. (2008a) address possible outsourcing of upstream operation activities and base their discussion on a case from the Norwegian oil and gas industry where the relationship and collaboration between operations could become a challenge with the involvement of a third-party operator.

Most previous research has focused on routing problems and scheduling problems for offshore supply vessels, rather than emphasize the role of the supply vessels (Ozdamar et al., 2004, Aas et al., 2008b, Kaiser, 2010, Halvorsen-Weare et al., 2013, Cuesta et al., 2017, Alehashemi and Hajiyakhchali, 2018, Amiri et al., 2019). However, a few research studies have emphasized the role of supply vessels in implementing offshore activities (Tsvetkova, 2019, Aas et al., 2008b). Kaiser (2010) has recognized a special value provided by maritime transportation of goods and services within the offshore upstream supply chain system as the offshore supply chain system plays a connecting role between the supply base and offshore installation. With a notable focus on optimization and efficiency, (Tsvetkova, 2019, Borch and Batalden, 2014, Milaković et al., 2014) all address this value.

Further, Brachner and Hvattum (2017) focus on personnel transport with helicopters after a series of emergencies. Moreover, they provide insight into the operations helicopter are a part of and possible threats they face when operating, such as wind and poor visibility. Brachner and Hvattum (2017) address the importance of the helicopters' operations regarding safe personnel transport to and from the offshore installation and the onshore supply base. In addition to the importance-performance helicopter carries out during rescue.

The offshore installations have little storage available and are therefore dependent on frequent delivery of cargo to keep up the production. A challenge repeated in the literature is the weather; it is addressed by (Aas et al., 2008b, Vinnem, 2011, Milaković et al., 2014, Borch and Batalden, 2014). The temperature, degree of wind, wave height, light could all interferes with the speed of the supply vessels or delays in operations such as loading/offloading at the offshore installation. Aas et al. (2007) point out that it is not uncommon that the demand for delivery and pickups can be changed on very short notice due to unexpected events. If such events occur, the fixed schedule is not always possible to follow, as the remoteness of the installations in the North Sea gives a long sailing time when the lead time needs to be short to satisfy the new delivery/pickup demand. There are numerous researches on delays in offshore operations (Norlund et al., 2015, Kisialiou et al., 2018, Vieira et al., 2021).

Offshore operations come with high risk for human safety, assets, and the environment. For example, loading/offloading operations at offshore installations impose high risks on human safety and assets as it is a critical operation where the supply vessel and the offshore installation are particularly close to each other. Such closeness combined with strong wind or strong waves could put the vessel or the assets on a collision course (Abdussamie et al., 2018). Abdussamie et al. (2018) contribute in their research towards the development of the current guidelines for offshore operations.

There are some areas of future research. The increased use of integrated operation is an ongoing topic; Brachner and Hvattum (2017), Aas et al. (2008b) where a more thorough insight into which operations are involved. Moreover, the formal logistics knowledge in oil companies on the (NCS) is rather low, so Aas et al. (2008b) suggest more research concerning elements in the upstream chain and their interactions.

2.3 Offshore resources

Offshore resources involved in offshore supply chain operations are helicopters and supply vessels. Helicopters are parsley involved with personnel transport and the transport of some cargo, but at the same time, they are involved in urgent orders.

According to Ozdamar (2011), research on helicopter mission planning is quite limited, despite that helicopters are used in a wide range of crew exchanges among offshore oil platforms, medical emergencies, and disaster relief. In recent years not many changes have been made to the offshore oil and gas emergency preparedness compare to the changes done in the last decades. Vinnem (2011) emphasizes the huge improvement the SAR helicopter has made for offshore emergency preparedness. SAR helicopters can carry medical evacuation supplies to ensure treatment during the transport from offshore installation to onshore hospitals to increase the patient's chance of survival, which has improved the patient's care as it starts already in the transport back to shore. However, (Brachner and Hvattum, 2017) emphasize that helicopter transportation is highly dangerous. There have been recorded multiple accidents under offshore personnel transport with several fatalities.

SAR-helicopters have the capacity to board only 21 people within 120 minutes; see Figure 2. If the offshore installations are further away than 86 nm from the closest SAR-helicopter, emergency preparedness is ensured by implementing one or more of the following measures; reduction in the passenger capacity, assistance from several SAR helicopters, assistance from emergency vessels, or assistance from MOB preparedness (Ranum et al., 2018).

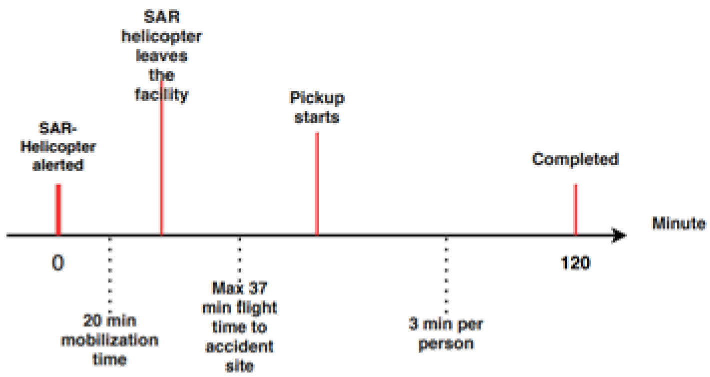

Figure 2 SAR helicopter coverage area. (Adopted from Ranum et al., 2018)

Offshore oil and gas installations need to be supplied frequently to ensure continuous oil and gas production. The only way to supply the installations is by using supply vessels. The importance of these vessels shows in cost as they are a huge financial burden. Aas et al. (2008b) state that they represent one of the largest cost elements in the upstream supply chain of oil and gas installations. Thus, the oil and gas companies usually rent the supply vessels, but they are still responsible for scheduling and routing.

The feature of the supply vessel is decided by the location of the offshore activity, weather condition, the amount of supply needed, and the distance from the supply base. Anyhow, a supply vessel is becoming more and more a multitask vessel and is expected to be designed for many different purposes, which have resulted in a choice to determine whether or not the design should be based on the economy of scale (in terms of size) or economy of scope (specialization) (Aas et al., 2008b).

Aas et al. (2008b) address the main supply chain features of a supply vessel to be carrying capacity, sailing capacity, and loading/unloading capability. Arguably, these features are the main ones, but as supply vessels also have multifunctionality, they are involved in different activities and contribute to emergency preparedness. They are given more features associated with an emergency vessel and have the capacity to host around three hundred persons at any time (Tsvetkova, 2019).

Future research is needed for more empirical research on vessel technology and equipment needed for the specialization of offshore supply vessels and multi-functionality. Therefore, future research may focus on extending the knowledge about how these capabilities of offshore supply vessels contribute to value-creating activities in offshore projects. And how supply vessels can ensure the resilience of offshore operations to respond to contextual challenges and mitigate the possibility of unforeseen situations and emergencies (Ose et al., 2013, Brachner and Hvattum, 2017, Tsvetkova, 2019). Tsvetkova (2019) addresses that the resources in the offshore emergency preparedness area and their supply chain operations have been recognized in providing extra support regarding safety at sea, which has shown to be favorable for marine logistics.

It looks like that the supply vessels have multiple functions, not only in cargo transportation but are also in other value-creating activities. There is a lack of research on how supply vessels can serve in cargo transportation and be involved in emergency preparedness, and this will be explored in this investigation.

2.4 Emergency preparedness

Emergency preparedness has been defined in the literature by WHO (2017, p. 14) as:

> *"the knowledge, capacities and organizational systems developed by governments, response and recovery organizations, communities and individuals effectively to anticipate, respond to, and recover from the impacts of likely, imminent, emerging, or current emergencies"*

It has also been highlighted by Hammervoll (2014, p 27.) as:

> *"the measures taken to limit the consequences of incidents that could lead to a major accident."*

Moreover, Fakhur'l-Razi (2008) addresses emergency as an intense period with a high level of urgency. It is bound to this period where lives and essential property are at immediate risk. Fakhur'l-Razi (2008) also defines a major emergency as one that can cause severe injury or loss of life and/or cause comprehensive property damage.

As the definition of Hammervoll (2014) mention the term major accident, put in context for offshore oil and gas operations Vinnem (2011) has defined major accidents in the offshore industry as an event which is out of control and has the potential to cause five fatalities or more.

Oil and gas installations in the North Sea are large with populations of several hundred and often fare from shore in semi-deep and deep water. Vinnem (2011) emphasizes that these

installations need to be fully self-sufficient concerning being prepared for all types of emergencies. The harsh environmental condition in the North Sea and the remoteness of the installations cause long response times. Relying on outside emergency services to assist could result in higher consequences of the emergency because of the time used by the outside emergency services to reach the site.
In the Norwegian oil and gas sector, three areas have an extensive cooperation scheme for emergency preparedness; this cooperation is called area-based emergency preparedness. Area-based preparedness involves cooperation between installation in the area and usual marine resources, as shown in Figure 1. Which frequently incorporate an all-weather SAR helicopter and traffic center for surveillance towards passing vessel on a possible collision course (Vinnem, 2011). For the emergency preparedness area, the Norwegian government has established guidelines for the operators operating within site. It is important to emphasize that only guidelines are established, so the operators in the emergency preparedness area may make some changes they see fit.

Rahman et al. (2021) introduce the economics of a new suggestion to improve offshore oil and gas emergency preparedness. The concept of an intermediate offshore resource center to exist as an intermediary between offshore installations and onshore support can be reassuring for the operators operating far away offshore. The main goal for an intermediate offshore resource center, as Rahman et al. (2021) address, is to provide an intermediate helicopter landing station and be an onward staging area for emergency response. Besides, it reduces the response time in emergencies by reducing the logistical risk with the significant distance from shore. Rahman et al. (2021) point out the cost of such an installation as a risk reduction strategy and point out that the cost will only be a fraction of the total cost of remote offshore developments.

Consequences of any emergency that takes place offshore can resolve damage to the environment and the involved workers. An oil spill impacts marine wildlife, human health, and society (Chang et al., 2014, Chiri et al., 2020). The impact on the marine ecosystem relates to both the injury and the recovery from the oil spill. The marine wildlife is structured in complex ways by many interacting species, and the impact will affect each of them differently. The number of different toxicity pathways in species is myriad; the oil could be ingested, accumulate contaminants in tissues, DNA damages, mass mortality of eggs and larvae, and vapor inhalation (Chang et al., 2014).

