Master's degree thesis

LOG950 Logistics

Helicopter medical services in Norway: an institutional logics approach to understand supply chain management resilience

Muhammad Omer Farooq and Daud Ahmed

Number of pages including this page: 82

Molde, 25.05.20

Molde University College
Specialized University in Logistics

Mandatory statement

Each student is responsible for complying with rules and regulations that relate to examinations and to academic work in general. The purpose of the mandatory statement is to make students aware of their responsibility and the consequences of cheating. Failure to complete the statement does not excuse students from their responsibility.

*Please complete the mandatory statement by placing a mark **in each box** for statements 1-6 below.*		
1.	**I/we hereby declare that my/our paper/assignment is my/our own work, and that I/we have not used other sources or received other help than mentioned in the paper/assignment.**	☒
2.	**I/we hereby declare that this paper** 1. Has not been used in any other exam at another department/university/university college 2. Is not referring to the work of others without acknowledgement 3. Is not referring to my/our previous work without acknowledgement 4. Has acknowledged all sources of literature in the text and in the list of references 5. Is not a copy, duplicate or transcript of other work	Mark each box: 1. ☒ 2. ☒ 3. ☒ 4. ☒ 5. ☒
3.	**I am/we are aware that any breach of the above will be considered as cheating, and may result in annulment of the examination and exclusion from all universities and university colleges in Norway for up to one year, according to the Act relating to Norwegian Universities and University Colleges, section 4-7 and 4-8 and Examination regulations** section 14 and 15.	☒
4.	**I am/we are aware that all papers/assignments may be checked for plagiarism by a software assisted plagiarism check**	☒
5.	**I am/we are aware that Molde University College will handle all cases of suspected cheating according to prevailing guidelines.**	☒
6.	**I/we are aware of the University College's rules and regulation for using sources**	☒

Personal protection

Personal Data Act

Research projects that processes personal data according to Personal Data Act, should be notified to Data Protection Services (NSD) for consideration.

Have the research project been considered by NSD? ☒**yes** ☐**no**

- If yes:

Reference number: 272952, 927508

- If no:

I/we hereby declare that the thesis does not contain personal data according to Personal Data Act.: ☐

Act on Medical and Health Research

If the research project is effected by the regulations decided in Act on Medical and Health Research (the Health Research Act), it must be approved in advance by the Regional Committee for Medical and Health Research Ethic (REK) in your region.

Has the research project been considered by REK? ☐**yes** ☒**no**

- If yes:

Reference number:

Publication agreement

ECTS credits: 30

Supervisor: Antonina Tsvetkova

Agreement on electronic publication of master thesis

Author(s) have copyright to the thesis, including the exclusive right to publish the document (The Copyright Act §2).

All theses fulfilling the requirements will be registered and published in Brage HiM, with the approval of the author(s).

Theses with a confidentiality agreement will not be published.

I/we hereby give Molde University College the right to, free of charge, make the thesis available for electronic publication: ☒yes ☐no

Is there an agreement of confidentiality? ☐yes ☒no

(A supplementary confidentiality agreement must be filled in)

- If yes:

Can the thesis be online published when the period of confidentiality is expired? ☒yes ☐no

Date: 25.05.2021

Preface

This master's thesis finalizes our two-year program at Molde University College and concludes our Master of Science in Logistics. There were many ups and downs while working on this thesis that made it exciting and exhausting at the same time. But it gave us an excellent opportunity to have an insight and better understanding of helicopter emergency services behind the scenes supply chain and operations.

The ongoing global pandemic of COVID-19 provided us with a fair share of challenges that affected us mentally and physically (i.e., the data collection phase). When we felt demotivated, mutual support from the people around us and positive feedback from our supervisor helped us come back to finishing our dissertation with quality work.

First and foremost, we thank the Almighty Allah for making this research a success. Secondly, we would like to express our gratitude to our supervisor, Antonina Tsvetkova, for her professional perspective and guidance on this master's thesis. She was very supportive and helpful in guiding this master's thesis. Her expertise, excellent advice, and critical feedback have been crucial. Without her quick response and close collaboration, this work would not have been possible.

Thirdly, we are very grateful to the people who accepted our request for the interview, their participation, willingness to share information and help with the data collection. The insight and knowledge of personnel provided valuable contributions to this master's thesis.

Lastly, we would like to thank our family and friends for their motivation and for being there for us whenever we needed them, as well as our classmates, Bao, Thuy, and Saad, for good and sweet memories throughout two fantastic years at Molde University College. Furthermore, we would likely present our utmost gratitude to our university, giving us a chance to study at Molde University College.

Molde, May 2021

Muhammad Omer Farooq & Daud Ahmed

Abstract

Emergency preparedness requires quick-responded supply chain management (SCM) able to deal with many resources to be effectively mobilized when any potential emergency happens. A number of challenges and issues in emergency supply chain operations can raise disruptions and delays in patient transportation and providing quick medical support. Any delays could affect response time, raise transportation costs, and put people's lives at risk. It determines a perspective to make the performance of emergency supply chain operations resilient. However, there seems to be a lack of understanding of how patient transportation is coordinated to provide reliable and resilient medical support in an emergency without any delays. This area of research is still unexplored within the SCM field. Being motivated by the mentioned above theoretical gaps, the overall purpose of this master's thesis is to explore how supply chain management resilience is developed in the Norwegian healthcare sector. This purpose was divided into three research questions (RQs):

RQ-1 How are HEMS regulated by the government and hospitals in Norway?

RQ-2 What kind of challenges affect HEMS during emergency operations in Norway?

RQ-3 How do HEMS contribute to emergency preparedness and response supply chain operations?

This master's thesis applies a qualitative single case study approach. The empirical case presents emergency supply chain operations by helicopters in Norway for patients in remote areas with limited access to medical facilities. Data from two semi-structured interviews and archival materials were interpreted through the theoretical lenses of an institutional logics approach. Content analysis was applied to find meaning and connections between different interviews and literature.

Our findings have revealed a paradox in performing emergency operations by helicopter emergency medical services (HEMS). HEMS has been considered one of the most effective modes of patient transportation compared to other transportation services. However, this mode of patient transportation is one the most dangerous that are well-famous for many crashes. Despite this fact, our findings have also identified that HEMS facilitate making

patient transportation resilient because they provide quick response time compared to other ambulance transportation services by airplanes, water, and ground. Helicopters offer short response time due to the capability of low altitude long flights by which any complicated remote place can be made accessible. It is also emphasized that several institutional and contextual factors affect the SCM operations of HEMS, including bad weather, which creates no-fly conditions causing delay and sometimes canceling of HEMS mission.

Further, the Norwegian government plays an essential role in organizing these services; as it is a state-owned service, the government makes regulations to promote equal access to emergency medical services readily available to all people all over the country. Lastly, in conducting the HEMS mission, the pilot is considered the chief of the staff. He must ensure the crew's safety, make flight plans, and decide to accept or decline the HEMS mission request from the emergency medical services.

Keywords: Supply Chain Resilience, Emergency Preparedness, Helicopter Emergency Medical Services (HEMS), Emergency Supply Chain, Response Time, Healthcare Sector, Patient Transportation, Institutional Theory, Case Study.

Terms and Definitions

Supply chain management – "... the managing network of companies involved in the upstream and downstream flows of products, services finances, and information from the initial supplier to the ultimate customer" (Pettit, Fiksel, and Croxton 2010).

Supply chain resilience – "... the ability to proactively plan and design the Supply Chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operation" (alizadeh mousavi et al. 2017).

Emergency preparedness – "...the knowledge and capacities and organizational systems developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent, emerging, or current emergencies" (WHO. 2015).

Operational supply chain management –" the collection of processes and actions aimed at effectively supplying demands." *(*Kress 2002, *p.1)*

List of Abbreviations

SCM:	Supply Chain Management
COVID-19:	A global pandemic disease emerges from Wuhan, China.
HEMS:	Helicopter emergency medical services
NAAS:	National Air Ambulance Services
UNEP:	United Nations Environment Program.
WHO:	World Health Organization
USAID:	United State Agency for International Development
CAMTS:	Commission on Accreditation of Medical Transport Systems
NAEMSP:	National Association of Emergency Medicine Services Physicians
EMS:	Emergency Medicine Services
SAR:	Search and Rescue
NACA:	National Advisory Committee for Aeronautics
GP:	General Physician
NSD:	Norwegian Center for Research Data
EMCCs:	Emergency Medical Communication Centers
JRCC:	Joint Rescues and Coordination Centers
AMK:	Akutt Medisinsk Nødssentral

List of Tables

List of Figures

Table of contents

Chapter 1. Introduction

This chapter provides an overview of our investigation by presenting the motivation of our analysis with the critical theoretical gaps. The objectives of the study have been developed to support three research questions. Lastly, the structure of the master thesis has been provided.

1.1 Motivation of the study

Emergency preparedness is a proactive approach to quick response in an emergency. These situations require a detailed plan of emergency response procedures, speedy operations, available resources, and a team of qualified workers with clear assigned roles. (Kjeserud and Weisæth 2007) argue that it is impossible to predict all potential emergencies before they take place in real life. The only practical measure to reduce the severity of risks for new emergencies is to learn from the experience of past incidents. The gained knowledge can help prepare for future unpredictable scenarios, preventing the destruction and loss of valuable human lives (Pedersen et al. 2016).

One of the essential aspects of emergency preparedness includes planning, allocating resources, quick responsiveness, and implementing the plan in real emergency relief situations. Emergency preparedness requires three modes of ambulance services (air, water, and road) whenever an incident occurs. The management of operational supply chains in emergency preparedness emerged noticeably after the outcome of disastrous events worldwide, either natural or artificial, that may happen anytime, anywhere, with massive consequences for a particular area (Pedersen et al. 2016). The existing literature on emergency preparedness has commonly used the term logistics. In emergency preparedness, the nature of resources varies from type of emergency; the resources are not located near the point of need and in enough quantity to be effectively mobilized. This refers us to emergency supply chain management (SCM), having more participants sharing a more considerable amount of information about the resources that need to be mobilized to prepare, respond, and recover from disaster events (Young and Peterson 2014). It is worth noting that many researchers have distinguished business SCM from emergency SCM for a better

understanding of emergency operational performance and supply chain strategies (Kress 2002). (Johnson. et al. 1999) have argued that business SCM is a process that consists of several stages, including planning, implementation, and controlling of the business processes efficiently. These processes require smooth information flow throughout the supply chain, e.g., from the origin of manufacturing of a good to the endpoint of origin, where the customers consume goods or services at the lowest possible total cost (Ballou 1999, Chelst and Barlach 1981).

Previous research has primarily concentrated on describing supply chain operations in business practices and almost neglected the emergency specifics. However, emergency supply chain operations have a distinct nature of the performance issues and objectives when rescuing people from emergencies. This factor is deeper addressed in our master's thesis. The main focus is to save people from emergencies, which makes the emergency supply chain utterly different from the business supply chain. However, emergency SCM has raised many challenges and issues to organize emergency preparedness, which need to be addressed more clearly as they are not researched in business supply chains.

Emergency supply chain operations require a quick response time that plays a critical factor for prehospital care to be successful. Therefore, response time must be managed to increase the chances of patient survival (Lawner et al. 2016). Further, emergency supply chain operations are costly. High costs are associated with capital funds to meet emergency response needs (i.e., special medical treatment, fuel consumption, and skilled employees). The central portion of these costs relates to patient transportation to the nearest medical facility.

There are many problems and concerns that must be overcome to carry out emergency supply chain operations without any disturbances or delays. Any delays could jeopardize the successful implementation of ambulance support, raise transportation costs, and put people's lives at risk. As a result, providing ambulance service to save people's lives in an emergency is difficult. It establishes a strategy for making emergency supply chain operations more resilient. Resilience is a crucial component in emergency supply chain operations while transporting patients. The provision of emergency medical relief services is needed to be robust that can withstand disruptions. Any significant disturbance in the supply chain can lead to adverse situations. In this aspect, there seems to be a lack of understanding of how patient transportation is coordinated to provide reliable and resilient medical support in an

emergency. This area of research is still unexplored, and investigation in the perspective of resilience will be worth doing.

1.2 Problem statements

Emergency SCM includes various stages of operational performance, from planning to executing the mission of ambulance services. These days, many people still live in highly remote areas where they face challenges accessing medical facilities and hospitals. Their remoteness requires a quick response and effective performance of providing ambulance support in emergencies. Helicopter emergency medical services (HEMS) are considered one of the most effective modes of patient transportation compared to services offered by land and water. Due to the high risk involved in transporting patients, helicopter emergency medical services (HEMS) are emerging as the most critical mode of patient transport (Godfrey. and Loyd. 2020). Being motivated by the mentioned above theoretical gaps, **the overall purpose of this master's thesis is to explore how supply chain management resilience is developed in the Norwegian healthcare sector.**

Our investigation applies a qualitative single case study approach. The empirical case presents supply chain operations within the HEMS framework in Norway (emergency transportation of patients by helicopters in Norway). Due to several geographical issues and contextual settings such as mountains, long-distance roads, fjords, tunnels, offshore oil platforms, and installations in the North Sea, the Norwegian government is liable for intense medical emergency preparedness and rescue services for patients in emergencies equally all over Norway. Helicopter services play a considerable role in providing ambulance support for evacuating patients from remote areas lacking a proper medical support facility (Waje-Andreassen, Østerås, and Brattebø 2020). The overall purpose of our investigation is divided into three research questions (RQs) to make our study more comprehensive.