Furthermore, Chang et al. (2014) address the societal impact; an oil spill can affect human society in three major ways. First, oil can affect ecological processes and therefore cause direct harm through eating seafood with oil toxins. Second, an oil spill can affect the economics of fishers because of the impact on the fish. Last, the vapor from the oil spill can cause direct harm to humans through inhaling the vapor. Moreover, as Pula et al. (2006) address, there is a chance of fire from any leakage or spillage of flammable material where only a spark can trigger a fire. Explosions are also a possibility because of gas and vapor on the offshore installations. There is no doubt that such an event can harm the workers at the installations and have the possibility of causing harm to the environment because of emissions.

Robustness is a challenge Vinnem (2011) addresses, especially within area-based emergency preparedness. Vinnem (2011) points out this cooperation has removed individual standby vessels for each installation within the area, which can consequently result in a reduction in the emergency preparedness for the given area or at each installation. On the contrary, the perceived quality of emergency preparedness has improved continuously throughout the period after the introduction of area-based emergency preparedness.

Vinnem (2011) emphasizes that the emergency preparedness level should be maintained high, but how to maintain a high emergency preparedness level is unexplored (Deacon et al., 2010, Vinnem, 2011, Pedersen and Ahsan, 2020). It seems like there is a limited understanding of how area-based emergency preparedness is organized with respect to what is a real and perceived risk in emergency preparedness, how to operate a helicopter rescue cluster, and the organization of standby vessels.

2.5 Emergency supply chain operations

Several previous research has highlighted that there are no explicit definition of emergency preparedness supply chain operations yet (Hammervoll, 2014, Sheu, 2007). The literature mostly uses the term emergency logistics. This master's thesis focuses on different SCM practices within the offshore ecosystem. Therefore, SCM and supply chains are used instead of logistics terms. There is increased attention to emergencies within SCM and logistic studies (Hammervoll, 2014).

However, Sheu (2007, p. 655) has used the definition of the term business logistics to clarify meaning for emergency supply chain operations:

> *"A process of planning, management and controlling the efficient flow of relief, information, and services form the points of origin to the points of destination to meet the urgent need of the affected people under emergency conditions.*"

Hammervoll (2014) has defined the term emergency supply chain operations as slightly different than Sheu (2007). If a rescue helicopter or similar does not arrive on time, the logistics have failed. It is the responsibility of the emergency response logistics to bring about an operational collaboration so the emergency response network can carry the emergency response resources where they are needed and in time. Hammervoll (2014) addresses such an emergency response network as collaboration with three or more emergency actors. Thus, Hammervoll (2014, p.51) defines emergency supply chain operations as;

> *"Emergency supply chain operations is thus understood as the transfer and return of emergency resources and the cooperation between emergency operators in the event of an undesirable event."*

The term business logistics has been known much longer than the term emergency logistic. It has been defined in literature by many authors with small differences; Sheu (2007, p.655) use the definition:

> *"Logistics is the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption to conform customer requirements at the lowest cost."*

The above definition does not fully correspond with the nature of emergency logistics. Therefore the alteration business logistics definition of Sheu (2007) gives the term emergency supply chain operations a clearer label and separates it from business logistics. Hammervoll (2014) further describes emergency supply chain operations as a process consisting of dispatch and return of emergency resources with professionals using the resources on a scene of an accident. Response time is the most important factor.

Sheu (2007) has argued that the management of resources, unlike business logistics where operational resources are known (containers, servers, modes) and easily controllable to suppliers. Emergency supply chain operations have corresponding resources from both the public and private sectors, making the operational environment uncertain as they need to communicate across companies. Hammervoll (2014) has a different approach to the matter; the degree of cooperation says nothing about the more cooperation, the better. Or that the more the emergency preparedness operators work closely together, the better the cooperation. The interactions could be minor, a lot, or something in between. Hammervoll (2014) clarifies that a perfect collaboration can mean that the emergency response operators have little contact with each other, while other times, it is required that they work closely together. Hammervoll (2014) further clarified the success of the dispatch and return of emergency recourses as to which extend the appropriate emergency resources arrive at the scene of the accident, at the right time, in the right quantity, in the right condition and at the right cost. After an incident where emergency resources are needed, an incident rapport is made where the aftermath will show if the supply chain operations failed or if it was just as it was planned to be.

Offshore preparedness planning was traditionally driven by the response time, with time supply chain concepts and terminologies have found their way into emergency preparedness (Brachner and Hvattum, 2017). Supply chain operations are providing the offshore installations with supplies, but it is also responsible for the second line emergency response. This means evacuation of personnel when needed and taking the responsibility to create a satisfactory emergency preparedness on the other installations in the area if an emergency occurs (Ose et al., 2013).

Rahman et al. (2020) emphasize some critical phases of emergency supply chain operations, such as promptness or vessel reaching the site on time and on-site operations.

Promptness depends on the distance of the site, vessel readiness, uninterrupted vessel transit, and existing physical environments. There should be a focus on overcoming the challenges of supply chain operation associated with remoteness and onboard operations as these are factors that can, to a certain extent, be controlled, in contrast to weather.

Brachner and Hvattum (2017) have shown a mutual dependence between operations and preparedness. Their problem combines a cooperative cover location problem with a routing problem, with the objective to minimize the total route distance. The chosen routes determine the demand, in contrast to the classical problems where the demand is given. In their problem, several rescue units can collaborate to conduct the operation, to rescue a person in the sea faster. If both operations and emergency preparedness are planned jointly, it opens the opportunity to bundle demand, the routes which have been determined. Brachner and Hvattum (2017) specify, it is useful in environments with sparse infrastructure and long distances, as their research shows that resources could be used more efficiently this way. To bundle routes by choosing a common onshore base or using routes that are close to each other, which give the rescue units the possibility to cover several routes simultaneously.

Supply chain aspects have been academically explored for decades in other industries but are comparably new in the offshore oil and gas industry. It is fair to assume that the offshore oil and gas industry has a lot of knowledge that is not shared with the academic world (Aas et al., 2008b). A huge limitation on how emergency supply chain operations operate is the available data. Since unfortunately, the data used in research on emergency preparedness and emergency supply chain operations are data from actual accidents with different levels of urgency and assistance. An agreement in the academic world (Balcik, 2008, Vinnem, 2011, Pedersen and Ahsan, 2020, Rahman et al., 2021) is that further improvement or research could be possible if more data were available. However, more emergencies should not occur, despite their value for further studies. This lack of experience data makes it hard to do thorough research on emergency operations and how different instances react. It is, however, for the best for the involved parties in the industry that it stays this way.

Marine surveillance services are an important resource within emergency supply chain operations. This service is an all-day, every day throughout the year service with the important task in their hands. Some of the tasks marine surveillance services provide are radar monitoring of fields and facilities' safety zones, maintaining oil spill detection, and observations of oil at sea using satellite. In addition to performing the role of operation section chief for second-line emergency preparedness. Also, it coordinates and optimizes the use of guard and area emergency response vessels and assess and decides on short-term needs for additional vessels. Moreover, maintain internal and external notification of unwanted incidents offshore, create and follow up the sailing plan for vessels and allocation, coordination, and optimization of supply and storage vessels (Ranum et al., 2018).

In every emergency preparedness area, there is a need for a standby vessel. Such a vessel is designed, organized, equipped, and maintained in such a way that it might carry out rapid evacuation assistance in the event of an emergency. They are multipurpose vessels equipped to prevent dangers to personnel and the environment. They are equipped with firefighting systems, oil recovery equipment, solutions for the intake of lifeboats, hospitals, and remotely operated vehicles (Ranum et al., 2018).

Another emergency resources are MOB boats. They must be able to pick up a person who falls into the sea up within eight minutes after the incident, so the respective resources in the area should implement it. A standard MOB boat has the capacity to carry 15 persons.
The use of emergency vessels to take care of the MOB-preparedness has declined over the last decade. Partly due to that, the area preparedness vessel cannot leave its starting position for reasons of response time. If the distance between the devices on the field is large, the response time is long for some vessels if the area preparedness vessel is to be nearby on the opposite side of the field (Ranum et al., 2018).

Further research in this area could be how to distinguish effective relief from ineffective relief (Balcik, 2008, Feng et al., 2019, Rahman et al., 2019). Whenever the support arrives on time and why are essential for the emergency supply chain operations, and as mention above by Hammervoll (2014), the emergency operations have failed if the support does not arrive when it is planned to arrive.

There seems to be a lack of understanding of how it is possible for oil and gas companies to ensure emergency preparedness by using a limited number of resources (particularly within a unified emergency preparedness area) (Vinnem, 2011, Chiri et al., 2020)
Furthermore, Sheu (2007) is suggesting further research on emergency supply chain resource allocation, which focuses on how to distribute the emergency resources, in this case, maritime vessels and helicopters. Lastly, more data from offshore personnel, ship captains, or academicians are favorable to collect to expand the scope of understanding, suggested by Rahman et al. (2019). Moreover, there seems to be a lack of understanding of how it is possible to ensure that all operations are performed when there are so many delays and actors are both competitors and collaborators within the offshore ecosystem (Hannah and Eisenhardt, 2018).

3.0 Theoretical framework

This chapter acknowledges ecosystems within supply chains as the theoretical framework for this master's thesis. And will describe the theory behind the connections between actors involved in the offshore supply chain to explain who they operate together in a coherent where they are both collaborate and compete simultaneously. This chapter will also elaborate on SCM resilience and its essential role in supply chain operations.

3.1 Offshore ecosystems

In the SCM research, the concept of ecosystems as a structure of economic relationships and competitive environments is quite new in the literature. The term ecosystem has been presented in biological science. Recently, this term has started to be used in other fields. Teece (2007, p.1325) has determined an ecosystem as:

"community of organizations, institution, and individuals that impact the enterprise and the enterprise's customers and supplies"

Moreover, Jacobides et al. (2018, p.2264) has viewed the term ecosystem as:

"an ecosystem is a set of actors with vary degrees of multilateral, nongeneric complementarities that are not fully hierarchically controlled"

Jacobides et al. (2018) definition is built by using the definition from Teece (2007), so there are some similarities in the above definitions, but they are also focusing on different aspects of the term. This master’s thesis will focus on the ecosystem within the oil and gas industry and consider how actors are organized around platforms.

Håkansson and Persson (2004) address three trends in SCM: one about activities across firm boundaries, a second about the appearance of strongly specialized actors within the supply chain, and the third about innovation and change. The first trend aims to reduce costs, such as inventory cost, handling cost, and reduce throughput time for the product. In the second tend, companies have often outsourced activities to ensure specialization of the activities they continue to conduct. In the third trend, companies realized that the rate of product change increases and the need for agility to be able to respond to market changes are necessary. Håkansson and Persson (2004) also suggest a different look at the economic importance of interdependence between actors in the same supply chain and how they determine the priorities of the use of resources in pursuing the economies involved for different companies. Thus, there seems to be a lack of understanding of how the actors involved in the ecosystem are coherent (Jacobides et al., 2018, Wamsler et al., 2016, Adner, 2017).