In Norway, the public-funded primary health care system has been divided into 426 municipalities and specialized healthcare in four health regions: northern, midland, western, and joint southern-eastern regional health authorities. All the Norwegian air ambulance and rescue helicopter bases record all the missions prospectively, and then the data is transferred to the National Air Ambulance Services (NAAS). This leads to our first research question:

RQ-1 How are HEMS regulated by the government and hospitals in Norway?

The positioning of HEMS is a very challenging task from the strategic decision point of view compared with emergency supply chain operations. Every decision based on an emergency would be difficult, and these decisions ultimately determine the death or life of the patient. Recently, air ambulances in emergency operations have increased, which has triggered some challenges in this perception. Considering the importance of such emergency operations by air ambulance, these challenges are worth investigating. However, to reach our goal. Our next research question is:

RQ-2 What kind of challenges affect HEMS during emergency operations in Norway?

HEMS operations require a quick response in delivering the patients to the nearest medical facility. Consequently, our analysis does not only focus on responsible supply chain operations and decision-making. In addition, on an important role which HEMS plays in supporting the health care sector of Norway by resilience in patient transportation operations. Due to HEMS, the patients have more opportunities to reach the nearest medical hospital facility even when there are too many challenges (Waje-Andreassen, Østerås, and Brattebø 2020). This critical role follows up on our final question that:

RQ-3 How do HEMS contribute to emergency preparedness and response supply chain operations?

1.3 Structure of the thesis

Chapter 1 is about the introduction & motivation of our study and defined problem statements.

Chapter 2 covers the literature review of the current knowledge written on emergency preparedness, supply chain resilience, and helicopter emergency medical services (HEMS)

Chapter 3 contains the institutional logic approach for our master's thesis.

Chapter 4 consists of all the methodologies, including philosophical views, research design, ethical consideration, case studies, and different data collection tools, and how we will analyze the collected data for our master's thesis.

Chapter 5 includes the case description of HEMS operations and bases in Norway for our master's thesis.

Chapter 6 has been provided by empirical findings of HEMS, including historical development, regulations, main actors, and challenges for our master's thesis.

Chapter 7 describes the analysis and detailed discussion about our empirical findings and supply chain resilience in the healthcare sector in Norway.

Chapter 8 consists of our conclusions, limitations, and future research suggestion for further development in our master's thesis topic.

Chapter 2. Literature review

This chapter presents the concepts related to Norway's helicopter emergency preparedness services, definitions, and implications. Later on, it shows the studied literature regarding emergency supply chain operations to draw an overview of the picture. Furthermore, it describes the guidelines, response time, the geographical spread of helicopter emergency medical services in Norway. In addition to that, its historical background, motives, and importance in conducting emergency operations. Ultimately, it describes the theoretical framework within the emergency supply chain and preparedness.

2.1 Supply chain management: patient transportation

The word supply chain refers to interconnected enterprises within a complex network that continuously changes, creating unpredictable events (Ensuring SC resilience, Global 2007). As numerous businesses are developing, more complex supply chains are also evolving with more unforeseeable circumstances. Thus, supply chain management defined by Christopher *as*

> *"the managing network of companies involved in the upstream and downstream flows of products, services finances, and information from the initial supplier to the ultimate customer"* (Ensuring SC resilience, Christopher 1992).

As reported by Beamon B. (1998), supply chain management is

> *"a structured manufacturing process wherein raw materials are transformed into finished goods, then delivered to end customers."*

Bridgefield Group (2006) defines supply chain management as

> *"a connected set of resources and processes starts with sourcing the raw materials and expands through the delivery of finished goods to the end consumer."*

Pienaar W. (2009) defines supply chain management as

"a general description of the process integration involving organizations transforming raw materials into finished goods and transporting them to the end-user."

Little, A. (1999) defines supply chain management as

"the combined and coordinated flows of goods from origin to the final destination, also the information flows that are linked with it."

According to Chow, D., and Heaver, T. (1999), supply chain management is

"the group of manufacturers, suppliers, distributors, retailers and transportation, information and other logistics management service providers that are engaged in providing goods to consumers. A Supply Chain comprises both the external and internal associates for the corporate".

Our master's thesis uses our perception of SCM compiled from the different definitions presented above to support our investigation of natural and artificial disasters, such as hurricanes, flooding, earthquakes, infectious diseases, terrorism, and many others are becoming more common. They are causing financial damages and loss of human life. The scheduling, operations, and planning of emergency SCM are considered necessary in relief operations (Chern et al. 2010). These supply chains are different concerning business supply chains as they are ambiguous, subject to various constraints, nature wise and environment wise. Emergency operations often incorporate mutual coordination of other organizations, effective and optimum resource utilization, minimization of the damage caused by the disaster on a priority basis. In any catastrophic, disastrous event, natural or artificial, every second count. Any delay is crucial to the affected people. The significant challenges faced in disaster operations are transportation, distribution of aid, and patient recovery. As human life is critical in disaster relief operations, emergency medical services provide onsite first aid and prehospital care to the patients. The services offer a limited level of medical care due to the resources and other circumstances. When the patient is acute and needs intense medical attention, the patient is transported from that specific area to the hospital or trauma center with a better level of care.

The transportation of patients in an emergency creates a supply chain network that consists of several actors. The nature of this supply chain is complicated compared to the regular business supply chain as our focus is on saving human life rather than financial gains. The variables that affect this supply chain type include infrastructure, equipment, qualified personnel, unpredictable events, and patient profiles. A typical system responds to an emergency call for transportation utilizing an ambulance (ground, air, or air) within a specific period. The flow of patients throughout the chain is a trajectory path that requires controlled administrative steps of interconnections and synchronizations within the network.

2.2 Supply chain management resilience

The existing literature on supply chain resilience focuses on business supply chains and emergency disaster supply chains (Bruneau et al., 2003; McManus et al., 2007; Scholten et al., 2014). Supply chain resilience has been defined as

> *"the ability to proactively plan and design the Supply Chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operation" (Pettit, Fiksel, and Croxton 2010).*

Several events create turbulence in the supply chain network and increase its level of complexity. This turbulence made researchers and experts build robust and resilient supply chains that can undergo different disruptions with minimum adverse aftereffects (Ensuring SC resilience, Ahlquist et al. 2003). The challenges that make the complicated supply chain vulnerable can be categorized into natural events and artificial events. The risks related to unnatural events can be mitigated by relative measures, training, and guidance. However, disruptions caused by natural disasters can only be overcome by resilient preparedness, which decreases vulnerability and creates an effective supply chain (Evolution of resilience in SCM, Glaser and Strauss 1967). Natural disasters include any emergency event that needs a quick supply of humanitarian aid at a considerable scale. The need for immediate relief assistance made business leaders and agencies like UNEP and USAID services use this concept of resilience to get strategic advantage within their supply chains and the market where they provide their services. Researchers have proposed four abilities that are the basis of resilient performance, which include effectively respond, monitor, learn and anticipate

different circumstances (Evolution of resilience in SCM, Hollnagel, 2011). Incorporating the concept of mentioned four abilities into emergency management and humanitarian SCM identifies as emergency response, hazard mitigation, disaster preparedness, and disaster recovery, together known as disaster management (Chowdhury and Quaddus 2016). In the context of disaster events, emergency supply chain and disaster relief services consist of several activities which include delivery of essential commodities of life, search and rescue, medical aid, transportation of people to the hospitals, building basic infrastructure to facilitate the rapid movement of support (Scarpin and Anderson 2014). Conducting such operations is not an easy task. It requires many organizations and actors to work together in one single team without hindering the other.

2.3 Emergency preparedness

Emergency preparedness has been defined as

> "*the knowledge and capacities and organizational systems developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent, emerging, or current emergencies*" (WHO. 2015).

Emergency incidents and natural disasters are very prone to happen anytime, anywhere without giving warning. The severity level is dependent mainly on the nature and magnitude of these happenings. The possible way to overcome and deal with these types of situations is to have an efficient plan to prepare and respond, utilizing the available resources. But all emergencies are not similar, and every event has its challenges. A report from Fritz Institute (Thomas. 2003) has outlined the main issues faced in preparing and dealing with catastrophic situations: assessment, mobilization of resources, assets, tracking, tracing, and stock management. Further, (Sheu 2007) has disclosed many challenges that response operations face during an emergency, whether these emergencies are caused by artificial means or natural anytime worldwide. Previous studies have also mentioned a few natural disastrous events around the world, i.e., earthquakes in Taiwan (1999) and Iraq (2003), the tsunami in the Indian ocean (2004), as well as Hurricane Katrina in the USA (2005). As a result, researchers ranked emergency preparedness as a critical component to deal with such disastrous situations. Preparation is a state of a written emergency plan, understanding the

case to eliminate undesirable consequences (Thomas. 2003). The preparedness plan explains the functional roles and the logistical support required to carry out the operation (Thomas. 2003). However, another critical factor in managing emergency preparedness is SCM operations.

2.4 Emergency preparedness operational supply chain

Operational supply chain management, as referred by (Kress 2002, p.1),

"to the collection of processes and actions aimed at effectively supplying demands."

According to (Tovia 2007), an effective preparedness plan should include mobilizing resources and operations. Emergency preparedness plays a crucial role in managing emergency supplies, relief, shelters, and evacuation activities. These days different response offices and humanitarian aid groups use an emergency response plan to carry out the activities involved in emergency supply chain operations. The efficient response plans are developed based on the emergency response models. The model ensures all required time parameters, indicated risk factors, contextual settings and evaluates the time needed for timely decisions. Current research on emergency SCM has pointed few diverse characteristics such as social hazards, allocation, transportation, and relief activities of affected areas with sudden natural disasters. A few disasters are earthquakes, floods, hurricanes, mudslides, and major traffic accidents. In all emergency preparedness activities, one crucial operational factor that is considered a priority is to transport critical patients to the nearest hospital facility by air ambulance or ground transport (Chiarini 2013).

2.5 Helicopter emergency medical services (HEMS)

The air ambulance has been proven itself to be more advantageous and impactful in performing search, rescue, and remote medical evacuations (Reid et al. 2019). Recent literature reviews (Johnsen et al. 2013) have shown that HEMS is viewed as specialized services that mainly provide transportation of patients, pregnant women in a very safe and efficient way to the nearest hospital. Most of the time, the infrastructure is adversely affected, the land routes get destroyed, making the affected area remote and harder to reach. This remoteness creates a hurdle for the relief services to carry out emergency operations at such

places. (Ozdamar, 2011; Xavier, 2018; COMAER, 2013). Under these circumstances, the only way to access the affected area and supply aid is by using helicopters and airplanes. As lead time is crucial under these circumstances, air transport plays a vital role in the first days of any disaster operations.

The helicopter air ambulance has recently become an essential part of modern healthcare that facilitates the transfer of patients from one point to another for a better level of care, rescuing patients from inaccessible areas to the trauma centers faster than other means of transportation. In 2016 during the Kumamoto Earthquake disaster in Japan, 75 patients were transported to the trauma centers using helicopters (Aeromedical Transport Operations Using Helicopters during the 2016 Kumamoto Earthquake in Japan). The advantage of using helicopters at the accident scene is to provide a mobile and quick advanced life support system in a remote area that can save the patient's life. Accessing remote places would be impossible or will take much valuable time if ground medical services are used. (Lopes, 1987; Mazzotti, 1987). Helicopter missions are expensive; for instance, the flying cost related to the helicopter with payload (patient) ranges around $ 2000-3000 per hour Stapleton et al. (2009). Keeping the high price in mind and the severity of missions, an effective SCM plays a significant role in keeping up the system. (Planning helicopter supply chain in disaster relief Linet Ozdamar). The planning and management of helicopters for air transport follow a five-phase structure from data collection, estimation, limitations of usage, resource limitation, and routing process to complete the missions. Experts usually do the first four steps, but for the last phase, different mathematical models are used to solve complex routing problems and to provide optimized results (Myers, 1998; COMAER, 2005; COMAER, 2013).