Actors involved in the same ecosystem are coherent and adapting to the operations performed by other actors in the system. In such adaptation, the actors involved seem to both cooperate and compete. Hannah and Eisenhardt (2018) identify three strategies with a balance of cooperation and competition. First, the bottleneck strategy, where the actors cooperate and compete in the ecosystem and compete with rival ecosystems. Second, the component strategy where actors cooperate in the ecosystem and compete with rival actors and ecosystems. Third, the system strategy where the ecosystems compete with rival ecosystems. Hannah and Eisenhardt (2018) highlight that each of the strategies brings firm growth. Anyhow, there is still much to learn about how the actors involved in the offshore ecosystem are both cooperative and competitive at the same time (Hannah and Eisenhardt, 2018, Wamsler et al., 2016, Adner, 2017).

Ritala et al. (2013) and Adner (2017) view an ecosystem in context to a cluster of businesses that aims to create and capture value from innovative activities. In this context, Ritala et al. (2013) define value-creating activities as the collaborative process and activities of creating value for customers and other stakeholders. And refer to value capture as the individual firm-level actualized profit. This is how firms pursue to ensure competitive advantages and secure related profit. However, there seems to be a lack of understanding of how value-creating and value capture activities coexist within the ecosystems.

3.2 Resilience in supply chain and operations management

Wieland and Durach (2021) highlight that supply chain resilience is one of the essential aspects of the functioning of supply chains. In production, resilience in the supply chain corresponds to their ability to adapt when changes occur, which could affect the level of performance satisfaction. This ability depends on the contributions of all the members of the supply chain and their overall performance (Wlendahl et al., 2003). Wieland and Durach (2021, p.2) define supply chain resilience as follows:

> "*Supply chain resilience is the capacity of a supply chain to persist, adapt or transformer in the face of change*"

When looking at supply chain resilience, the term risk management is often set up against each other. Ho et al. (2015, p.44) address multiple definitions, one defining risk management as:

> *"The identification and management of risks within the supply network and externally through a coordinated approach amongst supply chain members to reduce supply chain vulnerability as a whole"*

To avoid downtime of production, it needs to be resilient, but it is easier said than done. A huge challenge following resilience is anticipation, which means that the logistic department needs to be constantly alert for every possible hazard (Ose et al., 2013, Tsvetkova, 2019). This is not realistic in practice; an event that was not anticipated could occur but, the logistic department must deal with it to the best of their ability.

On supply chain resilience Wieland and Durach (2021) address two perspectives, engineering resilience and social-ecological resilience. The perspectives are built on the idea that resilience relates to both the ability of a system to bounce back after an event and the capacity to adapt and transform and not in terms of stability. Engineering resilience strives for optimality and fail-safe design, but social-ecological resilience extends towards experiments and a fail-safe design.

Pettit et al. (2010) highlight four principles that can create supply chain resilience. The first being that in advance of a disruption, resilience is actively built into a system within the supply chain. Second, a higher level of collaboration within the chain is an important aspect of identifying and managing risks. Third, to have agility, which is essential to react quickly. Fourth, to have a culture of risk management.
Furthermore, it seems that in the literature, resilience and risk management are often looked upon as you either have one or the other, but both Pettit et al. (2019) and Pettit et al. (2010) are addressing supply chain resilience as an enhancement to risk management, not a replacement for it.

Hollnagel (2015) highlights that a system cannot be resilient, but it can have the potential for resilient performance. Furthermore, it addresses four abilities that are necessary for resilience performance proposed by Resilience engineering. Which is the ability to respond, monitor, learn and anticipate. According to Resilience engineering, these abilities are absolutely necessary for the system to have a resilient performance.

Further, Azadegan and Dooley (2021) address resilience strategies but from three different network-level perspectives. They are micro-, macro-and meso-level resilience. Micro-level resilience occurs when buyers and suppliers work directly together on supply risk preventing and recovery. Macro-level resilience happens when corporations include competitors and collaborate to regulate long-term supply risks. Last, meso-level resilience emerges when several supply networks work together on short and medium-term supply risks.

There are several calls for exploring how to ensure the resilience of offshore operations to respond to contextual challenges (Ose et al., 2013, Tsvetkova, 2019). This kind of knowledge allows us to fill in a theoretical gap about uncertainties and risks related to offshore oil and gas projects. Tsvetkova (2019) and (Ose et al., 2013) emphasize a lack of research and suggestion further research on how to ensure the resilience of offshore operations to respond to contextual challenges, and not to forget mitigating the possibility of unforeseen events and possible emergencies.

4.0 Methodology

The methodology is describing the whole process of how the research conducts research, every step from gathering and processing relevant information and data to answering the research purpose (Johannessen et al., 2011). The purpose of this chapter is to provide deeper insights into what kind of methods, tools, and techniques were applied to reach the overall purpose. It describes philosophical views, the strategies for research design, and case study. Further, the chapter will provide insight into how empirical data were collected and the quality of the research.

4.1 Philosophical position

Scientific research philosophy plays a vital role as it is a system of the researcher's thought, following which new, reliable knowledge about the research phenomenon is obtained. There are two primary philosophical positions underpinning social science research: positivism and interpretivism.

Research studies on positivistic assumptions use methods similar to those of the natural sciences to understand society. In the social sciences, positivism is often characterized by quantitative approaches, which usually test hypotheses. Interpretivism, which also goes under the name social constructivism or anti-positivism, believes those social phenomena come from social actors concerned with their lives' perceptions and consequent actions (Saunders et al., 2019). Interpretivism believes further that the looked upon reality is socially constructed based on human senses (Alharthi and Rehman, 2016). Consequently, interpretivism rejects "all permanent and unvarying requirements by which reality can be universally understood" (Guba and Lincoln 2005, p. 204).

Interpretivism could be further explained as the worldview where individuals attempt to understand the world in which they live and work.

Creswell (2014) highlights that the studies built on the assumptions of interpretivism use the views, ideas, and experiences of respondents. As a result, interpretivists usually use qualitative research methods, such as ethnographic fieldwork and open-ended interviews.

The different views on reality in epistemological and ontological assumptions, both paradigms positivism and social constructivism, highlight the differences.

4.2 Research design

Research design is the framework provided for collecting data and analyzing it. The research method and was the chosen technique for data collection (Befring, 2016). When conducting research, there are three types of strategy to choose of, either quantitative, qualitative, or a combination of both. While a qualitative approach focuses on social phenomena, a quantitative approach is theory-based with objective measurements, figures, and statistics (Befring, 2016).

This master's thesis applies qualitative investigation. This approach is beneficial because it can provide insights that are specific to an industry which will be helpful in this thesis to reach the research questions. The process itself is open-ended, so there is no "right" or "wrong" answer, which makes data collection much easier. Statistics are useful in the way they can be used to identify trends, but this approach incorporates the human experience as it should not be ignored. Further, it has a great level of flexibility as the respondents may follow up on any answer they wish to give more in-depth answers. This method does not require a specific pattern or format for data collection. The process used can be changed immediately.

It is important to be aware of the disadvantage of this approach as well, to know its weaknesses. The approach is not a statistically representative form of data collection. It only provides research data from perspectives. It relies heavily upon the experience of the researcher. The researcher needs to have good interview skills, be able to ask follow-up questions, and so on. With such an approach, it can be difficult to replicate results, and the respondents may change their perspective daily. The reason why a qualitative approach was used and not a quantitative approach was because of the nature of the research. Quantitative research uses randomized samples, which would make it extremely hard to reach the research questions as there is a need for respondents who has knowledge about the phenomena. And the research would have needed a much larger sample of respondents to conduct thorough research than with qualitative, where more information is collected from each respondent. Further, a quantitative approach does not consider the meaning behind social phenomena, which in this thesis is necessary.

This master's thesis is a descriptive exploratory study. The descriptive approach is used to describe the characteristics of the phenomenon studied, which gives a helping hand to answer the research question. The explorative approach was used to investigate and give insights into the research questions. This approach made it possible to answer the research questions as such an approach is usually used to clarify the exact nature of the problem which the research aims to solve (Befring, 2016). Qualitative research is primarily exploratory. These two go hand in hand to gain an understanding of underlying reasons. However, as exploratory research is often conducted to gain a better understanding of the existing problem, it does not always lead to a conclusive result (Befring, 2016).

4.3 Case study

This master's thesis applies a single case study approach. This approach was used to generate an in-depth understanding. The benefits of using a single case study approach are the ability to being able to close in on real-life situations. Also, it has the advantage of letting the researcher test views directly in relation to the phenomena as they unfold in practice.

This was a great advantage for this thesis as some situations in the literature do not always reflect what was done in practice. Furthermore, this research design was suitable to use to answer the research questions because they are formulated in such a way that they aim to explain a current situation (Befring, 2016).

Even though case studies have some advantages, it is important to be aware of the disadvantages of this approach. Single case studies have been known to have many disadvantages, which could make the result of the study not reliable. Flyvbjerg (2006) addresses five misunderstandings of the use of case study in researches and are correct all of these misunderstandings one by one.

The first one being that practical knowledge is less valuable than theoretical knowledge. As predictive theories are not found in the study of human affairs, concrete and context depended knowledge could be seen as more valuable knowledge. Therefore, it was not right to stand firm on that theoretical knowledge was the most valuable knowledge. Second, it is not possible to generalize from a single case, which means that the single case study is not contributing to scientific development. Flyvbjerg (2006) emphasizes that it is possible to generalize based on a single case. It depends, however, on the case and how it was chosen. When it comes to scientific development case study could be central by using generalization as an alternative to another method. For the third, a case study was most useful to create hypotheses, and other methods are more suitable for testing hypotheses. It derives from the second misunderstanding that one cannot generalize based on a single case study. As the second misunderstanding is altered, Flyvbjerg (2006) also corrects the third: a case study was most useful to create hypotheses, other methods are more suitable for testing hypotheses. Flyvbjerg (2006) concludes that the case study was useful for testing hypotheses. The fourth, the case study, contains a bias toward verification. Flyvbjerg (2006) emphasizes that the case study did not consist of more bias toward verification than other methods of inquiry and was revised the fourth misunderstanding. And the last fifth, it was often difficult to summarize specific case studies, it is indeed difficult to summarize case studies, but it does not apply to case outcomes. The challenge in summarizing is more due to the properties of the study than the case study itself as a method of research (Flyvbjerg, 2006).

4.4 Data collection

4.4.1 Primary data collection

This master's thesis used multiple sources for data collection, and the primary data was the main source by applying semi-structured interviews. In semi-structured interviews, the interviewer prepares questions beforehand to make sure that the conversation stays on topic and to help guide the interview in the right direction but is a flexible form of an interview where the interview does not need to follow the interview guide strictly. Such structure allows more open-ended responses, as the information from the respondents could give more depth to the answer. Also, it allows two-way communication where the interviewers and respondents can have a discussion rather than having an asking and answering relationship, but the respondents should always be the ones to speaks the most.

In total, four semi-structured interviews were conducted, including one face-to-face interview, one interview by phone, and two by email. The respondents from different areas within oil and gas project activities were chosen (see Table 1). The choice of these respondents was made according to their wide experience and knowledge in the industry. The interview guide was prepared differently for each of the respondent's groups. Each of these groups is experts in operations within their field of the workplace, but not necessarily in the field of the other respondents. Therefore, there was a need for a slightly different focus in the questions in the interview guide to make sure the interview captured the knowledge and experience the respondent in each group has in their own field and their thought about the phenomenon. At the same time, not all the respondents had knowledge on certain topics and did not wish to answer those such questions thoroughly.

Table 1: Respondents overview

RESPONDENT	POSITION	VESSEL/RIG	AREA	EXPERIENCE
1	Steward	Supply vessel	The North Sea/Norwegian sea	15 years
2	Sailor	Supply vessel	The North Sea/Norwegian sea	6.5 years
3	Process Engineer in Operations	Oil rig	The North Sea	1 years
4	Steward	Emergency vessel/ Standby vessel	The North Sea/Norwegian sea	18 year

The first interview was conducted on 11.04.2021. Respondent 1 was a man between the age of 30-50, who has worked on different supply vessels around the world but mostly on supply vessels that serve platforms on the Norwegian continental shelf. Respondent 1 is not in a position where he has authority over the route of the supply vessels, but with around 15 years of experience in the offshore supply vessels industry, he is well aware of the scheduled operations and what affects them. As well as being aware of what operations needed to be done on a daily basis. The supply vessels are of a certain size and have a very small crew, compare to other vessels the respondent has worked on. This makes the respondent close to all of the workers and their daily tasks and schedule as well as the operations the vessel conduct. The interview with Respondent 1 was face-to-face and lasted for two hours and 40 minutes. The interview guide is attached in Appendix A and consists of 49 questions.

The second interview was conducted on 13.04.2021. Respondent 2 was a man between the age of 30-50 who has worked on different supply vessels on the Norwegian continental shelf: Norwegian Sea, North Sea, Barents sea. Respondent 2 has about 16.5 years of experience on working on supply vessels and are well aware of the daily task needed to be done and the importance of these tasks. The supply vessels are of a certain size and have a very small crew. This makes the respondent close to the other workers and their daily job, as well as the operations the vessel conduct. The interview with Respondent 2 was conducted through email. The interview guide was shared in advance the same day as Respondent 2 conducted the interview, and the interview lasted for 53 minutes. The interview guide for Respondent 2 is attached in Appendix B.

The third interview was conducted on 14.04.2021. Respondent 3 was a man between the age of 20-30 who works on an oil rig which is located in the North sea. He is relatively new in the industry as he has about one year of experience. Anyhow this experience has relatively new eyes and, therefore, the ability to see the operations in a different light, both the operations himself is conducting but also the rest of the oil rig. The interview with Respondent 3 was conducted through email, and the interview guide was shared in advance on the same day as the interview was conducted, and the interview lasted for 42 minutes. The interview guide is attached in Appendix C.

The fourth interview was conducted on 21.04.2021. Respondent 4 was a woman between the age of 30-50 and had 18 years of experience in the oil and gas industry. She has worked on both supply vessels and emergency standby vessels in different seas within the (NCS). Respondent 4 recently has the position as a steward with some responsibility for the safety of the crew on board. With almost two decades in the industry, she has great knowledge of the operations and the changes been made over the years. The interview with Respondent 4 was conducted by phone and lasted for 57 minutes. The interview guide for Respondent 4 is attached in Appendix D.

Prior to the interviews, the four respondents were given the NSD letter of Consent to read and sign, where they were given information on the research and an understanding that they participate anonymously. The interview transcripts were the primary data used for this master's thesis. The interview with Respondents 1 and 4 was recorded after getting permission from the respondents; the recorded interview was then transcribed by hand. Respondents 2 and 3 were answering the questions in the interview guides in writing.

Because of the pandemic, my data collection faced many challenges in finding potential respondents and conducting all the interviews in a face-to-face way. Because of the restrictions from the Norwegian government, some of the respondents had quarantine periods for various reasons, which consequently prevented personal meetings with the respondents. Interviews by phone and email were a solution to these restrictions. As for Respondents 2 and 3, phone coverage was a problem; therefore, they were conducted by email.

4.4.2 Secondary data

Secondary data are already existing data conducted before the research is organized (Johannessen et al., 2011).
Secondary used sources for this master’s thesis were archive materials of historical records, press releases, official reports, official websites, the Norwegian regulation, and laws. The usage of several sources for secondary data material was essential because it potential could support the primary data for this master’s thesis.

4.5 Data Analysis

As qualitative data are expressed in texts, this research cannot use statistical analysis to give meaning to the data. Therefore analysis of qualitative data needs other methods of analysis (Bengtsson, 2016). After collecting the data, I received multiple fragmented texts, including interview transcriptions and written answers. First, I used the storytelling technique to present the empirical findings in a more understandable and clearer way (Johannessen et al., 2011). Then, content analysis was applied to reveal patterns that may not have been obvious before the research. Content analysis is viewed by Kohlbacher (2006) as the study of recorded communication between humans, which matches the primary data collection for this master's thesis.

In qualitative content analysis, to gain more understanding of the meaning behind the fragmented texts, the key aspects of the research questions are located, and the other words or phrases that appear next to them are identified to analyze the meaning of the texts.
Kohlbacher (2006) presents three analytical procedures for qualitative content analysis; summary, explication, and structuring. A summary approach aims to reduce the material but still prevent the reflections of the original material; often, texts are paraphrased. For explication, the material is clarified and explained and then narrowed down. In a structuring approach, the goal is to filter out a particular structure from the material. The material can be structured according to content or form. It is this procedure that was used in this master's thesis when analyzing the collected primary data.

Kohlbacher (2006) emphasizes some stages to perform a structuring approach. In the first stage, the units and categories of analysis were defined. In the second stage, a set of rules of coding was developed. This coding helps organize the units into the right categories. Then, all the texts were reviewed, and the relevant data was recorded into the appropriate categories. After the texts were categorized, the collected data was examined to determent patterns and conclude in response to the research questions. In the final stage, the results were processed and additionally used in the presentation of the findings.

Content analysis cannot reveal the reasons for specific patterns of content; it can merely describe them. This can be looked at as a disadvantage of this method.

4.6 Quality of research

4.6.1 Validity

Validity is a term for how well the research has measured what was intended to be measured or examined (Befring, 2016).
Befring (2016) presents five different validity categories: descriptive validity, the validity of interpretation, theoretical validity, generalization validity, and evaluation validity.

The descriptive validity deals with the quality of the description of observations and interview data, where the requirement is unambiguity and accurate, for this master's thesis that meant a thorough review of the interviews with an eye on details.

The validity of interpretation deals with getting behind what an informant expresses by gaining a deeper understanding and obtaining the informant's opinions and describing the phenomenon from the informants' perspective—further, the theoretical validity, which deals with raising data to a theoretical basis level. In order to achieve theoretical validity, there must be a credible connection between the phenomenon from the informant's perspective.

The generalization validity deals with making the research result applicable to other people, times, or situations. The core of qualitative research is to describe the uniqueness of different phenomena and situations. However, the experiences talked about can be recognized in others in a similar situation and will thus have general value.

The evaluation validity deals with asking evaluative questions and assessing what the informants say (Befring, 2016). However, qualitative research projects are not intended to assess the validity of what is being said against some form of truth standard. Regardless, there needs to be a level of trust that the respondent shares their knowledge and experience wholeheartedly. In order to be sure that everything that is said is in the right context and for the respondent's own assurance that the knowledge is used correctly, the interviews were recorded so as not to lose tone, sarcasm, and the ability to have their comments on certain answers.

4.6.2 Reliability

The term reliability expresses the accuracy and stability of data and refers to that during any circumstance, the research, if conducting in the exact same manner, would give the same result. Thus, the process of collecting data gives the most concern because it needs to be absolutely clear where the data comes from and which steps have been taken to collect it (Befring, 2016). However, data in qualitative studies are difficult to reproduce. It may therefore be questionable whether reliability is a suitable concept in such a context. Nevertheless, it is a fundamental requirement in qualitative research schemes that all parts of the process are carried out in a reliable manner. It presupposes an accurate description of the procedures used from start to finish (Befring, 2016).

As this research was using interviews, implementing a transcript could have been demanding. A sub-communicated reliability problem could occur as credible quality controls of speech-to-text transmission are rarely performed (Befing 2016). When transcript a speech-to-text transmission, this was something to be alert of. The interview guide is attached in the Appendix to clear what has been used to create the result. If using the interview guides, it should be possible to reproduce the data collected.

4.6.3 Generalization

The goal of generalizing is to make concrete phenomena general as well as to simplify and create an order based on a complex reality (Polit and Beck, 2010). There are three types of generalization models; statistical, analytic, and transferability.

Statistical generalization is often used in quantitative research as it is based on the statistic of a selected population. Analytic generalization, in contrast, is most often linked with qualitative research. In a model of analytic generalization, qualitative researchers develop conceptualizations of processes and human experiences through in-depth scrutiny (Polit and Beck, 2010).

In the analysis of this master's thesis, it was distinguished between information that was relevant to all (or many) respondents, in contrast to aspects of the experience that was unique to particular respondents.
Transferability refers to the degree to which the results of qualitative research should be generalized or transferred to other contexts or settings. From a qualitative perspective, transferability was primarily the responsibility of the one doing the generalizing.

An analytic generalization approach was adapted into the generalization of this master's thesis. Because this approach focuses on the research analysis and understanding of circumstances rather than collecting representative data. This could be done with the number of respondents for this research.

4.6.4 Ethical considerations

Research must be rooted in recognized ethical values. The basic values are designed as research principles, and these are norms that will contribute to the research process being carried out in a dignified and responsible manner (Befring, 2016).

Four ethical theories should be used respectably to achieve worthy and sound research. Consequence ethics, which emphasizes the consequence the subject will face by participating. Ethics of duty was based on requirements for performing certain duties and actions in accordance with values and norms. The question was thus whether the action to be performed is ethically acceptable, good, and right. Mindset ethics emphasizes the motives behind an action, and it was the mindset that decides whether the actions are ethically acceptable, good, and right. The ethics of responsibility sheds light on interpersonal relationships, such as the relation between interview-holder and interviewees (Befring, 2016).