According to (Yi et al. 2014), the role of HEMS in the transportation of the patients to the nearest medical facility requires excellent coordination between all the actors involved in the operation. This research also includes 229 helicopter flight rescues in which 284 patients were transported from the Ulleung-gun Health Center and County Hospital to mainland general hospitals from January 2007 to March 2013. Many different case studies of HEMS were put forward in the literature, including an extra physician, paramedic staff, rescue location, the severity level of injury, and the mortality rate. The study presented the flight duration from the takeoff to the helicopter's landing on formal flights and the transfer delay and rejection of calls due to bad weather conditions. The researchers analyzed the outcomes

of the collected information using-test run on the SPSS version 18.0 program (SPSS Inc, Chicago, IL). (Ringburg et al. 2009) has further extended the argument about the advantages of having HEMS in EMS to facilitate the patients in the trauma. The critical factor discussed is the dispatch of the rescue team to the patient. Their research has shown that HEMS is more efficient and impactful in providing emergency services to more traumatized patients to less injured patients.

2.5.1 HEMS guidelines

The literature of several researchers indicates HEMS as a better alternative than traditional emergency medical services (road and water ambulance) (Lerner et al. 1999). It provides quick, responsive, and reliable medical support (Colella 2019). The use of HEMS has been made more efficient by using a decision-making process. This process is based on different guidelines, which act as a standard operating procedure. Using these guidelines, the authorities who provide HEMS decide the dispatch of medical air support (Thomson and Thomas 2003). These guidelines are generally used worldwide by different organizations according to the region, resources, and geography. Table 2.1 gives an overview of the key selection factors for the usage of HEMS which are mutual in the following three guidelines as mentioned by (Lenz, Kossyreva, and Colella 2019).

1. National Association of EMS Physicians (NAEMSP)
2. Wisconsin Helicopter Emergency Medical Services
3. Commission on Accreditation of Medical Transport Systems (CAMTS)

Table 2. 1. Key selection guidelines (Lenz. 2019)

1	The patient is in critical condition and needs quick medical aid, which cannot be provided by a ground ambulance.
2	The patient is having a more significant trauma score and can be transported to the near trauma center.
3	Provision of critical care at a geographically remote region within a limited time window cannot be met by ground ambulance.

2.5.2 Use of HEMS in Norway

(Johnsen et al. 2020) has conducted a retrospective cohort study. The aim was to show an overview of HEMS regarding the structure, management, and performance in Norway by focusing on the tasks, challenges, preparedness, and future improvement. The medical database LabasNG from three HEMS bases was used for the period 2000-2016. The HEMS bases covered mountains, urban areas, and terrains in Lørenskog, Ål, and Arendal. The missions which were not medically relevant were excluded. Only medically relevant missions were included with variables of incident nature, tasks, resources, challenges, reaction time, and condition of the patient (Vlok and van der Berg 2020). The major incidents identified were road travel accidents and hiking accidents, which mainly occurred in rural areas. The majority of them happened in summer during daylight. The main tasks performed by HEMS were the treatment and transporting of patients directly to the regional trauma center. Few incidents needed extra personnel and equipment such as a doctor, rescue paramedic, rescue dog with a handler, stretchers, triage equipment, and medical aid (Johnsen et al. 2020). The major challenges identified by the researcher in HEMS missions were unsuitable weather for flying, ongoing fires, uneven terrain for landing, and in some cases, communications problems.

2.5.3 HEMS response time in Norway

(Jansen et al. 2015) has argued and questioned the location of different air ambulance base locations in Norway with a unique perspective on whether they are optimal for rural and urban landscapes. 12 HEMS bases are working in Norway, providing advanced medical transport care (NOU 1998). The help of mathematical modeling has been used to run a maximal covering location model (Church and ReVelle 1974) to get the optimal location and number of bases required to run the current setup (Murray 2015). The population was divided into a 1 km x 1km grid of all the 428 municipalities with a threshold time of 45 minutes (St.meld 2000) to finish the rescue operation. In the model, different parameters were used including, speed, current base locations, helicopter type, and flight time. After running the model, the optimal bases stated by the model were ten which can cover the whole population of Norway that can save the resources (Roislien et al. 2017). Erik (2014) researched the actual flying time taken by HEMS during the rescue process and the missions with different human life severity levels in Norway. The data used for analysis consisted of the total helicopter flying time from the base to the accident site, the municipality where the

rescue operation was performed and the severity level of the patient's condition having the score from the National Committee on Aeronautics to understand the idea that, does the current EMS system fits for all rescue mission? Every rescue helicopter included a pilot, paramedic team, an anesthesiologist (Zakariassen, Uleberg, and Roislien 2015).

In 2002, (Heggestad and Børsheim 2002) published results on the convenience and distribution of the Norwegian national air emergency service. Their study indicated that the mean reaction time of 8 minutes was taken in acute missions (from the ringing of alarm until takeoff), and the mean total responsive time from alarm until scene arrival was 26 minutes collectively. However, approximately 98 percent population was reached within 60 minutes. In case of emergency, the level of severity is characterized by emergency medical communication centers before deciding HEMS dispatch for a particular mission. NACA is an international severity score that is used within the air medical society to rank the seriousness of the illness using values ranging from 0 (no health-related problem) to 7 (death), as shown in the table (Raatiniemi et al. 2013).

Table 2. 2. NACA scoreboard (Heggestad. 2002)

Score Level	Patient's Status
NACA 0	No injury or illness
NACA 1	No acute disease or injury
NACA 2	Acute intervention not necessary; further diagnostic studies needed
NACA 3	Severe but not life-threatening disease or injury; hospitalization necessary
NACA 4	Development of vital (life-threatening) danger possible
NACA 5	Acute vital (life-threatening) danger
NACA 6	Acute cardiac or respiratory arrest
NACA 7	Death

(Services. 2015) focuses that each municipality in Norway has the responsibility to provide out-of-hour services that constitute one on-call GP and the availability in out-of-hour emergencies. Nine municipalities of Sogn and Fjordane reorganized their all-out-of-hour services in 2019, such a way that only one large medical facility in Førde was responsible for all the out-of-hour services for an area of 6400 km^2 and 35000 inhabitants. The data used

for the study (Havard.Wahl.Kongsgaard. 2015) was based on all the HEMS dispatches in Sogn and Fjordane for 2004-2013. The HEMS base at Førde registered the patient data, operational data, timeline, and cancellation reports in their database. The analysis of data was done as dispatches/1000 inhabitants. Distances were measured by using coordinates of the postal code between the out-of-hours service and the municipalities (Raknes and Hunskaar 2014). The processing of data was done by statistical analysis using the interrupted time series regression method (Lopez Bernal, Cummins, and Gasparrini 2016).

The study (Nystøyl et al. 2020) showed that relocation increased the average driving distance to 100 km with 1 hour and 45 minutes with more dispatches for the rural area than urban area. Before the relocation in 2009, the average driving distance to the out-of-hours medical service was 45 km with 40 minutes of driving (Havard.Wahl.Kongsgaard. 2015).

2.6 Causes and effects of unavailability of HEMS on patients

Some areas located far from big cities and with a low population generally have small medical facilities. For intense medical attention, patients are referred to nearby, more extensive medical facilities. In-country like Norway, HEMS carries out the emergency transfer of patients. Some situations arise when the need for HEMS increases and is not available. In the literature, some researchers had presented such a study when HEMS was not available due to reasons, and patients were transported by ground ambulances to the hospital. The study was carried out on one of the bases of Norway located in Sogn and Fjordane. The HEMS base at Førde covers the central part of the region with one way flying time of 20 minutes. In this region, the HEMS activities were also conducted by neighboring countries when required. In addition to that, the military performs search and rescue operations (Zakariassen et al. 2019). In Sogn and Fjordane, there are three hospitals, which provide services related to medical emergencies. If the patient's severity level is high, the patient is transported to Bergen (Haukeland University Hospital).

The related mission reports were assessed, which showed the reasons for the non-availability of HEMS. The main issues were unsuitable flying conditions, technical issues, and exceeding duty time (L. 2016). Further, the study concluded that the affected patients who did not receive quick medical attention had to wait long hours for ground emergency services to rescue them. Few people had severe life-threatening conditions, and some took more time to recover from trauma (Østerås, Brattebø, and Heltne 2015).

2.7 Offshore helicopter operations

Offshore operation is a term used for the activities over the water, with objectives needed to be completed away from the land (Stuhr et al. 2016). Working on offshore platforms with the oil and gas industry is very harsh and challenging. These conditions increase occupational injuries by 50% compared to other working environments (Pelat and Awotula 2014). In recent years, due to high oil consumption globally, offshore companies need a high workforce to work in these operations leading to an increase in the chances of injury. Thus, HEMS is considered a suitable transport medical ambulance to evacuate patients from remote offshore structures to the nearest medical facility (Taylor et al. 1993).

In an emergency on offshore oil rigs, an onboard medical officer can always perform primary medical treatment. In severe and complex cases, patients need to be transported to the onshore medical facility due to limited resources available on the offshore platforms (Ponsonby, Mika, and Irons 2009). Each offshore HEMS crew consists of an anesthetist nurse, a specialist for the rescue operation, a hoist specialist pilot, and a co-pilot (Taber, Carroll, and Douglas 2012). The pilot and the rest of the crew are well trained to carry out rescue activities over offshore structures (Kozey et al. 2009). The anesthetist nurses must pass yearly certification on an advanced life support system to keep working in the offshore emergency missions (Evensen AMC and G. 2006). In addition to that, there is an onshore doctor available who can be contacted by phone call or video call throughout the mission if early medical treatment is necessary (Ponsonby, Mika, and Irons 2009). However, these emergency evacuations can be affected by bad weather conditions. It usually takes 5-6 minutes for the helicopter to take off during the day.

In comparison, night operations require 20-30 minutes (Cox 1970). For better visibility at night, all crew members are equipped with night vision glasses. A study from Norwegian offshore rigs reveals that the average rescue time for an entire HEMS mission ranges up to 3.8 hours with a flying limit of 18.5 km from the coastline(Samdal et al. 2018).

A study conducted on emergency response calls in Norway concluded that all emergency missions were prioritized into three categories. According to the emergency index of medical assistance (red, yellow, and green). The red response is a life-threatening condition, yellow describes not life-threatening but urgent, and green represents the stable condition. The nurse

is responsible for deciding the severity category of the patient after the preliminary inspection (Lexow 2012). The severity category was based on an 8 point scale made by NACA to estimate a patient's prehospital condition. (Tryba M, Brüggemann H, and V. 1980)

In literature, several researchers have focused on safety-related issues while performing offshore medical operations (Howson 2006, Nascimento, Majumdar, and Jarvis 2012a, Nascimento, Majumdar, and Jarvis 2012b, Robinson et al. 2008, Rowe, Howson, and Sparkes 2005, Taber 2013, 2014, 2016, Taber and Taber 2020). The main challenges that affected the HEMS activities were communication, decision-making, facility layout, logistical issues, weather conditions, protocols, standard operating procedures, and poor offshore injury reporting (Huzaini et al. 2019). Improvement is currently being made by introducing advanced medical equipment and training the crew with intense exercises to compete for the discussed challenges (Burt 2020).

2.8 Covid-19 and helicopter emergency medical services

In December 2019, the novel coronavirus was discovered in Wuhan, China. Within a short passage of time, this airborne virus spread throughout the world and was later declared a pandemic by World Health Organization (Sohrabi et al. 2020). The spread of the coronavirus resulted in several casualties worldwide, and people who needed emergency medical services, especially related to transportation from one facility to another, also raised (Lopez et al. 2020).

The helicopter emergency medical services have been proven very useful in response to the covid-19. Italian government used military helicopters extensively to transport patients when the virus was expanding rapidly (Parsons 2020). The infection spread mainly through minute respiratory droplets from the infected one, contaminated surface, and medical equipment (Khan et al. 2020). The current helicopters used in regular emergency services could not give an isolated environment that protects crew and pilots from this airborne virus. The helicopters were modified with safety protocols and special medical training to contain the virus while keeping up the HEMS operations (Liew et al. 2020). The safety protocols were followed in flight operations, dispatch, medical crew, protection equipment, and patient care (Alexander, Masters, and Warren 2020, Osborn et al. 2020). (Hilbert-Carius et al. 2020) researched with the help of six European countries (Austria, Denmark, Germany, Luxembourg, Norway, and Switzerland) to study the experience of HEMS during the

transportation of covid patients. Almost all countries used patient isolation units that provided all the necessary medical assistance to the infected patient but kept the crew and the pilot safe (Albrecht et al. 2020).

Chapter 3. Institutional logics approach

This chapter will present the institutional logics approach as our theoretical framework to explore different institutional logics within HEMS in Norway.

Within the field of organizational studies, Alford and Friedland (1985) were the first to present and describe the idea of institutional 'logics' that emphasized the inter-institutional structure and its inconsistencies, such as market, family, organizational logics (Friedland & Alford, 1991). The normative aspects of institutions and intra-institutional moral inconsistencies within organizations were the subject of Jackall (1988). Using these as a foundation, Thornton and Ocasio (1999) created their concept of institutional logics that they defined as

> *"socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values, beliefs by which individuals and organizations provide meaning to their daily activity, organize time and space, and reproduce their lives and experiences"* (Thornton et al., 2012, p. 2).