A research ethics basis consists of all participants being based on consent, and that consent must be given on a free, informed, and understood basis (Befring, 2016). It was not enough to just inform; the information must be understandable and comprehensible. This was of high focus, and all the respondents had the opportunity to ask for more information or clarify if they found anything unclear or incomprehensible.

Respondents in research are entitled to have all confidential information about personal matters treated confidentially. At the same time, it was a requirement that collected research data needed to be anonymized. There are thus strict requirements for the use of name lists, and rules have been laid down for storage and storage of data, corresponding to requirements for shredding. To ensure the respondent's integrity while protecting their privacy. In this master's thesis, the respondent's anonymity was protected by giving each respondent a number and a letter to distinguish them and not mention any personal information in the recorded interviews and on the handwritten transcripts.

No real names of oil companies, shipping companies, and respondents are mention in this master's thesis. However, the emergency preparedness areas are presented with real names because this is open official information.

5.0 Offshore oil and gas development on the NCS: context description

The major oil and gas production areas are in the northern and southern parts of the Norwegian Sea and the North Sea. The first area to be developed was the southern part of the North Sea, where Ekofisk started production in 1971. The Norwegian Sea is the smallest and last area to be developed, and the production started in 1993. A total of 115 fields has been developed since 1971. Today, 90 fields are in production on the (NCS), of which 67 are located in the North sea, 21 are located in the Norwegians Sea, and two in the Barents Sea. (Norwegian-Petroleum, 2021b).

Oil and gas companies located on the (NCS) aim more and more to gradually install units for production underwater on the seabed with remote-controlled surface installations instead of fixed infrastructure. It is still expected that the need for supply vessels remains high throughout many years to come (Aas et al., 2008b). The installations in each of the fields are supplied from one or two dedicated supply bases. On the (NCS), there are particular harsh weather conditions, which make the supply of the installations challenging. And combined with more demanding offshore activities, the supply vessels face new obstacles to resolve (Aas et al., 2008b). The Norwegian offshore fleet is the world's second-largest with just under 600 vessels, reported back in 2012 (Norwegian-shipowner-associtation, 2012).

The world fleet of supply vessels consists of different vessels. They were commonly built in the late 1970 and early 1980s when offshore fields started up developments and become complex infrastructures (Norwegian-Petroleum, 2021b). Most of the vessels operating in the (NCS) are somewhat new and modern compared to the world fleet. A reason for this is that most oil companies want vessels that are cost-efficient and the right aspects regarding health, safety, and environment (Aas et al., 2008b). Also, the past few years it has been high oil prices, and it has led to an increased interest in exploration activity in new areas and consequently resulted in an increased demand for more supply vessels and some with new features. Despite a higher utilization of supply vessels, it is expected that with the fall in oil prices, the future demand for supply vessels will decline strongly (Tønne, 2015).

More modern vessels are expensive to chart and have become more important for oil companies operating on the (NCS) to maximize the utilization of chartered vessels. This because many of the areas on the (NCS) have turned into mature areas. Mature areas are characterized by known geology, well-developed infrastructure, declining production rates, and increasing unit costs. To be able to maximize the exploitation of such fields, it is important to keep the logistics costs low (Norwegian-Petroleum, 2021a).

Oil and gas companies that operate installations are responsible for the logistics, such as scheduling and routing of the supply vessels. Lager oil and gas companies are often carrying out these operations by themselves, but there are some agreements of cooperation between oil companies, and there are some examples of outsourcing of these types of operations (Aas et al., 2008b). Oil companies want to obtain high utilization of the vessels and usually achieve this by using the same vessel to serve several installations. This is possible and particularly cost-effective when several installations are naturally close and form a cluster. In the North Sea, there are a few supply vessel pools, which means that several oil companies share the same supply vessels. Such a pool often consists of three vessels that are used between installations from different oil companies (Aas et al., 2008b). The Norwegian government urges this type of cooperation as a part of its effort to explicitly ensure efficient exploitation of the country's oil and gas resources (Aas et al., 2008b).

Offshore oil and gas companies have had a tradition of helping each other when an emergency situation arises. This tradition was established when oil and gas companies started business in the (NCS) in 1965. From the outset, emergency preparedness was characterized by cooperation between the companies, especially in relation to the oil spill response. The first serious emergency on the (NCS) occurred in connection with the first well on the shelf. During unloading in November 1966, the supply ship "Smit-Lloyd 8" collided with the drilling rig Ocean Traveler. Two columns were punctured, and the rig had an inclination of about 8 ° and was close by capsizing. Fifty-one workers evacuated by jumping into the sea, but they were quickly picked up, and it was no fatalities. After the emergency, there was a clear focus on emergency preparedness, in addition to several operational conditions in it. Only 2-3 years earlier, 13 workers lost their lives on the British shelf when the drilling rig Sea Gem had capsized. These emergencies were both a part of the backdrop when the first safety regulations were adopted in 1967 (Vinnem, 2008).

The first major emergency on the Norwegian shelf, not looking at helicopter accidents, occurred in November 1975, when three people died in connection with evacuation from the Ekofisk A platform, which had an explosion and subsequent fire due to rupture of a riser. A rescue capsule was incorrectly operated on in connection with the evacuation, fell in free-fall straight into the sea, and three of the six onboard died. The others became seriously hurt. In March 1976, Deep Sea Driller ran aground outside Fedje in connection with towing to a workshop in Bergen, and six people drowned when a lifeboat capsized. And not least, in the Alexander Kielland accident in March 1980, the evacuation was a significant contributor to the deaths of 123 workers. The evacuation was, therefore, a significant area of focus, and the first free-fall lifeboats were installed on a mobile drilling rig in 1983 after pressure from then Statoil, now Equinor. There were also several deaths in the 1970s in man-over-board incidents, which shift the focus on emergency preparedness to rescue people who fell into the sea. Around 1980, internal control was introduced as a control principle for health and safety executive, and the first requirements for formalized risk analyzes were issued by the Norwegian Petroleum Directorate (Vinnem, 2008).

After a history of different emergencies and fatalities, the Norwegian oil industry national association published guidelines for area preparedness in 2000. In which requirements were formulated for rescuing personnel at sea in the event of helicopter emergencies and the event of evacuation from a facility. Requirements were set for a capacity of 21 people in the event of a helicopter emergency and a maximum time of 120 minutes before everyone should be rescued (Ranum et al., 2018). Furthermore, requirements were introduced for ambulance transport to the land of seriously ill / injured people. As a result of the introduction of area preparedness, several rescue helicopters have been placed on selected facilities(Vinnem, 2008). After repeated incidents, it was discovered that the survival suits were leaking a high amount of water into the suit, and a person could drown due to sea spray in the face. Therefore, it was started development of new suits with better technologies.

Over the years, some regulations have been issued for requirements for emergency preparedness on the Norwegian shelf, regarding the correction of discovered weaknesses with lifeboats, ambulance transport to land, and stricter requirements for robust MOB preparedness.

The coverage area for the emergency preparedness areas was calculated using the following factors, the speed of the helicopter, which is 140 knots, the pick-up time from the sea, which is set to be three minutes per person, and the response time for SAR-helicopters should not exceed twenty minutes. Thus, the coverage range is within 86 nm. If the installation is further away than 86 nm from the closest SAR-helicopter, adequate preparedness is ensured by implementing one or more of the following measures. Reduction in the passenger capacity, assistance from several SAR helicopters, assistance from emergency vessels, or assistance from own MOB preparedness (Ranum et al., 2018)

Below in Figure 3 is the geographical area that is included in (NCS). It consists of four seas: The Arctic Sea, Barents Sea, Norwegian Sea, North Sea.

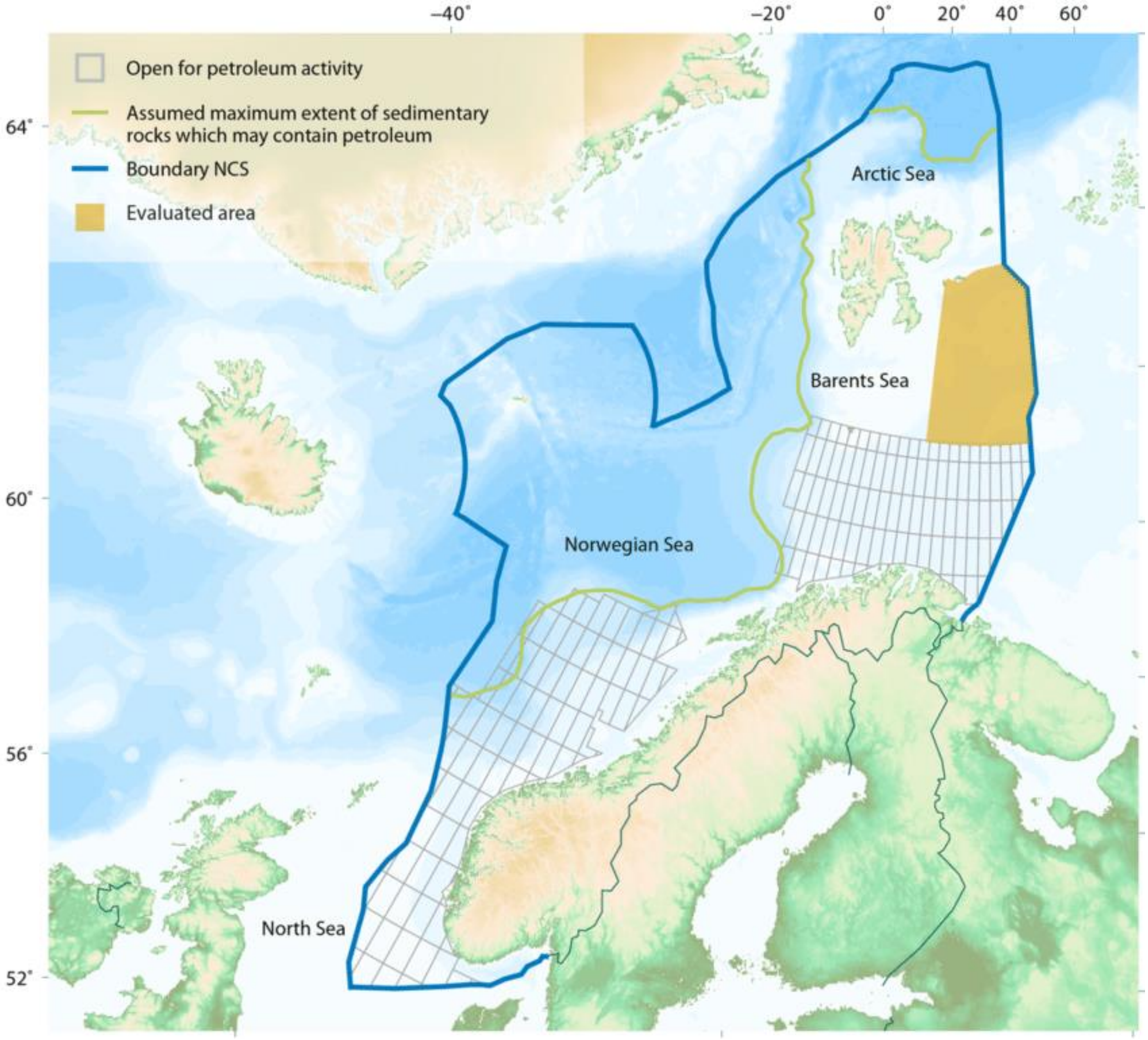

Figure 3 : Map of Norwegian Continental Shelf (adapted from (Bouffard, 2017)

Table 2: Overview of established emergency preparedness area (Adapted from Ranum et al. 2018)

AREA	RESOURSES	SAR RESPONSE TIME	VESSEL CAPASITY	VESSEL SPECIFICATION
Sørfeltet	2 SAR Helicopters	15 minutes* 30 minutes**		
Sleipner-Utsira	1 SAR helicopter 2 Emergency vessels	Between 07-19: 15 minutes Between 19-07: 20 minutes	320 peoples	MOB, intake of lifeboat, Hospital, Oil spill response equipment
Troll-Oseberg	1 SAR helicopter 1 Emergency vessel	Between 07-19: 15 minutes Between 19-07: 20 minutes	370 peoples 370 peoples	MOB, intake of lifeboat, Hospital, Intake for hyperbaric lifeboat, Helideck Oil spill response equipment
Tampen	1 SAR helicopter 1 Emergency vessel	Between 07-19: 15 minutes Between 19-07: 20 minutes	370 peoples	MOB, intake of lifeboat, Hospital, Intake for hyperbaric lifeboat, Helideck Oil spill response equipment
Halten-Nordland	1 SAR helicopter 2 Emergency vessels	Between 07-19: 15 minutes Between 19-07: 20 minutes	370 peoples 320 peoples	MOB, intake of lifeboat, Hospital, Intake for hyperbaric lifeboat, Helideck Oil spill response equipment
Barents-Goliat	1 SAR helicopter	Between 07-19: 15 minutes Between 19-07: 20 minutes		

* with helicopter traffic

** Without helicopter traffic

There are six established emergency preparedness areas on the Norwegian shelf; Sørfeltet, Sleipner-Utsira, Troll-Oseberg, Tampen, Halten-Nordland, and Barents-Goliat, distributed over the seas. Those areas have different amounts of resources within them; Table 2 shows an overview of the resources in the area. The Sørfeltet area has two SAR-helicopters, one with a 15-minute response time and the other with a 30-minute response time. This area does not have a standby emergency vessel. The Sleipner-Utsira area has two standby emergency vessels, both with a different starting position and one SAR- a helicopter with a response time between 15-20 minutes. Troll-Oseberg area has one SAR helicopter with a response time between 15-20 minutes and one emergency vessel. The Tampen area has the same resources, one SAR helicopter with a response time between 15-20 minutes and one emergency vessel. The Halten-Nordland area has one SAR helicopter with a response time between 15-20 minutes and two emergency vessels. Last, the Barents-Goliat area has one SAR helicopter available (Ranum et al., 2018). In this investigation, we are talking about Tampen; this area is a part of the case of offshore supply ecosystems. And the idea of joint utilization of infrastructure in the Tampen area dates back to around the year 1990 but did not appear in official sources until the year 2000 (NorwegianOil&Gas, 2000). Tampen has an average of around 90 helicopter missions per year, with some annual variation. (Ranum et al., 2018).

6.0 Empirical findings

This chapter presents the empirical findings for this master's thesis, including the offshore ecosystem and the emergency preparedness in the North Sea. The challenges of the operators within the supply chain will be emphasized, and the operations of supply vessels will be accounted for, including extra value-creating activities.

6.1 Offshore ecosystem and emergency preparedness in the North Sea

The case offshore ecosystem involves five offshore field projects that produce oil and gas. There are a number of different actors, including an operator, shipping companies, supply base, and platforms. The five offshore field projects are relatively close to each other and located in the same emergency preparedness area (see Table 3). The single emergency preparedness areas are unique on the (NCS), where a limited number of resources serves several offshore installations. There is one SAR helicopter stationed at Platform B, which serves all the platforms in that area at once. Also, the same installations are served by only one standby vessel located between Platform A, B, and C. In the event of an emergency, there are these two resources – i.e., SAR-helicopter and standby vessel, that mainly perform rescue operations. The start position for the standby vessel and the helicopter has an impact on response time to the emergency site. However, Respondent 4 emphasizes that emergencies are a rare occurrence, and when they happen, standby vessels do not have delays in their operations:

> *"[...]it is most emergency drills. Emergencies are not something that happens often, and when they happen, we do not have delays".*

It seems like constantly emergency drills ensure almost instant response without delays in an actual emergency.

Standby vessels are a huge part of the emergency preparedness in each area as they are equipped to handle all possible emergencies connected with the operations at the offshore installations. As well as help at other smaller incidents by other maritime vessels closes by. According to Respondent 4, the standby vessel in this single emergency preparedness area have hospital beds for 34 passengers and are equipped for oil spill recovery, fire, and man overboard events.

All five of the platforms are located far away from the shore and are served by the same supply base. Table 3 presents the distance between the offshore platforms and the supply base. It takes approximately 12 hours to reach the platforms from the supply base at cruising speed. From the supply base, the platforms are served by more than two shipping companies and are getting supplies frequently.

Table 3: Overview of Platforms

Actors	**Location**	**Challenges**	**Recourses**	**Distance from the supply base**
Platform A	North Sea	Weather conditions	1 SAR-Helicopter 1 Standby vessel	144 nm
Platform B	North Sea	Weather conditions		144 nm
Platform C	North Sea	Weather conditions		144 nm
Platform D	North Sea	Weather conditions		143 nm
Platform E	North Sea	Weather conditions		143 nm

The operator is Oil company A, which is a broad energy company with a long history of operating in the areas surrounding the coast of Norway. Oil company A is one of the largest operators on the Norwegian shelf, among the world's largest offshore operators, and an increasingly important player in renewable energy. And are also oil, gas, wind, and solar in more than 30 countries. Oil company A does not own the supply vessels operating in the area but rents them from shipping companies. The schedule and the logistics of the supply vessels are the responsibility of Oil Company A.

As there is only one leading actor in the ecosystem, there are the shipping companies that compete with each other. Oil companies often rent several supply vessels from multiple shipping companies. However, as emphasized by Respondent 1, there seems to be a trend towards contracts between platforms and shipping companies, where only one shipping company serves the platform.

"the supply vessel has a new contact so, we only serve the same platform."

6.2 Once upon a time… an accident in the North Sea

In 2019 there was an accident onboard platform A. During a loading operation late at night, the operating supply vessel collided with platform A. After the collision, the platform was put in audit stop. There were a total of 276 people on board Platform A when the incident occurred, but no one was injured onboard the platform. Since the collision caused damage to the lifeboat station onboard Platform A, the personnel were moved from Platform A to nearby platforms; Platform B and Platform C. During the evacuation, two SAR helicopters and one helicopter from the rescue center were used to evacuate personnel. Meanwhile, the extent of the collision was clarified with assistance from the area emergency vessel on the field.

Figure 4: Picture of the damage at Platform A . Foto by: NTB scanpix

6.3 Challenges for offshore emergency preparedness in the North Sea

Challenges can occur at many stages in the supply chain. Respondents 1, 2, and 4 emphasize that a huge challenge for offshore operations and the operations associated with emergency preparedness is the weather conditions.

> “ *Bad weather such as high waves and strong wind makes the operation difficult to perform. If the wind is too strong, the helicopters are not operating because the risk is too high*.”

The weather has a lot to say about the efficiency and quality of the operations and how well they can be performed under the above-mentioned conditions.

Emphasized by Respondent 4, it often happens that several supply vessels can arrive at the same platform at once, which could increase the risk of collision around and next to the platform:

> *"if there is a lot to do, there are several supply vessels, and there were probably three vessels from shipping companies last time I was there."*

This could indicate that the platform has some sort of logistics problem;
The supply vessels need to cooperate and prioritize what platform they need to serve first. According to Respondent 1 and 2 one of the main reasons for delays are the logistics department:

> *"The reason for delays is the logistics department."*

This can be planned slack to keep the flexibility, as supply vessels play a great role in contributing to value-creating activities for developing this ecosystem despite competitions. The supply vessel's role excludes disruptions, thereby ensuring resilience on offshore oil and gas field projects. As supply vessels from shipping companies exclusively work to ensure that platforms have what they need to keep producing.

6.4 Supply Vessel operations

6.4.1 Cargo transportation

The supply vessels are the link between the onshore supply base and the offshore oil and gas installations. They are the providers of supplies such as food, equipment, water, concrete, diesel, methanol, and slugs, etc. And to return empty containers, waste, and equipment no longer in use.
The primary function is to deliver cargo to the platforms and return waste from the platform to the supply base, which all of the respondents agree upon:

> *"It is simply providing platforms with everything. The tasks are to bring goods etc. , to the platforms such as pipes, containers, water, diesel, mud, cement, methanol,*

barite and deliver most of what you can find on an oil platform. Everything from food and clothing to protective equipment, various parts for the plant, electronics. Then, of course, we have to bring things back again[…]"-

Another important aspect to look at is how it is possible to ensure cargo transportation without disruption when the platforms are so far away from the supply base. Respondent 1 address that the distance increases with bad weather:

"If we have normal cruising speed, then the longest is 12 hours away, and the nearest is maybe 4 hours away. But it is most common with about 6-12 hours. But if the weather is bad, it can suddenly take 24 hours."

It seems that the vessels carry extra supplies as they have an uncertain but also hectic schedule to follow. Respondent 1 emphasizes this when talking about a voyage when they needed to change course because of reprioritization and afterward fulfill the original operations with no mention of the need to refill the vessel with supply:

"Too often, it happens that we sailed outside Bergen and told that we have to go to Stavanger because there is something that must be prioritized first. Then we have to go back to Bergen and do the operations there […]. Or we can be told that we will stay at a location until tomorrow, and then 2 hours pass, and then we are told that we have to depart because there is someone who needs something from our supply."