As a metatheory of institutions, institutional logics can describe homogeneity and heterogeneity (Thornton et al., 2012) as

> *"A core premise of the institutional logics perspective is that the interests, identities, values, and assumptions of individuals and organizations are embedded within prevailing institutional logics*" (Thornton et al., 2012, p. 6).

The framework based on the work of Pache and Santos (2013) focuses on how individuals within an organization perceive and react to competing for/conflicting logics. Individual responses to a given logic within given organizations are based on how closely they conform to that logic, according to Pache and Santos (2013). Organizations and their different actors require adherence to a specific logic or multiple logics to satisfy institutional referents. The level of response by a person may be affected by concerns about social acceptance, rank, and identification external to the organization. (DiMaggio & Powell, 1983).

The institutional logics approach emphasizes actors' social identities in influencing interactions with others and how these social identities interact with organizational logics (Thornton et al., 2012). Further, it goes beyond the idea that cognitive scripts and theories justify the irrational acceptance of such behaviors. (DiMaggio & Powell, 1991; Friedland & Alford, 1991). The objective here is to integrate the various levels of analysis while also considering how institutions constrain and empower individual agencies and organizations. (Thornton et al., 2012). The principle of institutional logic is a useful tool for analyzing institutional change (Gestel & Hillebrand, 2011; Pallas, Fredriksson, & Wedlin, 2016; Scott et al., 2000; Thornton & Ocasio, 2008; Thornton, Ocasio, & Lounsbury, 2012).

Chapter 4. Methodology

This chapter presents all the methods, tools, and techniques we applied to reach our overall purpose during our investigation. It describes our philosophical view. The main aim of presenting this chapter is to support our analysis by conducting a systematic study to justify our research questions. After this, the research design is elaborated, along with our case study based on our investigation. The process of our data collection and data analysis is further presented in detail. Additionally, the ethical consideration of our study is given.

The methodology describes the actions to be taken during an investigation to investigate a research problem and the different procedures used to identify and analyze the research problems. Therefore, this section helps the reader to evaluate the research's overall reliability and validity. This section of the investigation describes the data collection process, its analysis, reliability, and validity as per our research questions (Kallet 2004).

Since the main objective of our master's thesis is to investigate the supply chain management resilience with the help of HEMS, the most valuable source of our information and knowledge is based on the previous research papers & articles held explicitly around the topic of our master's thesis.

4.1 Philosophical views

Scientific research philosophy is vital because it is a system of thought that leads to new, reliable knowledge about the research phenomenon. In most of the conducted research studies, it is essential to understand the fundamental philosophy and methodology used in the investigation by the researcher (Kallet 2004). According to (Saunders et al. 2019), there are two prominent philosophical positions, also called paradigms, underpinning social science research: positivism and interpretivism. The researchers mainly adopt these two. In the social sciences, positivism is usually defined by quantitative approaches that test hypotheses. In contrast, interpretivism or social constructivism, also known as anti-positivism, believes that social phenomena are caused by social actors concerned with their lifes' perceptions and subsequent actions.

The adopted philosophy in our research is interpretivism; the reason behind employing this philosophy is its unique understanding of data and one’s perception, as support to provide

the finding information and facts during an investigation. In this philosophy type, the qualitative approach/method is applied to in-depth investigation to support the researcher's findings. The researcher's perception, which they believe people are attempting to comprehend the world they live and work in. Study participants' views, ideas, and experiences are used in studies based on interpretivism assumptions (Creswell 2014). As a result, interpretivism typically employs qualitative research techniques such as ethnographic fieldwork and open-ended interviews.

With our thesis, initially, we conducted a literature review based on the research papers and articles written explicitly on Norway (Skjærseth et al. 2021, Nystøyl et al. 2020, Johnsen et al. 2020, Samdal et al. 2019, Reid et al. 2019, Zakariassen et al. 2019, Bjornsen et al. 2018). Information about attributes and in-depth understanding about our selected topic was attained from primarily literature review and ranked according to the most valuable and supportive for our investigation. After conducting our literature review, we then prepared interview guides for our potential respondents to know the practical, factual information other than the knowledge based on our completed literature review.

The interviews were based on a general overview of the helicopter emergency medical service (HEMS) operations and SCM avoiding any sensitive information related to patients and the company. Our interview questions followed all the data protection protocols in Norway and were later published in the Norwegian center for research (NSD). (Saunders et al. 2019) suggested that to prove any theory or information, the researcher should analyze findings from the data. The data collected from our investigation was being processed into valuable information, which was analyzed objectively.

4.2 Research design

According to (Hollweck 2016), a research design connects the data collected and the formulated research questions. It is a credible plan for how the study will be carried out during the whole investigation, with the primary goal of ensuring that the outcomes of the data answer the research questions. However, there are three completely different research design methodology choices which are following (Saunders et al. 2019):

1. Quantitative, using a numeric approach
2. Qualitative, using the non-numeric approach
3. The combination of both above approaches

The quantitative research method deals with the processing and analysis of numerical data. It is expressed in terms of numbers, figures, graphs, tables, and patterns. Generally, this type of research is done to support or reject a hypothesis. Standard techniques used are numerical observations, well-structured interviews, questionnaires, and surveys. In comparison, the qualitative research method deals with the processing and analyses of non-numerical empirical data. This type of research is carried out to understand deeper insights into the problem by individual ideas, thoughts, experiences, and how they react. The standard techniques to conduct qualitative research are semi-structured in-depth interviews (individual or group), case study research, documents, and behavioral observations (Wright et al. 2016, McCombes 2019).

We chose a qualitative research design for our investigation because it is best suited for conducting in-depth and descriptive research to gain a comprehensive understanding of our selected topic on helicopter emergency medical services in Norway. Therefore, we consulted with our supervisor and mutually agreed to conduct a qualitative approach on our chosen topic. This design helped provide deeper insights into how HEMS are organized and managed in Norway and exploring main actors' opinions, views, experiences, and actions during emergency operations when an emergency took place and patients required urgent medical assistance from an extremely remote region. As our study is related to real-life events, two semi-structured interviews were conducted to understand the perspective of the respondent’s point of view. This unique perspective has enabled us to investigate our research questions close to the directly associated people with these emergency medical services in

Norway. The interviews provided us with an understanding of the decisions and procedures made during an emergency operation.

According to (Scott 2015), questionnaires and interviews are standard methods for gathering data and interpreting the results. In this thesis, pre-defined interview guideline questions were used to conduct video and telephonic interviews with our respondents. These are two standard methods that (Scott 2015) highlights. Considering the thesis's limited timeframe, this supports the decision to use the qualitative method of data collection for our masters' thesis.

4.3 Case study

There are various definitions of a case study in literature. However, there are no clear boundaries for how a case study should be defined and implemented among researchers (Yazan 2015). When deciding on a case study approach for this master's thesis, we were inspired by Robert Yin's work. According to (Yin 2018).

> "*an empirical method that investigates a contemporary phenomenon in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be evident*."

Since our research questions attempt to address "how" and "why," we decided to apply a single case study approach for our master's thesis; this approach will help us better understand complex organizational methods from different perspectives. Secondly, it will provide access to information that is not readily available to the general public. Finally, it will allow us to focus on a single problem in detail that cannot be achieved through multiple case studies with a large sample size and statistical analyses.

Our case will present emergency supply chain operations, emergency preparedness challenges, HEMS response time, government policies, and resilience provided by HEMS in the Norwegian healthcare sector. Being a small country with extensive networks of rail and roads, still creating a need for air support in transporting patients from highly remote areas to the more extensive well equipped medical facilities (Ozcan, Han, and Graebner 2017).

4.4 Data collection

During the study, there are two types of techniques for data collection. These techniques are primary data collection and secondary data collection. In our investigation, we have used both data collection methods. Yin (2009) suggested that it is essential to use multiple sources of evidence rather than rely on a single basis to provide a high-quality case study because various sources of evidence enable a researcher to explore a broader range of historical and behavioral issues.

4.4.1 Primary data collection

The primary data source is the specifically gathered knowledge by the authors that are directly relevant to the study goal (Saunders et al. 2019). We gathered empirical data from a variety of sources. Two semi-structured interviews were conducted. Table 3.1 provides the interview schedules and dates. We found semi-structured interviews to be beneficial for our investigation. Semi-structured interviews helped us carry out qualitative research, especially in services related to healthcare (DeJonckheere and Vaughn 2019, Harrell and Bradley 2009). According to Kreiner et al. (2005), semi-structured interviews enabled us to see how respondents derived meaning from their daily routines and interpreted the legal practices they were required to follow during their service. We used some analytical aspects during the interviews to enable a deeper shared understanding between the informant and the author. According to Bradford and Cullen (2012), qualitative semi-structured interviews were one of the most stimulating data collection practices in our whole investigation in a limited period.

Our interviews were based on our research criteria, relevant questions for our interview guide, and other information discussed and planned with our supervisor. For our master's thesis, we successfully conducted a couple of interviews with our respondents. The first interview was conducted with a volunteer helper in search and rescue missions from Bodø. The second interview was conducted with an anesthetist nurse from Ålesund. The first interview was conducted on Skype as per our agreed time. However, the second interview was held on mobile call due to the short availability of our respondents. Both interview guides were elaborated and sent to the respondents before the interview (See Appendix A and B). All the information was anonymous. We provided both our respondents with a letter

of consent. Both interviews were recorded and transcribed after we got permission from our respondents. These interviews provided us with valuable data that helped in the investigation of this master's thesis and was used as a primary data source for the empirical findings.

Table 4. 1. Interview overview.

Date of the interview guide sent	Date of the interview conducted	Respondents	Interview type
05.03.2021	28.03.2021	a volunteer helper in search and rescue missions in Bodø town	Skype
24.04.2021	27.04.2021	an anesthetist nurse who works onboard emergency helicopters in Ålesund town	Phone

The goal of our two interviews was to establish a dialogue between us (researchers) and the respondents. According to (Paradis et al. 2016, Sutton and Austin 2015), we followed our respondents and gently corrected them if the conversation veered off course. Later, we also kept in touch with them for any follow-on questions.

At the same time, we faced many challenges to arrange the interview conduction with potential respondents due to the global pandemic "COVID-19". Our investigation concerns the health sector. During this challenging time, privacy protection of patients' records and operations are considerable challenges in Norway. These challenges also limited us from the extraction of valuable information for our master's thesis. We found and tried to contact many potential respondents from several organizations, namely Norwegian Air Ambulance Service, Lufttransport, and Norsk Luftambulans, Kristiansund heliport (Kvernberg) Nordland regional hospital (in Bodø). We tried to reach them with phone calls as provided on their websites and sent many requests by email with a description of our investigation, inviting potential and relevant respondents to search for a chance to interview with us. Our potential respondents were in various Norwegian regions that provide HEMS and fixed-wing aircraft ambulance services. Due to the pandemic time, all these potential respondents declined to help us. It took a lot of time and energy to find these potential respondents in a

limited timeframe of our thesis. We, both authors of this master's thesis, are international students. We experienced many challenges with data collection because Internet resources provided most of the data about HEMS in Norway only in Norwegian. So, this thesis demanded extra effort to process the information into English to make it valuable for our master's thesis within the submission deadline.

4.4.2 Secondary data collection

Secondary data sources are accumulated, mainly from press releases, archived medical reports from the hospitals, HEMS mission reports, annual reports, Norwegian government policy for HEMS, existing articles, statistical data, current regulations, Health Norway (HelseNorge) website, and air ambulance(luftambulanse) website. For this master's thesis, secondary data were essential because of the limited number of respondents we could interview. Therefore, secondary data is mainly used as a credible and primary data source for this master's thesis.

4.5 Data analysis

The processing and analysis of gathered data are based on content analysis (Saunders et al. 2019). Content analysis was helpful for us to find connections and patterns based on recorded communication content and evaluate the meaning of a large amount of data gathered from multiple sources. We identified the keywords and definitions provided by various texts during the data analysis, including the interview transcriptions, the laws and archival materials, emergency medical services' performance, and patient transportation by helicopters in Norway. These keywords were considered practical terms in various texts in collected data to determine how the Norwegian government regulates the performance of HEMS and how the behaviors of different actors involved affect patient transportation in any emergencies. The content analysis was critical in choosing the desired content of various texts to interpret organizational and individual behavior when providing ambulance services by helicopters.

Further, we defined units built on questionnaires of what, where, when, and who; using the defined units, additional categories were made, and then the defined units were organized into predefined categories. We also recorded the relevant data in the appropriate variety.

Finally, we examined the collected data, found patterns, and answered the research questions. These steps were done according to (Bengtsson 2016, Erlingsson and Brysiewicz 2017, Clootrack 2018, Luo. 2019). The Content analysis was helpful in our master's thesis ensure that our collected data is reliable, specific, and transferable to other settings and provides continuity in future research.

4.6 Research Quality

The evaluation of qualitative research (Bryman and Bell 2015) recommends evaluating research quality based on trustworthiness and authenticity. Reliability consists of four parts which contain dependability, transferability, credibility, and conformability. These factors were assessed to ensure the trustworthiness and authenticity of this thesis.

Credibility is the initial step in evaluating and analyzing the research to investigate its trustworthiness. To analyze and assess the credibility of our thesis. Firstly, different literature reviews were conducted in which a preliminary case study background about helicopter emergency medical services in Norway was addressed. This study was based on our selected keywords for the thesis. Secondly, the secondary data has been examined involving academic literature, and relevant theories studied on the interview guide, and the research framework for our thesis has been compiled.

Transferability is the second most element of trustworthiness and authenticity. (Bryman and Bell 2015) stated that the transferability of a thesis is used to assess its generalizability. The study defines the HEMS challenges and supply chain consequences of the onboard crew members during an emergency operation. However, it also helps the reader to have a general idea about the difficulties during a rescue mission.

The third and fourth factor is dependability and conformability, which show consistency and biasness, respectively. Dependability in research refers to the research's consistency, which implies that it is repeatable by a new researcher in a diverse setting, and new researchers can trust the findings of the previous researchers. Lastly, conformability is all about the evaluating level of biasness of the respondents, which they are showing during an interview (Bryman and Bell 2015). Our thesis is based on a qualitative single case study, so it is quite impossible to check the conformability, and it is also not necessary. In such qualitative

research, conformability can only be determined by researching and analyzing the prior study and evaluating them while accepting or rejecting them concerning the research objective. This evaluates the significance of choosing appropriate and relevant literature while also considering the authors' meaning aside, which is greatly felt in the investigation.

4.7 Validity and reliability

Creating trustworthy and accurate research is, no doubt, a top priority for any researcher. On the qualitative research, there are many factors to consider when conducting credible research in the field of supply chain management, including "transferability and contextualism" and "trackability and explicitly."(Halldorsson and Aastrup 2003). Yin's design was used as the primary methodology for ensuring validity and reliability in this master's thesis. His system consists of four individual tests, each of which is an updated version of the others: (i) Construct validity, (ii) Internal validity, (iii) External validity, and (iv) Reliability, as presented in Table 4. Since internal validity tests are uncommon in exploratory research, the thesis will concentrate on construct validity, external validity, and reliability (Runeson and Höst 2008).

Table 4. 2. Case-study tactics for four design tests (Yin, 2018).

Tests	Case study tactic	Phase of research in which tactic occurs
construct validity	use multiple sources of evidence	data collection
	establish chain of evidence	data collection
	have key informants review draft case study report	Composition
internal validity	do pattern matching	data analysis
	do explanation building	data analysis
	do time-series analysis	data analysis
external validity	use replication (logic in multiple case studies)	research design
reliability	use case study protocol	data collection
	develop case study data base	data collection

4.7.1 Construct validity

It is necessary to identify the appropriate operational measures for the concepts being studied to ensure validity. Under this theme, three steps must be considered: sources from multiple evidence, a chain of evidence, and the draft report reviewed by the informants (Runeson and Höst 2008). As previously mentioned, we gathered primary data from our two conducted interviews. However, secondary data was collected from three sources: literature review, HEMS providing companies codes of ethics, and other relevant information from current affairs in Norway.

As recommended by (Runeson and Höst 2008), a chain of evidence was also attempted to be established. Keeping save all interview transcripts, translations, and a record of our respondents, i.e., while writing and coding, we as authors can trace the information back to its source of the channel. By doing this, it strengthened the reliability. Lastly, both of our respondents were told that the researchers must audio record the interviews to write an accurate and complete transcript of what was said. This transcript was then sent to all informants for review and confirmation and the interviewee for any needed adjustments.

4.7.2 External validity

External validity is described by (Yin 2018) as

> *"The extent to which the findings from a case study can be analytically generalized to other situations that were not part of the original study."*

It addresses to what extent the results of this exploratory case study can be applied to other case studies as mentioned by (Runeson and Höst 2008). Case studies often take an abstract generalization approach. The findings are contrasted with other cases with similar characteristics to assess generalization potential (Runeson and Höst 2008). Therefore, it is essential to link the theory to the literature available to compare the results. A contrast of this kind can assist in addressing and explaining contradictions or shortcomings in the literature. This improves generalizability by introducing new information during the investigation by the researchers. For our thesis, we applied a single case study approach, which helped us reinforce the generalization by comparing the literature findings with our

conducted interviews. According to (Liew et al. 2020), one critical element of research reliability is

"*rival explanation for your findings*."

He argues that the more "rival theories" there are, the more accurate and reliable the analysis would be. Additionally, both our findings and the results of others would generate ideas for future studies and thereby make the research investigation acceptable. Therefore, we had conducted two semi-structured interviews. The empirical results discovered in this thesis have the potential to be generalized to the literature. The literature discussed in this research and other related literature has been carefully considered and reviewed. To promote generalizability, we have used literature and previous studies as a guide for the interviews.

4.7.3 Reliability

The reliability objective is to ensure that another researcher achieves the same results by following the same procedures as we did when collecting the data. According to (Yin 2018)

"The goal of reliability is to minimize the errors and biases in a study."

Furthermore, (Yin 2018) emphasizes that documenting the procedures and techniques used in the case study is vital in demonstrating reliability. When gathering the data, a structured approach was used to maintain a chain of evidence and reviewing and preparing the interview guide under the support of our supervisor. Before proceeding with data collection, a test pilot of the interview guide was conducted with an experienced professional. We were always two people running the interviews, supporting each other, and reviewing the information. Interviews were always between 60 and 90 minutes long. As (Creswell and Creswell 2018) suggested, transcripts of all interviews were created and reviewed together for errors and follow-up questions. We met regularly during this thesis through WhatsApp and Zoom video conferences, exchanging information, daily progress and discussing the analysis together. According to (Huyler and McGill 2019),

"This improves the results' reliability."

4.8 Ethical considerations

During data collection for our research, the relationships between us (researchers) and participants can raise various ethical concerns. These concerns may include privacy protection, establishing friendly and honest interaction between parties (researchers and participants), and avoiding misrepresentation. According to Richards and Schwartz, the word ‘confidentiality’ delivers different implications for health care practitioners and researchers. For the Practitioner's concerns, confidentiality means no revelation of patients' personal information except in certain conditions (as per agreed terms). However, for researchers, the responsibility of confidentiality is less clear and may require the elaboration of the results out of that research. Therefore, we are aware of the ethical concerns related to our research work and later for our master’s thesis (Bell and Bryman 2007).

Chapter 5. Context description

This chapter describes the contextual settings for our investigation about emergency supply chain operations by helicopters in Norway. Further, this chapter emphasizes the importance of HEMS in Norway, their operations, companies providing these services, division of regions, and location of HEMS bases.

5.1 HEMS operations in Norway

HEMS is an incorporated part of the Norwegian medical health care system due to one of the highest-income countries in Europe (WHO Emergency care system framework, 2018) (Taylor et al. 2011). The main advantage of HEMS in Norway is to deliver progressive interventions ahead of traditional most emergency medical services (EMS), such as shorten response time and providing access to challenging locations that are not reachable by any other mode of transportation (Reid et al. 2016, Røislien et al. 2018). EMS like HEMS is very limited and expensive to operate, so identifying and providing efficient use of HEMS is very important. To gain the most availability and optimal use of air ambulance, resources for HEMS guidelines and dispatch of the helicopter must be available for the safety and risk involvement of HEMS mission is very significant. Any lack of comprehensive and consistent flight operation concerning safety technology must be identified by the safety board (Haugland et al. 2019).

In Europe, European civilian air medical transport is responsible for European union aviation safety regulations. However, the Norwegian air ambulance (Norsk Luftambulance AS) operates all the HEMS operations 24 hours and seven days a week in Norway. A flight followed by a team and physician-staffed model was first initiated from the inspiration taken from West Germany and Switzerland, which continuously monitors the HEMS operations visually by using a transponder technology and with the help of radio communication. This system follows the operations from the takeoff to the landing of the helicopter. The HEMS operations are mainly performed in controlled airspaces, while Nordic geography offers a poor flight radio coverage range below the commercial flight level. Therefore, it is not feasible for the air transport services to perform flight following for the HEMS (Skjærseth et al. 2021). In the case of a no-flight scenario, the alternative transport method for the crew is to use rapid response cars that are present on all HEMS bases. For sea and land rescue,

Westland Sea King helicopters were used with bigger cabin space to transport patients to the nearest medical facility or trauma center.

In January 2017, the ministry of health in Norway agreed to centralize the Coordination and flight following operations of HEMS into four different regional emergency communication centers (EMCCs) instead of 12 regional EMCCs situated near the HEMS bases. This decision of the Norwegian government was based on the reports published in 2016 and several reports recommending a more centralized coordination system for HEMS (Government 2015). Cruel incidents like the mass assassination at Utøya Island on July 22, 2011, along with the disastrous HEMS crash at Sollihøgda in 2014, preceded to improve the HEMS flight following and coordination within Norway (Health 2012). With the help of a centralized system, all the local EMCCs were expected to ensure less disintegrated and highly efficient use of HEMS resources during an emergency operation.

5.2 HEMS bases in Norway

The geographical division of Norway consists of 4 regions concerning air emergency services, as illustrated in Figure 1 (Luftambulanse 2021). The bases located in these regions provide HEMS and fixed-wing aircraft ambulance services as well. The regions are divided into Health-North (Helse- Nord), Health Central (Helse-Midt), Health-West (Helse-Vest), and Health-South-East (Helse-Sør-Øst). Every HEMS base has a different owner, aircraft, operator, and liable hospital explained below region-wise.

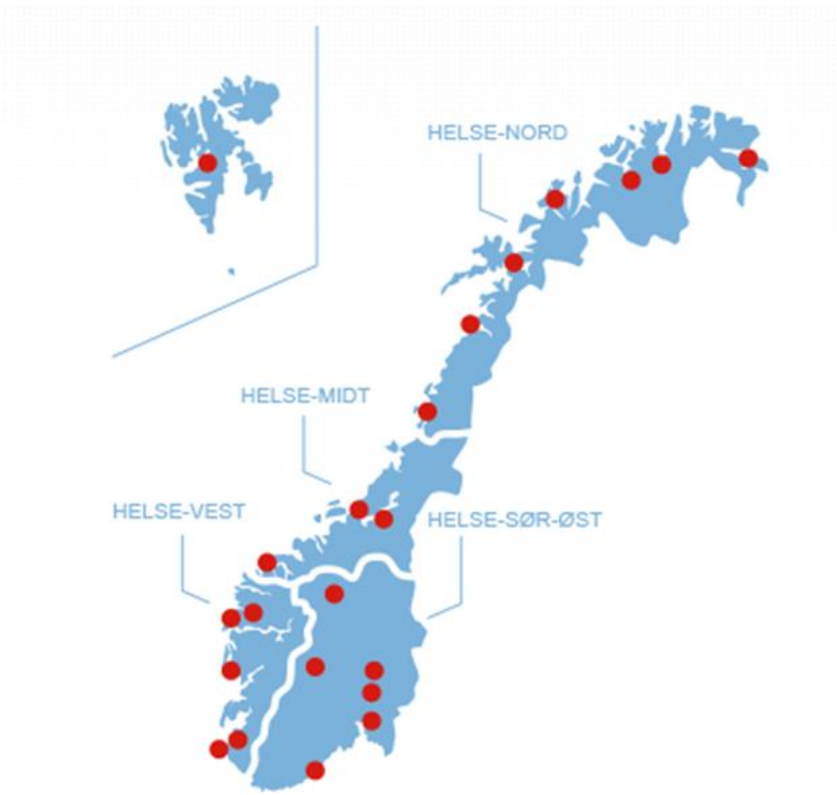

Figure 5. 1. Map of HEMS bases in Norway (Norsk lufthambulanse)