This indicates that the supply vessels do not have an all-fixed order list over what the platforms on the voyage need, but rather are loaded with some general cargo, so they can supply platforms not included in the schedule on short notice.

It is also addressed by both Respondent 1 and 2 that it is always uncertain how many platforms are to supply on one voyage:

"*It can vary how many platforms/installations we visit on each voyage […] a voyage can vary from 1 day to 14 days [...] if it 3-4 days we could supply 3-5 platforms."*

Supply vessels engage in value-capture activities. Respondent 1 emphasizes they are always competing to get more activities while waiting to start scheduled operations:

"[...]*we are always prepared since we are fighting for new jobs (i.e., activities) all the time. [...] And when you know that a specific operation may only take 4-6 days, you want to fill up the vessel and keep it operating at all the time. [...] There are very often delays so, we have a lot of wait time and need to fill the time when there are long delays."*

The vessel Respondent 1 is working on is competing with other shipping companies to keep their own vessel in activity as much of the time possible. The supply vessels are a huge cost, and they are not generating value when waiting or not operating.

6.4.2 Extra value-creating activities

Other function supply vessels are providing are value-creating activities that assist in ensuring emergency preparedness. The supply vessels have a large survivor capacity as they can host up to 250 people and are prepared to feed them for three days. Supply vessels also have the function of operation as standby vessels in the emergency preparedness area. In every emergency preparedness area, there is always a vessel watching the installations in each area, in case of an emergency. Respondent 1 highlighted that some platforms always want to have a vessel nearby; although the area has a standby vessel, supply vessels are sometimes requested to wait nearby the platform until another supply vessel or service vessel arrives.

Respondents 1 and 2 highlights that the supply vessels have firefighting equipment in addition to a fog system to extinguish external fires, oil spill recovery, de-icing features, MOB boats, life rafts, and hospitals with accompanying medicines.

Respondent 1 acknowledge that supply vessels function as a standby vessel when the actual standby vessel has crew change:

> *"Standby vessels must also sail to land when they have crew change, and then we can take over their operations for about two days before they return."*

After all, the main goal is to ensure that the platform has everything they need so if there is a need to stay outside of a platform, the supply vessels do so as long as they have supplies. Which is acknowledged by Respondent :

> "*Some platforms just want a supply vessel there all the time, in case they need it*"

Respondent 1 recognize that they all are working towards a common goal; that the platforms are continuing production because that is why they all are working:

> *"Everyone works towards ensuring productions at the offshore installations."*

Highlighted by Respondent 1, it also happens that supply vessels must re-prioritize operations and sail towards a different platform and give up the current operations in favor of the other:

> "*Then the rig had to go all the way down to Stavanger (...)the weather was bad, so it was four days delayed, so then we went to meet the rig. We filled up the vessel and sailed. After that, we waited three more days close to that rig in case they needed more of what we had onboard.*"

Further, there seems to be a culture or a common understanding that all actors involved are working in coherence and therefore are ready to assist with emergency and to offer value-creating activities in this ecosystem. Respondent 1 emphasizes this on multiple occasions:

> *"It is almost an emergency vessel we have in a way [...] So, the vessel can help a lot [...] we are ready to assist with an accident, and if there are only a few people in distress, we can send our mob boat".*

Respondent 2 agrees and further highlights that supply vessels must assist if they are capable:

> *"[...]we must participate in fire extinguishing and lifesaving in the event of an emergency".*

Respondent 3 acknowledges the risk of working offshore, which affects every actor involved

> *"There is always a risk involved in the job when working offshore."*

Respondent 4 further emphasizes that when operating at sea, all actors assist where they have the ability to help:

> *"[...] when you are at sea you help where you can all the time. [...] It often happens that they (i.e., supply vessels) assist with emergencies".*

Respondent 4 highlights, supply vessels often assist in the event of emergencies. Supply vessels reprioritize their operations to perform emergency preparedness operations.

Additionally, Respondent 1 acknowledges two extra activities for offshore supply vessels:

> *"We have also had salmon boat equipment. [...]some shipping companies have rebuilt their supply vessels into salmon boats so they can load salmon. [...] Some supply vessels are also rebuilt to carry wind turbines and such. [...]A supply vessel is like a large wheelbarrow that you can fill what you want with"*

Such acknowledgment is unique as it is not knowledge addressed much by previous literature. That offshore supply vessels could ensure value-creating activities by taking on activities associated with fisheries and using the remaining space available to transport cargo. As the offshore wind farms grow, the fact that already serving supply vessels could be used in the development of wind farms shows another value-creating activity.

6.4.3 Ensuring resilience within the ecosystem

Supply vessels are engaged in monitoring the current situation at sea, and they share weather conditions and real-time pictures between different actors involved. Moreover, they engaged in anticipating different potential emergencies that can occur both with observation and reporting, which is highlighted by Respondent 1, 3, and 4:

> *"We constantly had to make a risk report several times a day for what emergencies could happen and what we do to avoid them."*

Resilience within the ecosystem includes all the activities that exclude activities that make disruptions, such as delays and emergencies. If an emergency happens onboard, a supply vessel or around, or onboard the platforms, all operations will be completely stopped.

Even though emergencies are a disruption of operations, Respondent 4 emphasizes that emergencies are a rare occurrence:

> *"[...]it is most emergency drills. Emergencies are not something that happens often".*

This could be the result of strict routines and reporting near misses to learn from them and minimize the risk for actual emergencies to happened and disrupt operations.

It seems that delays are and much more common disturbance of offshore operations than emergencies. Both Respondents 1 and 2 highlights that delays are and daily occurrence:

> *"Delays you just have to reckon with, it happens almost every single day. "*

Moreover, Respondents 1 and 2 recognize that the schedule for supply vessel operations is constantly changing. Supply vessels increase the flexibility of the supply chain recourses to make it possible to easy reallocate in the event of a reprioritization – i.e., an emergency. There is a level of slack in the supply chain with delays every day, as highlighted above by Respondent 1, with longer delays other than the scheduled operations are performed to utilize the supply vessel.

Respondent 2 acknowledges that it is not always bad weather are taken into account when scheduling the voyages and even suggested that oil and gas companies should include more supply vessels in the schedule to minimize the delays caused by weather conditions:

> *"[...]the logistic department has not taken into account bad weather and rented more vessels."*

7.0 Discussion

This chapter analyses and discusses the research findings through the concepts of ecosystem and resilience as theoretical lenses. Two paradoxes in offshore SCM practice revealed in the empirical findings are presented. One is emphasizing how emergency preparedness is ensured by using a limited number of resources. Another is emphasizing how operations are done in coherence with both competition and collaboration within the offshore ecosystem.

7.1 Analysis of the research findings through the ecosystem framework

Offshore operations have been viewed from the theoretical lenses of the ecosystem concept. According to the literature, actors involved in supply ecosystems are both competitors and collaborators simultaneously (Hannah and Eisenhardt, 2018, Wamsler et al., 2016, Adner, 2017).

The findings have revealed a huge number of actors involved in developing offshore field projects – e.g., oil and gas companies, shipping companies, supply bases, helicopter operators. The empirical case has shown that a single emergency preparedness area is part of the case offshore ecosystem. As the findings have specified, the resources are limited; there is only one standby vessel and one helicopter.

The findings have revealed that supply vessels operating in the offshore ecosystem are not only involved in cargo transportations but are also producing other value-creating activities – e.g., emergency preparedness. The supply vessels have features and equipment associated with an emergency vessel, such as firefighting and oil recovery equipment and equipment to rescue people and give treatment in the onboard hospital. This finding is consistent with what Tsvetkova (2019) has found in other contextual settings.

At the same time, my research findings have identified that shipping companies are competing for offshore operations, especially with contracts between platforms and shipping companies on NCS.

Vinnem et al. 2011 emphasize that offshore installations need to be self-sufficient regarding emergency preparedness because of long distances. The contextual offshore field project is located far from shore, isolating them from the resources available onshore, making delays crucial. On the one hand, the findings have revealed that standby vessels have no delays in their operations but that the travel time may cause a longer response time. On the other hand, the findings also reveal that the helicopter could be delayed if the wind is strong or the visibility is low.

The findings have revealed that some of the offshore installations within the case ecosystem prefer to have their own standby vessel, not only one standby vessel serving several installations at once. Based on the findings, it can be supposed that sometimes supply vessels serve as an additional standby vessel due to a hectic schedule.

On the one hand, by operating as a standby vessel, supply vessels compete with the concrete standby vessel for this activity, as it could be a possible value capture activity for supply vessels. Supply vessels already have the features, and with serving contracts with fixed platforms, supply vessels will be able to operate only in the single emergency preparedness area.

On the other hand, these value-creating activities by supply vessels could be a collaboration, where supply vessels only serve as an additional standby vessel under crew change and occasionally when platforms request this activity. The findings do not reveal whether or not supply vessels can obtain a competitive advantage over the concrete standby vessel.

The findings indicate that there is some kind of agreement that if there is an emergency, the close by maritime resources assist as long as they are capable. This could further indicate that field projects do not need to stand alone to be self-sufficient; rather, the supply ecosystem with all its maritime resources should be self-sufficient together regarding emergency preparedness, which builds on the research of Vinnem et al. (2011).

Therefore, the study has revealed a paradox that refers to the ability of oil and gas companies to ensure emergency preparedness by using a limited number of resources. The findings have revealed that supply vessels perform cargo transportation and are also contribute to emergency preparedness operations. Supply vessels adapt quickly to changes, such as reprioritizing and acting as a key link in facilitating integration between various actors.

7.2 Analysis of the research findings through the resilience framework

The study has also revealed another paradox that relates to the ability of oil and gas companies to ensure that all operations are performed when there are so many delays, and actors are both competitors and collaborators within the case offshore ecosystem.

Pettit et al. (2010) highlight principles that can create supply chain resilience. Agility is one such principle and is essential for supply chains to react quickly to changes. The findings reveal that the logistics department must be constantly alert to avoid disturbance in the operations at the oil and gas platforms. This means that the logistic department must monitor where the offshore supply vessels are at every moment to enable them to respond quickly if needed and reallocate.

The findings indicate consistency in delays in the operations of supply vessels and illustrate huge uncertainties in the operations. Pervious routing problems and scheduling problems all seem to focus on getting rid of these delays. However, as common delays are, it does not seem realistic to remove all delays within the offshore operations. The findings have revealed that delays are something offshore operations expect every day. It could be possible that some of the delays are kept to ensure a level of flexibility in the schedule to conduct fast changes and, therefore, ensure supply chain resilience. A flexible schedule could facilitates that decision-making can optimize the operations and fast response in case of an emergency without increasing the resources available. This finding is consistent with the theoretical assumptions of the recent research (Ose et al, 2013; Tsvetkova 2019).