5.2.1 Health-North

5.2.1.1 Svalbard

Location: Longyearbyen Airport

Type: Rescue helicopter

Liable hospital: Universitetssykehuset Nord-Norge

Airline operator: Luftransport AS

Owner of the base: Avinor

Number of aircraft: 2

5.2.1.2 Kirkenes

Location: Kirkenes sykehus

Type: Ambulance helicopter

Liable hospital: Finnmarkssykehuset HF,

Airline operator: Norsk Luftambulanse AS

Owner of the base: NLA Solutions AS

Number of aircrafts: 1

5.2.1.3 Banak

Location: Banak Airport

Type: Rescue helicopter

Liable hospital: Finnmarkssykehuset HF

Airline operator: Air Force 330 Squadron

Owner of the base: The Air Force

Number of aircraft: 2

5.2.1.4 Tromsø

Location: Universitetssykehuset Nord-Norge

Type: Ambulance helicopter

Liable hospital: Universitetssykehuset Nord-Norge

Airline operator: Norsk Luftambulanse AS

Owner of the base: Universitetssykehuset Nord-Norge

Number of aircraft: 1

5.2.1.5 Evenes

Location: Evenes airport

Type: Rescue helicopter

Liable hospital: Nordlandssykehuset Bodø

Airline operator: Air Force 330 Squadron

Owner of the base: The Air Force

Number of aircraft: 1

5.2.1.6 Bodø

Location: Bodø airport

Type: Rescue helicopter

Liable hospital: Nordlandssykehuset Bodø

Airline operator: Air Force 330 Squadron

Owner of the base: The Air Force

Number of aircraft: 2

5.2.1.7 Brønnøysund

Location: Brønnøysund Airport

Services: Ambulance helicopter

Liable hospital: Helgelandssykehuset HF

Airline operator: Norsk Luftambulanse AS

Owner of the base: Norsk Luftambulanse AS

Number of aircraft: 1

5.2.2 Health-Central

5.2.2.1 Trondheim

Location: Brønnøysund Airport

Services: Ambulance helicopter

Liable hospital: St.Olavs hospital

Airline operator: Norsk Luftambulanse AS

Owner of the base: NLA Solutions AS

Number of aircraft: 1

5.2.2.2 Ørland

Location: Brønnøysund Airport

Services: Ambulance helicopter

Liable hospital: St.Olavs hospital

Airline operator: Air Force 330 Squadron

Owner of the base: The Air Force

Number of aircraft: 2

5.2.2.3 Ålesund

Location: Ålesund Sykehus

Services: Ambulance helicopter

Liable hospital: Ålesund sykehus

Airline operator: Norsk Luftambulanse AS

Owner of the base: Helse Sunnmøre HF

Number of aircraft: 1

5.2.3 Health-West

5.2.3.1 Førde

Location: Førde sentralsjukehus

Services: Ambulance helicopter

Liable hospital: Førde sentralsjukehus

Airline operator: Norsk Luftambulanse AS

Owner of the base: Helse Førde HF

Number of aircraft: 1

5.2.3.2 Florø

Location: Florø airport

Services: Rescue helicopter

Liable hospital: Helse Førde HF

Airline operator: CHC Helicopter Service

Owner of the base: The Air Force

Number of aircraft: 1

5.2.3.3 Bergen

Location: Nygårdstangen

Services: Ambulance helicopter

Liable hospital: Haukeland Universitetssykehus

Airline operator: Norsk Luftambulanse AS

Owner of the base: Helse Bergen HF

Number of aircraft: 1

5.2.3.4 Sola

Location: Sola airport

Services: Rescue helicopter

Liable hospital: Helse Stavanger HF

Airline operator: Air Force 330 Squadron

Owner of the base: The Air Force

Number of aircraft: 16

5.2.3.5 Stavanger

Location: Stavanger Universitetssjukehus

Services: Ambulance helicopter

Liable hospital: Stavanger Universitetssjukehus

Airline operator: Norsk Luftambulanse AS

Owner of the base: NLA Solutions AS

Number of aircraft: 1

5.2.4 Health-South-East

5.2.4.1 Dombås

Location: Dombås, Oppland

Services: Ambulance helicopter

Liable hospital: Sykehuset Innlandet HF

Airline operator: Norsk Luftambulanse AS

Owner of the base: NLA Solutions AS

Number of aircraft: 1

5.2.4.2 Ål

Location: Hallingdal else enter

Services: Ambulance helicopter

Liable hospital: Vestre Viken HF

Airline operator: Norsk Luftambulanse AS

Owner of the base: Vestre Viken HF

Number of aircraft: 1

5.2.4.3 Lørenskog

Location: Akershus universitetssykehus, Lørenskog

Services: Ambulance helicopter

Liable hospital: Luftambulanseavdelingen, Prehospitalt Senter, OUS HF

Airline operator: Norsk Luftambulanse AS

Owner of the base: Oslo Universitetssykehus HF

Number of aircraft: 2

5.2.4.4 Rygge

Location: Rygge airport

Services: Rescue helicopter

Liable hospital: Oslo universitetsykehus HF

Airline operator: Air Force 330 Squadron

Owner of the base: The Air Force

Number of aircraft: 2

5.2.4.5 Arendal

Location: Sørlandet sykehus Arendal

Services: Rescue helicopter

Liable hospital: Sørlandet sykehus HF

Airline operator: Norsk Luftambulanse AS

Owner of the base: Sørlandet sykehus Arendal

Number of aircraft: 1

Chapter 6. Empirical findings

In this chapter, findings regarding the historical development of HEMS in Norway, regulations, the actors involved in this service, the challenges faced during the transportation of patients from one point to another, the contribution of HEMS to emergency preparedness, and response operational supply chain are discussed. Those findings are supported by the primary data taken from the interview and the secondary data from the literature.

6.1 Historical development of HEMS in Norway

Presently, humans are moving away from big cities due to the increasing population in the world. This requires emergency SCM and preparedness to be more responsive by using air ambulance than land and water ambulance services. Due to the high risk of transporting patients, helicopter emergency medical services (HEMS) are emerging as the most critical mode of patient transport. The geographic location of Norway is characterized differently in mountain ranges, including many rivers, fjords, lakes, and remote islands. Therefore, HEMS is considered the most reliable rescue service. The first known patient transported with the help of an air ambulance in Norway was performed in 1932 with Viggo Widerøe as a pilot. In 2018, two Norwegian companies (Norsk luftambulanse AS and Lufttransport AS) (luftambulansetjenesten. 2017)successfully held contracts to provide air ambulance services by airplanes and helicopters. Considering the geographical location of Norway, seven sites have been selected for nine planes ambulance which covers (Kirkenes, Alta, Tromsø, Bodø, Brønnøysund, Ålesund, and Gardermoen), along with two aircraft bases for Alta and Gardemoen. While on the other hand, the helicopter air ambulance is assigned in 12 location in Norway including 13 helicopters in service, covering major cities (Tromsø, Evenes, Brønnøysund, Trondheim, Ålesund, Førde, Bergen, Stavanger, Arendal, Ål, Lørenskog, and Dombås). HEMS and search and rescue (SAR) contribute to transporting equipment, patients, and medical personnel for emergency incidents in Norway. Air ambulance service is funded by the national government and consists of 3 elements: HEMS, SAR, and fixed-wing air ambulance. The organizational structure of Norwegian helicopter emergency medical services and search and rescue (SAR) is crucial from the emergency supply chain (Johnsen et al. 2017).

6.2 Regulation of HEMS in Norway

In Norway, the HEMS-related regulations are interesting. Structure wise the fixed-wing air ambulance and HEMS come under the responsibility of the Ministry of Health and Care Services and are managed by four regional health establishments. The flight operations are outsourced by contracting different firms that manage the aircraft, pilots, maintenance of aircraft, medical equipment, and flight operations. SAR helicopters come under the responsibility of the Ministry of Justice and Public Security. These missions are performed by Royal Norwegian Airforce, the squadron, which is specially made for these operations. The unit is known as 330 squadrons all over Norway. The 330 squadrons are only used for civilian emergency operations, not for military commanded missions. During an emergency, the local communication center for medical interventions (EMCC) dispatches the HEMS from the nearest base in one of the four regions as mentioned above. The SAR missions are sent and managed by two joint rescues and coordination centers (JRCC) mutually.
Here one thing is worth mentioning that SAR units are used explicitly for SAR missions, and HEMS units are used for air ambulance missions but, the EMCC and JRCC work and coordinate mutually. During the emergency mission and on request, EMCC and JRCC can order SAR units for air ambulance services and HEMS units for SAR services. The mutual coordination between these two organizations is considered an essential aspect of the Norwegian national medical air support system.

The provision of the crew and medical staffing in SAR units and HEMS is the same. Today, the contracted company provides the pilot, whereas the local hospital provides the paramedic and the anesthesiologist doctor. Figure 6.1 below shows the organizational structure of Norwegian HEMS and SAR (Johnsen et al. 2017).

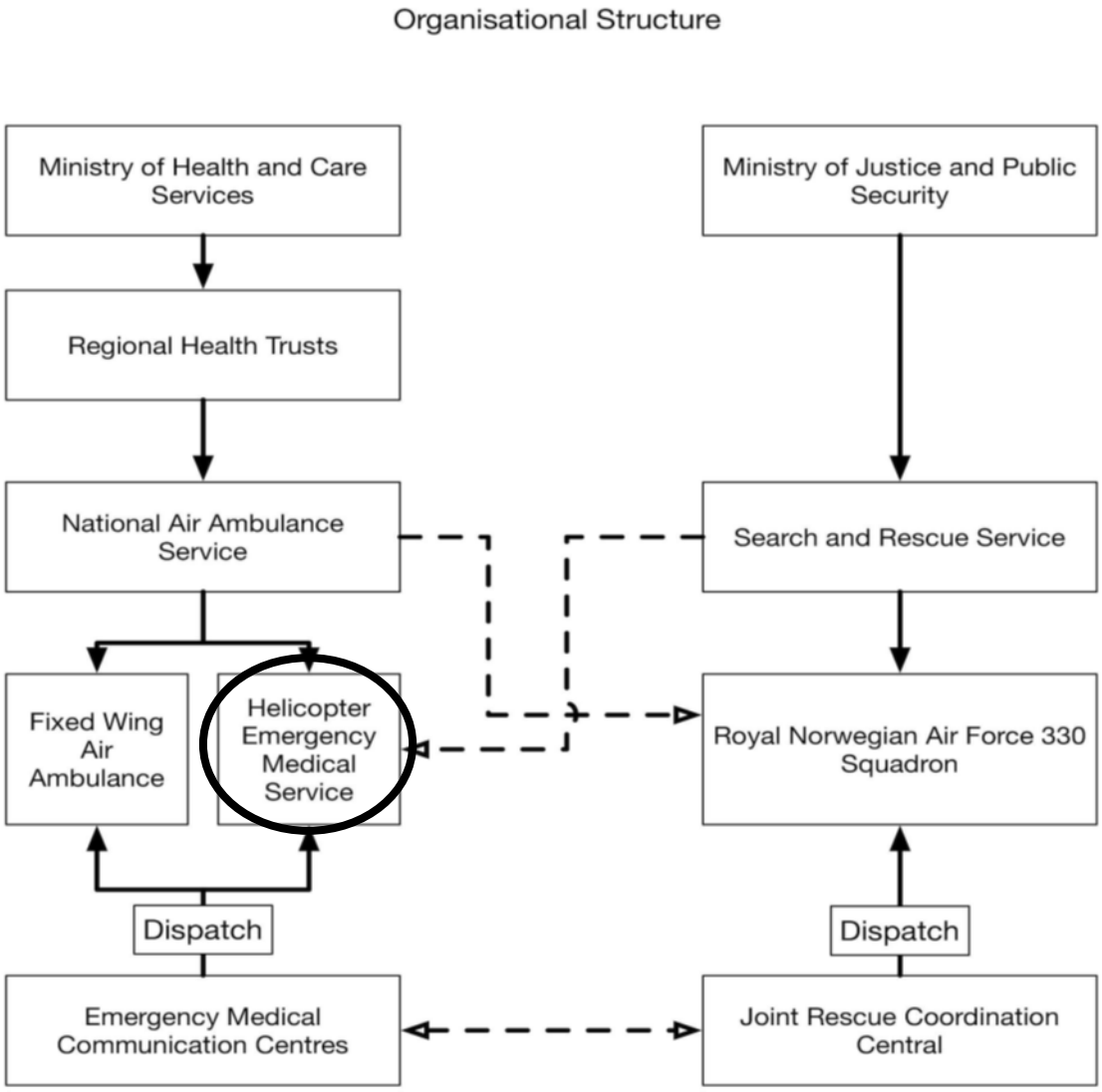

Figure 6. 1. Organizational structure of HEMS in Norway

6.3 Actors involved in HEMS in Norway

The organizational structure of HEMS is interesting. It consists of several actors who work as a team to carry out HEMS operations in Norway. As told by Respondent 2,

> *"the actors consist of a helicopter crew, emergency service helpline (Nødnett radio), medical emergency center (Akutt medisinsk nødssentral), police and the hospital."*

All these actors work mutually and coordinate to maximize the effectiveness and utilization of the available resources (helicopters, hospitals, and the HEMS crew). Every HEMS mission is carried out systematically. Respondent 2 added that their one shift consists of 48 to 72 hours. At this time, the whole crew is together on the base on stand-by. The emergency hotline in Norway is called Nødnett radio. All the emergency services and police use this radio to communicate and share information. This radio is always on. When there is a call for a mission, the alarm rings to alert the crew. The mission report is sent to the HEMS base from the emergency medical center (Akutt medisinsk nødssentral) with coordinates, patient condition, and lead time. Respondent 2 emphasized during the interview about the role of the pilot that

> *"the pilot is the chief of the crew and key person in providing emergency supply chain operations. The helicopter pilots have several duties and responsibilities."*

The duties and responsibilities of the pilot include inspection of the helicopter, instrumentation, pre-flight checks, flight plans, safety routes, pre-flight paperwork, weather forecast, and crew meeting. Before accepting the rescue mission, the pilot goes through the mission report. If he approves the mission on an operational basis, then the mission report is passed to the doctor who approves the mission on a medical basis. After both crew members approve the mission, they take off, rescue the patients from the specific location and transport them to the hospital. When the patient is transferred to the hospital, he is in the custody of the hospital. During the whole mission, the crew is in continuous contact with the emergency services through the radio. There are conditions when the HEMS crew needs mayday and back up. This disrupts the HEMS operations. The emergency medical center (Akutt medisinsk nødssentral) has a flight following service to deal with these situations. This service has to monitor the dispatched HEMS

unit throughout the mission, and if they encounter any problem, a backup helicopter is arranged. If the backup helicopter is not possible to arrange, then a rapid response ambulance is always available at the base for the backup service.

6.4 Challenges for patient transportation during HEMS in Norway

The operations of HEMS while transporting patients from the area of the incident to the hospital or trauma center may look very simple, but there are several issues which the crew and the whole HEMS team go through. The main challenges are discussed in the following.

6.4.1 Weather

Respondents mentioned bad weather in primary data sources, and many researchers also highlighted this as a challenge in secondary data sources. Respondent 2 added during the interview about no-fly conditions that.

> *"Due to the vast hilly landscape of Norway, the biggest and most common challenge faced by HEMS is the weather. Heavy snow, storms, fog, and strong winds create situations that are not suitable for flying".*

Weather creates unexpected and unreal challenges for the helicopter and the crew. The conditions can sometimes lead to the aircraft crash if the factor of weather is ignored. As told by Respondent 2 that,

> *"ice starts to form on the fuselage of the helicopter that makes it heavy. In every mission, safety is our priority."*

6.4.2 Development of new bases

HEMS is considered one of the most expensive emergency services that operate 24/7. The related costs are high due to aircraft usage, landing pads, airbase, and highly trained personals. Even in a wealthy country like Norway, few air bases in the Northern regions cover the population. As a state-run department, the government takes several decisions and estimations before developing a new HEMS base.

6.4.3 Treatment of patient on-board

After rescuing the patient, the treatment starts while the helicopter is in transit to the hospital. Treating the patient inside the moving helicopter is very different from treating the patient inside the ground ambulance or hospital. Respondent 2 emphasized that,

> *"the rotor of the aircraft produces a lot of vibrations and noise that creates challenges in communication and treatment."*

The medical staff of HEMS uses several hands and non-verbal signals to communicate with the patient and the rest of the crew. This communication barrier creates a further challenge in treating the patient and diagnosing the early symptoms in the helicopter.

6.5 Contribution of HEMS to emergency preparedness and response supply chain operations

HEMS aims to bring mobile medical services to the region where an incident occurs for triage, on-the-spot treatment, and transport. Catastrophic events that need immediate medical attention or transportation can happen in urban, rural, and remote areas. The tendency to manage this type of incident varies from country to country and region to region. In the Norwegian settings, the provision of acute medical services has been made easily accessible by all means. But considering it as an organization with the supply chain of treating patients from immediate neighboring areas to far remote areas can be challenging. Typically at the time of disruptions where the distances are far because of the long highways, tunnels, fjords, mountains, and unaccessible snow-covered paths in the mountain, it becomes nearly impossible to deliver emergency medical aid by ground services or the ground emergency medical services will take much time to rescue the patient. To avoid these types of

disruptions and to make the supply chain resilient, HEMS are used to deliver medical services to remote areas with 12 current bases all over Norway.
As told by Respondent 1,

> *"The Norwegian government is thinking to increase the number of bases in Norway to increase the emergency preparedness, but it is an expensive setup. On the other hand, increasing the number of bases will improve the rescue activities and lower the stress on some bases."*

After the disaster occurs, response supply chain operations take place to transport aid and medics to the affected area. These operations are not just limited to these activities. They contribute a significant role to disaster relief where the land access has been destroyed and only can be accessed by helicopters.
As emphasized by Respondent 1,

> *"When our team is conducting the search and rescue missions, there are some areas when it is hard for us to continue the rescue mission on the ground due to the terrain, vertical hike, or snow-covered paths."*

When the path is blocked, the groundcrew cannot carry out further search and rescue missions. They communicate with the HEMS crew to request airlift support. If the nearby HEMS is available, they provide transportation service to the ground crew in transferring their team members and equipment up to the mountains (desired area), where they are supposed to carry the search and rescue mission. This airlift support saves a lot of time and energy for the ground crew.

Chapter 7. Analysis and Discussion

The main findings of the thesis are analyzed and discussed in this chapter. This has been accomplished by conducting a single-case analysis, reflecting on the state-of-the-art knowledge provided in our literature review framework, and reviewing the literature. This Chapter addresses the insights and interpretation of our investigation that align with the existing literature.

7.1 Analysis of the empirical findings

Our findings have revealed one dominating "Safety" institutional logic. Organizations, such as emergency services, are affected by different contrasting institutional orders or logics (Friedland & Alford, 1991; Scott, 2001; Scott, Ruef, Mendel, & Caronna, 2000). Safety in air ambulance service aims to promote high standards for health and a secure working atmosphere. These high standards provide a systematic implementation of safety measures that comply with the requirements to achieve the workplace environment and safety legislation goals.

Emergency supply chain operations by helicopters are effective and efficient for providing medical services to avoid disruptions and delays in patient transportation. On the other hand, this type of transportation is one of the most dangerous and famous for many crashes for some reasons. This creates a paradox of the emergency supply chain operations provided by helicopters. The HEMS practice is well famous for numerous crashes. One of the most vivid examples of this was an EC-35 helicopter crash on 14 January 2014 in Sollihøgda, Norway. An experienced pilot of this helicopter lost control after colliding with unnoticeable power lines as it approached the scene of a road accident in Sollihøgda. This damaged the main rotor and caused the helicopter to lose altitude rapidly and crashing on the ground. The crash of this helicopter killed two of the three passengers and critically injured the third one.

At the same time, the pilot is the final authority for executing any HEMS flight from the aspect of safety rules and regulations. Therefore, it can be challenging for the government to provide equal access to helicopter ambulances to the civilians in need. From a pilot point of view, these challenges are crucial to be estimated and well-calculated, especially in bad weather conditions. Because of the careful risk analysis of the current situation by the pilot, patients in need of medical assistance might go unattended in the case of pilot rejection., or

another mode of emergency transportation may transport them, i.e., boat or ground ambulance that would require more time to reach the nearest hospital.

7.1 Analysis of supply chain resilience in the healthcare sector

According to (alizadeh mousavi et al. 2017),

> "*Supply chain resilience is described in the literature as a system's capacity and the possibility of healing and rebuilding from change, disturbances, and adverse outcomes in sections or the entire supply chain to its initial state or a better situation than before."*

Our findings have revealed several challenges such as weather conditions, new base development, and onboard patient treatment. All these factors can cause possible disruptions and delays in providing medical services. In this light, advanced helicopters are the only transportation mode that can prevent all these negative aspects of patient transportation due to their ability to fly in vertical and horizontal directions while keeping itself still in the air for a long time. Additionally, helicopters provide quick response time compared with other modes of patient transportation, making this service more reliable and quicker. As a result, Table 7.1 presents our findings of the stages and main elements of emergency supply chain resilience in the Norwegian healthcare sector. Four stages have been revealed in patient transportation/HEMS, which are coherent with the supply chain resilience definition.

Table 7. 1. Stages and main elements of emergency supply chain resilience in the Norwegian healthcare sector

Stages	Elements	Sub-elements
Readiness/Preparedness	Flexibility	• **Workforce with a wide range of skills** • **Contract versatility for suppliers / Flexibility in order fulfillment**
	Redundancy	• **Multiple sources of supply** • **Stock for safety** • **Availability of Reserve (materials, labors, inventory)** • **Standby systems**
	Collaboration	• **Partnership for Information Sharing and Trust**
	Visibility	• **Finances** • **data and information**

		• **Vehicles for transportation**
	Human Resource Management	• **Employee apprenticeships** • **Teams that work through departments** • **Employees with prior experience**
	Culture of risk management	• **Identification and evaluation of risks** • **Support from upper management** • **Integration of the organization**
	Efficiency	• **Reducing waste** • **Employee Productivity** • **Failure avoidance** • **Utilization of assets**
	Financial strength	• **Availability of funds** • **Beneficiary partnership** • **Reserves of money**
Reaction/ Response	Flexibility	• **Alternative channels of distribution** • **Sharing of risks** • **Rescheduled**
	Collaboration	• **Information exchange** • **Cooperation** • **Observability** • **Risk-sharing with collaborators.** • **Resource competition and cooperation**
	Culture of risk management	• **Government Commitment to Support** • **Command and control of the incident**
	Security	• **Protection in layers** • **Restriction on access** • **Employee Security Participation** • **Cybersecurity collaboration with the government** • **Employee safety**
	Agility	• **speed/velocity** • **a sufficient response**
Recovery and growth	Collaboration	• **Collaboration** • **Sharing of information** • **Supplier expansion**
	Recovery	• **Recovery time is short.** • **Absorption of loss** • **Reduction of impact**
	Efficiency	• **Reducing waste** • **Employee Efficiency** • **Failure avoidance**

According to the definition as mentioned earlier and different literature reviews, supply chain resilience definition can be divided into four stages, which are as follows:

1. Readiness/Preparedness: The mindset of someone being entirely prepared for a supply chain interruption.
2. Reaction/ Response: The capacity to respond in a disruptive manner.
3. Restoration/ Recovery: restoring the original condition after a disturbance.
4. Development/growth: the capacity for recovery after being interrupted.

In Table 7.1, we combined recovery and growth because some authors attempt to separate recovery and growth into two phases. We consider them to be in the same category since the definition of the healthcare supply chain is more connected to the service supply chain, which cannot easily describe the state of development and growth.

7.2 Elements of supply chain resilience

Different terminologies were used due to the diverse environment of supply chain resilience and the authors' perspectives. We presented the key elements of comprehension and deployment to various areas of healthcare disruption and their interpretations based on our findings. The following are our derived elements and their interpretations.

1. Flexibility: the capacity to easily adapt to a crisis.
2. Redundancy: the opportunity to offset the harmful impacts of transition by retaining resources in reserve.
3. Collaboration: The ability to successfully collaborate with other organizations for mutually beneficial.
4. Agility: a supply chain's ability to react quickly to change by adjusting its initial reliable performance.
5. Visibility: Identify an individual's accuracy and status transiting the supply chain, as recorded in a timely disaster alert.
6. Human Resource Management: the capacity to control an organization's human resources.

7. Culture of risk management: guaranteeing that all business leaders accept supply chain risk management.
8. Efficiency: is defined as the ability to generate outputs while using the fewest resources.
9. Financial strength: is characterized as the capacity to increase financial budgeting resources consistently.
10. Security: protection from intentional interference or assault.

Supply chain resilience is still an unclear area of research, according to several criticism and studies (Liu et al. 2020). We implemented the prior findings to understand the definitions, aspects, and procedures. Our understandings from stages, elements, and healthcare supply chain resulted in Table 7.1, where we listed the stages, elements, and sub-elements based on the healthcare supply chain.

Chapter 8. Conclusions, limitations and future research suggestions

This chapter provides a summary of the study with theoretical and practical implications. It concludes with the limitations and suggestions for future research in this field of study.

8.1 Theoretical implications

This master thesis aims to explore how supply chain management resilience is developed in the Norwegian healthcare sector.

Our investigation extends the literature on HEMS in the following ways. First, most previous research on HEMS has applied quantitative methods and focused on building mathematical models and propositions but not testing them in real-life scenarios (Christopher and Lee 2004). In contrast, our master's thesis provides an investigation into emergency supply chain operations by helicopters in real contextual settings. This thesis applies an institutional logics approach that has been rarely used within the SCM field. This approach was helpful to explore different views of various actors on HEMS from the same safety perspective.

However, our master's thesis also enhances the literature on emergency preparedness, response time, and supply chain management resilience related to HEMS in Norway. It has identified the factors and challenges within the literature review and during our investigation. Further, our findings agreed that emergency preparedness and response time are vital for conducting air ambulance operations. Thus, it will facilitate the Norwegian healthcare sector to establish a better organizational structure within HEMS according to the strategic and responsive perspective to fulfill future demand requirements.

Secondly, this thesis tends to fill the literature gap in the application of HEMS in Norway. It guides the research design of HEMS in Norway. It is quite a new area of research, and fewer academic studies have been done on it, especially in a country like Norway. However, advanced research on the challenges and supply chain resilience for HEMS in the health care sector of Norway is required.