Pettit et al. (2010) also highlight another principle that can create supply chain resilience; collaboration within the supply chain operations. The findings indicate that SCM is using integrated mechanisms to connect the actors into a close relationship as their operations have high risks and uncertainty. The findings have reveal that shipping companies are collaborating in the ecosystem. Supply vessels conduct value-creating activities, contributing to the overall safety around offshore oil and gas operations even though they are in competition with other shipping companies operating in the North Sea. They illustrate that it is possible to collaborate and be competitors simultaneously.

Offshore oil and gas companies ensure operations where there is som many delays by adopting supply chain resilience performance. The participation of offshore supply vessels ensures resilience in offshore oil and gas project development by adapting quickly to changes in the schedule because of reprioritizations – i.e., emergencies.

8.0 Conclusion limitations and suggestions for future research

This chapter presents the main findings of this master's thesis and reflects on the theoretical and practical implications. The chapter concludes with the research limitations and further research suggestions.

8.1 Implications for theory

This master's thesis aims to explore how offshore supply chain operations facilitate emergency preparedness and make the development of offshore oil and gas projects resilient on the Norwegian continental shelf.

Conclusively, emergency preparedness in the North Sea has limited resources. Offshore supply vessels facilitate emergency preparedness by performing value-creating activities, and the participation of offshore supply vessels plays a considerable role as a link between various actors involved. Thereby offshore oil and gas project development is ensuring resilience.

Moreover, offshore supply vessels' participation ensures resilience in offshore oil and gas project development by adapting quickly to changes in the schedule because of reprioritizations – i.e., emergencies. This master's thesis provides deeper insights into offshore operations' resilience, response to contextual challenges, and mitigating the possibility of unforeseen events and possible emergencies.

This master's thesis emphasizes the importance of supply vessels in providing offshore operational resilience by acting as this connecting link between supply vessels and other actors in the ecosystem, illustrating that there are integrated mechanisms in the SCM.

Implementing integrated mechanisms practice in the SCM of all the offshore supply operations would help offshore oil and gas companies to improve the level of uncertainty and connect each actor in the ecosystem closer together, which would improve the collaborations and communication between the actors.

My findings extend the literature regarding ecosystems in the supply chain and how the actors involved are collaborating. The findings have revealed that supply vessels in offshore ecosystems performing extra value creation activities – i.e., emergency preparedness operations. Simultaneously, supply vessels are performing value creation activities to ensure competitive advantages in cargo transportation. Consequently, making shipping companies both collaborators and competitors in offshore supply operations on NCS.

In contrast to previous research on offshore operations that primarily focuses on vessel schedules and building theoretical models, this master's thesis is based on a case-study approach where the finding is revealed in context to the real practice of offshore operations.

8.2 Implications for practice

For the implication for practice, the role of supply vessels will be reflected in the eyes of managers of oil companies, supply chain managers, and policy-makers.

For managers of oil and gas companies, the role of supply vessels is to ensure cargo transportation and return empty containers and waste to the supply base. The findings have revealed that supply vessels are highly adaptable to changes, which indicates that reprioritization could happen fast if a platform needs a container. However, since supply vessels perform other value-creating activities – i.e., emergency preparedness, reprioritizing in operations could also result in that a platform needs to wait longer for cargo or equipment. Which is something managers of oil and gas companies have to take into account when scheduling offshore operations.

For supply chain managers, supply vessels play a connecting role between the actors involved in the supply chain. By playing this role, supply vessels increase the communication and collaboration between the actors because they have a mutual dependency on the operations supply vessels perform.

The role supply vessels play for policy-makers could strengthen regulation on emergency preparedness. They perform as an extra resource in the event of an emergency and serve as a standby vessel on some occasions. These value-creating activities could be an indication that the regulation on emergency preparedness should be strengthened by making the guidelines for emergency preparedness areas more strict. This to ensure that the emergency preparedness resources are sufficient to perform a fast and successful rescue.

8.3 Limitations and suggestions for future research

The contextual setting for this investigation was chosen to focus on supply chain operations in the North Sea. Future research could provide deeper insights into ensuring offshore operation resilience and emergency preparedness in other contexts and seas.

A limited number of respondents were interviewed. Other findings can be obtained if the number of respondents is extended – i.e., from offshore personnel, captains, helicopter operators, and supply bases. Future research could give more profound insight into how delays occur and what factors cause them in offshore supply chain operations.

The findings of this master's thesis have revealed and focused on the primary role of offshore supply vessels. Other resources are also involved in emergency preparedness, and helicopter mission planning is still quite limited in the literature. Further research could provide deeper insight into how helicopters contribute to emergency preparedness and SCM resilience within offshore field projects.

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Appendix

Appendix A

1. Are you working in the North Sea, or have you worked there on an earlier occasion?
2. Does the vessel have firefighting cannons?
3. Does it seem from what you say that the boat you are on now has an artic standard in the North Sea?
4. Have you worked in other oceans? Which?
5. On the supply vessel you are currently working on, how many different platforms do you visit on a trip? (Which ones? And frequency? If this is the knowledge you have).
6. With this new contract, are you more onshore?
7. So you rarely have a fixed Schedule?
8. Do you often stand as a standby vessel?
9. What are the tasks of the supply vessel you are working on? (follow-up questions- What tasks does the vessel perform on a trip)
10. What other task could a supply vessel perform after your opinion?
11. Do you think the workers on platforms you supply feel something special when they see the vessel you are working on approaching?
12. How do you feel when you see the platforms in the area the vessel supplies?
13. Should there be an accident (either small or large), do you feel safe? Why?
14. Are you afraid of any corona outbreak?
15. What would you say are some of the biggest challenges the vessel you are working on must tackle during the voyages?
16. Has the vessel you are working on now assisted in an accident (regardless of scope)
17. With the vessel, you are currently working on?
18. Have you ever worked on a vessel that has assisted in an accident?
19. How many hours does it take to reach the platform from the supply base?
20. How much time does it take for loading/offloading operations at the base and the platform?
21. At the platform, how long does it take there?

22. Are loading/offloading operations often delayed? What was the reason for these delays?
23. Will it be sent by helicopter then?
24. Is rain a problem?
25. What about wind?
26. Are delays something that normally occurs on a trip? What was the reason for these delays?
27. What is your position?
28. What are your responsibilities?
29. Which installations do you supply?
30. How are the weather conditions in this area?
31. How does weather affect the operations you conduct?
32. What challenges does this create concerning operations you carry out?
33. What challenges are connected to loading/offloading operations at the installations?
34. How do delays affect your work?
35. How often do delays happen?
36. In your opinion, what is the main reason for delays?
37. What do you do to minimize the effect these have on operations? Or prevent them from occurring?
38. So they are for all the observations you notice?
39. Do you always work with the same crew?
40. Other important aspects related to these operations that you wish to elaborate on?
41. What do you know about the emergency area at sea?
42. How many installations are involved in the emergency area?
43. How do you think if the supply vessels are engaged in emergency logistics if an accident happens? How will they support this activity?
44. Do you have such a certificate?
45. How is the supply vessel you work on equipped in case of any emergency or accident?
46. Can you tell me something about the emergency plan for the installations you supply?
47. Do you have the equipment to collect oil in the event of an oil spill?
48. What feelings do you get when you see land after a trip?
49. What are the duties of the captain?

Appendix B

1. Do you work, or have you worked in the North Sea on a previous occasion?
2. On the Supply boat you work on, how many different platforms do you usually visit on a trip?
3. For how many years have you worked on a supply vessel?
4. In your opinion, what are the tasks of the supply vessel you work on?
5. In your opinion, what other task can a supply vessel perform?
6. Do you think the workers on platforms feel something special when they see supply vessels approaching?
7. Do you feel safe in the event of an accident (either minor or major)? Why?
8. Are delays something that normally happens on a trip? What was the reason for these delays?
9. What is your position?
10. What is your responsibility?
11. How does the weather affect your everyday tasks?
12. How often happens delays?
13. In your opinion, what was the main reason for the delays?
14. Other important aspects related to these operations that you want to elaborate on?
15. What do you think about the supply vessels doing emergency logistics in the event of an emergency? How could the supply vessel support this activity?

Appendix C

1. Where is the oil rig you work on located?
2. Have you worked on a rig in the North Sea?
3. Have you worked in other oceans?
4. How many years have you worked on the oil rig?
5. In your opinion, what tasks do you think a supply vessel can perform?
6. How do you feel when you see the supply vessel approaching the rig?
7. Do you feel safe in the event of an accident (either minor or major)? Why?
8. Are delays something that normally happens? What was the reason for these delays?
9. What is your position?
10. What is your responsibility?
11. What are the weather conditions like in the area you work in?
12. How does the weather affect the tasks you perform? Does it create any challenges?
13. How often happens delays?
14. In your opinion, what was the main reason for the delays?
15. Other important aspects related to these operations that you want to elaborate on?
16. What do you think about the supply boats doing emergency logistics in the event of an accident? How will the supply boat be able to support this activity?
17. How is the rig you work on equipped in case of an accident?

Appendix D

1. Do you work, or have you worked in the North Sea on a previous occasion?
2. On the Supply vessel you worked on, how many different platforms did you visit on a trip?
3. When did you work on a supply boat, and possibly how many years?
4. What were the tasks of the supply vessel you worked on?
5. In your opinion, what other task can a supply vessel perform?
6. Do you think the workers on platforms feel something special when they see the supply boat approaching?
7. Did you feel safe in the event of an accident (either minor or major)? Why?

8. On the boat you are working on now, do you feel safe there in the event of an accident?
9. What would you say are some of the biggest challenges the vessel you are working on has to deal with during a trip? Were there the same challenges when working on a supply boat?
10. Has a vessel that you have worked on helped in an accident (regardless of scope)? What type of boat is it?
11. How many hours did it take to reach the platform from the supply base?
12. How long did it take for loading/unloading on the base and platform?
13. Is the delay of loading/unloading something that happens often? What was the reason for these delays?
14. Were delays something that normally happens on a trip? What was the reason for these delays?
15. What was your position?
16. What was your responsibility?
17. How were the weather conditions in the area that the supply boat supplied?
18. How does the weather affect the tasks of the boat?
19. How often did delays occur?
20. In your opinion, what was the main reason for the delays?
21. Other important aspects related to these operations that you want to elaborate?
22. What do you know about the emergency preparedness area at sea?
23. What do you think about the supply boats doing emergency logistics in the event of an accident? How will the supply boat be able to support this activity?
24. How was the supply vessel you worked on equipped in case of an emergency or an accident?