8.2 Practical implications

Aside from the theoretical implications discussed in the previous sections and the expansion of established literature, this analysis will yield some practical results. The close relationship between HEMS, supply chain resilience, and all actors associated with this service, i.e., supply chain managers, authorities, and hospitals, highlights the need for collaborative value creation to provide air ambulances in Norway (Ponis and Koronis 2012). In addition, collaboration with local and governmental bodies is equally important to make this service more reliable and effective in Norway. Therefore, this thesis heightens the significance of more HEMS local bases in various communities in Norway and the government regulations to overcome the challenges faced by HEMS.

Challenging factors that are recognized by the Norwegian government concern the supply chain resilience of HEMS in Norway (Liu et al. 2020). However, the Norwegian government should make new and better policies and regulations to ensure the availability of HEMS all over Norway within the emergency response time for rescue. Simultaneously, they should be aware of the perceived hurdles and cooperate with HEMS actors to find ways to alleviate them.

8.3 Limitations and suggestions for future research

This section will discuss the limitations and future research directions for inductive researchers. In general, whether a student or an academic body carries out a study, all researchers face certain restrictions. Research limitation is usually represented by the design characteristics of such methodology, limiting the interpretations of the results of a study to some degree. Furthermore, certain external factors, such as the availability of relevant data, affect and determine the final performance.

The currently available literature on HEMS in Norway was not enough and mostly presented in the native language. Each research paper took a different approach (primarily quantitative methods), making it difficult to obtain a cohesive observation and understanding of the proposed subject. The research topic and purpose often narrow the scope of the analysis to formulate the presented issues and find answers to the chosen research questions. As a result, only those papers that discussed and analyzed the topic of HEMS with a significant emphasis on challenges and supply chain resilience were chosen. Finally, the impact factors of the

relevant literature were also considered, which limited our collection of research articles to only high-impact journal articles, with an in-depth analysis and investigation of the thesis topic and the formulated research questions.

COVID-19 was the massive limitation of collecting primary data, which bound our approach to collect necessary preliminary data from only two semi-structured interviews. Owing to the inability to perform more interviews, our research methodology had to be modified from a narrowed down to a general method of emergency preparedness of HEMS focused on supply chain resilience. It could be argued that the study is more likely to be focused on secondary data due to COVID-19. Nonetheless, using primary data based on our two conducted interviews supported and been the most critical element in the in-depth exploration of the research issues.

Additionally, the time, which was just one semester, also limited us. It limits our ability to review the planned research goal thoroughly. As a result, the systematic analysis did not cover all aspects of the thesis topic. Even though our selected research papers and articles were chosen to reflect the complete picture of a given phenomenon, we tried our best to describe the research objective fully. Similarly, since the HEMS and supply chain resilience in Norway are still new and related research studies are missing, the research papers chosen for the systematic literature review did not come from high-ranking journals. Scholars have not yet given this phenomenon their full attention, and it has not been thoroughly studied. As a result, the number of high-ranking journals that could provide a detailed overview of the subject was few.

Since this research focuses on the HEMS in Norway, with a primary focus on supply chain challenges and resilience, further research is needed to investigate and understand this topic thoroughly. As a consideration, other research approaches are required to investigate the emergency preparedness, response time, supply chain resilience, and challenges associated with the HEMS in Norway.

References

Albrecht, Roland, Jürgen Knapp, Lorenz Theiler, Marcus Eder, and Urs Pietsch. 2020. "Transport of COVID-19 and other highly contagious patients by helicopter and fixed-wing air ambulance: a narrative review and experience of the Swiss air rescue Rega." *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* 28 (1):40. doi: 10.1186/s13049-020-00734-9.

Alexander, Andreia B., M. Meredith Masters, and Karma Warren. 2020. "Caring for Infectious Disease in the Prehospital Setting: A Qualitative Analysis of EMS Providers Experiences and Suggestions for Improvement." *Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors* 24 (1):77-84. doi: 10.1080/10903127.2019.1601313.

alizadeh mousavi, Behrouz, Amin Maghsoudi, Ali Bozorgi-Amiri, and Abbas Ostad Taghizadeh. 2017. *Supply chain resilience and healthcare delivery in disasters: A structured review*.

Ballou, R.H. 1999. *Business Logistics Management: Planning, Organizing, and Controlling the Supply Chain*: Prentice Hall.

Bell, Emma, and Alan Bryman. 2007. "The Ethics of Management Research: An Exploratory Content Analysis." *British Journal of Management* 18:63-77. doi: 10.1111/j.1467-8551.2006.00487.x.

Bengtsson, Mariette. 2016. "How to plan and perform a qualitative study using content analysis." *NursingPlus Open* 2:8-14. doi: https://doi.org/10.1016/j.npls.2016.01.001.

Bjornsen, L. P., A. M. Solheim, O. Uleberg, and E. Skogvoll. 2018. "Compliance With a National Standard by Norwegian Helicopter Emergency Physicians." *Air Med J* 37 (1):46-50. doi: 10.1016/j.amj.2017.10.001.

Bryman, Alan, and Emma Bell. 2015. "Business Research Methods."

Burt, John. 2020. "Offshore Helicopter Operations." https://www.skybrary.aero/index.php/Offshore_Helicopter_Operations.

Chelst, Kenneth R., and Ziv Barlach. 1981. "Multiple Unit Dispatches in Emergency Services: Models to Estimate System Performance." *Management Science* 27 (12):1390-1409.

Chiarini, Andrea. 2013. "Waste savings in patient transportation inside large hospitals using lean thinking tools and logistic solutions." *Leadership in Health Services* 26 (4):356-367. doi: 10.1108/lhs-05-2012-0013.

Chowdhury, Maruf, and Mohammed Quaddus. 2016. "Supply chain readiness, response and recovery for resilience." *Supply Chain Management: An International Journal* 21:709-731. doi: 10.1108/SCM-12-2015-0463.

Christopher, Martin, and Hau Lee. 2004. "Mitigating supply chain risk through improved confidence." *International Journal of Physical Distribution & Logistics Management* 34:388-396. doi: 10.1108/09600030410545436.

Church, Richard, and Charles ReVelle. 1974. "The maximal covering location problem." *Papers of the Regional Science Association* 32 (1):101-118. doi: 10.1007/BF01942293.

Clootrack. 2018. "What Are the Steps of Content Analysis?", accessed 20.11. https://clootrack.com/knowledge_base/what-are-the-steps-of-content-analysis/.

Cox, R. A. F. 1970. "Medical services to offshore drilling." *Injury* 1 (3):217-225. doi: https://doi.org/10.1016/S0020-1383(70)80058-4.

Creswell, John W., and J. David Creswell. 2018. *Research design : qualitative, quantitative, and mixed methods approaches*.

DeJonckheere, Melissa, and Lisa M. Vaughn. 2019. "Semistructured interviewing in primary care research: a balance of relationship and rigour." *Family Medicine and Community Health* 7 (2):e000057. doi: 10.1136/fmch-2018-000057.

Erlingsson, Christen, and Petra Brysiewicz. 2017. "A hands-on guide to doing content analysis." *African Journal of Emergency Medicine* 7 (3):93-99. doi: https://doi.org/10.1016/j.afjem.2017.08.001.

Evensen AMC, and Brattebø G. 2006. "Retrospective view and follow up on search and rescue and medical evacuation from oil fields in the Tampen area, North Sea, Norway." SPE International Health, Safety & Environment Conference, Abu Dhabi, UAE.

Godfrey., Andrew, and Joshua W. Loyd. 2020. "EMS Helicopter Activation." StatPearls Publishing, Last Modified 25 Sep 2020, accessed Jan. https://www.ncbi.nlm.nih.gov/books/NBK513336/.

Government, Norwegian. 2015. Ministry of Health and Care Services. First and foremost – a comprehensive system for dealing with acute diseases and injuries outside hospitals. NOU 2015:17. Norwegian Government. Oslo, Norway: Norwegian Government.

Halldorsson, Arni, and Jesper Aastrup. 2003. "Quality Criteria for Qualitative Inquiries in Logistics." *European Journal of Operational Research* 144:321-332. doi: 10.1016/S0377-2217(02)00397-1.

Harrell, Margaret, and Melissa Bradley. 2009. "Data Collection Methods. Semi-Structured Interviews and Focus Groups."147.

Haugland, Helge, Oddvar Uleberg, Pål Klepstad, Andreas Krüger, and Marius Rehn. 2019. "Quality measurement in physician-staffed emergency medical services: a systematic literature review." *International Journal for Quality in Health Care* 31 (1):2-10. doi: 10.1093/intqhc/mzy106.

Havard.Wahl.Kongsgaard. 2015. "Travel distance to out-of-hour services." Norwegian Directorate of Health. https://reisetid.helsedirektoratet.no/analyse/dashboards/e149e1fd-a109-4c6b-aad3-b9422282c0ee.

Health, Norwegian Directorate of. 2012. Learning for better emergency preparedness – the medical response to the terrorist incidents of 22 July 2011.IS-1984. Oslo, Norway Norwegian Directorate of Health.

Heggestad, Torhild, and Yngve Børsheim. 2002. "Accessibility and distribution of the Norwegian National Air Emergency Service: 1988-1998." *Air medical journal* 21:39-45. doi: 10.1067/mmj.2202.124220.

Hilbert-Carius, P., J. Braun, F. Abu-Zidan, J. Adler, J. Knapp, D. Dandrifosse, D. Braun, U. Pietsch, P. Adamczuk, L. Rognas, and R. Albrecht. 2020. "Pre-hospital care & interfacility transport of 385 COVID-19 emergency patients: an air ambulance perspective." *Scand J Trauma Resusc Emerg Med* 28 (1):94. doi: 10.1186/s13049-020-00789-8.

Hollweck, Trista. 2016. "Robert K. Yin. (2014). Case Study Research Design and Methods (5th ed.). Thousand Oaks, CA: Sage. 282 pages." *The Canadian Journal of Program Evaluation*. doi: 10.3138/cjpe.30.1.108.

Howson, D. 2006. "Research initiatives for improving the safety of offshore helicopter operations." *The Aeronautical Journal* 110:723-737. doi: 10.1017/S0001924000001597.

Huyler, Debaro, and Craig M. McGill. 2019. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, by John Creswell and J. David Creswell. Thousand Oaks, CA: Sage Publication, Inc. 275 pages, $67.00 (Paperback)." *New Horizons in Adult Education and Human Resource Development* 31 (3):75-77. doi: https://doi.org/10.1002/nha3.20258.

Huzaini, Ahmad, Roslina Mohammad, Norazli Othman, and Zuritah A. Kadir. 2019. "Exploring of Offshore Medical Emergency Response System Challenges in Oil and Gas Environment."

Jansen, Jan O., Jonathan J. Morrison, Handing Wang, Shan He, Robin Lawrenson, James D. Hutchison, and Marion K. Campbell. 2015. "Access to specialist care: Optimizing the geographic configuration of trauma systems." *Journal of Trauma and Acute Care Surgery* 79 (5).

Johnsen, A. S., S. J. Sollid, T. Vigerust, M. Jystad, and M. Rehn. 2017. "Helicopter emergency medical services in major incident management: A national Norwegian cross-sectional survey." (1932-6203 (Electronic)).

Johnsen, Anne Siri, Martin Samdal, Stephen Sollid, and Marius Rehn. 2020. "Major incident management by helicopter emergency medical services in South-East Norway from 2000 - 2016: Retrospective cohort study." *Acta Anaesthesiologica Scandinavica* 64. doi: 10.1111/aas.13583.

Johnson., James C., Donald F. Wood., Daniel Wardlow., and Paul R. Murphy. 1999. "Contemporary Logistics (7th Edition)."

Kallet, Richard. 2004. "How to write the methods section of a research paper." *Respiratory care* 49:1229-32.

Khan, Gulfaraz, Mohamud Sheek-Hussein, Ahmed Al Suwaidi, Kamal Idris, and Fikri Abu-Zidan. 2020. "Novel coronavirus pandemic: A global health threat." *Turkish Journal of Emergency Medicine* 20 (2):55-62. doi: 10.4103/2452-2473.285016.

Kjeserud, R., and L. Weisæth. 2007. *Ledelse ved kriser: - en praktisk veileder*: Gyldendal.

Kozey, John W., Chris J. Brooks, Sherma L. Dewey, Robert C. Brown, Kimberly A. Howard, Danika Drover, Scott MacKinnon, and John McCabe. 2009. "Effects of human anthropometry and personal protective equipment on space requirements." *Occupational Ergonomics* 8:67-79. doi: 10.3233/OER-2009-0160.

Kress, M. 2002. *Operational Logistics: The Art and Science of Sustaining Military Operations*.

L., ANS. 2016. luftambulanse. http://www.luftambulanse.no/%C3%A5rsrapport.

Lawner, Benjamin J., Jon Mark Hirshon, Angela C. Comer, Jose V. Nable, Jeffrey Kelly, Richard L. Alcorta, Laura Pimentel, Christina L. Tupe, Mary Alice Vanhoy, and Brian J. Browne. 2016. "The impact of a freestanding ED on a regional emergency medical services system." *The American Journal of Emergency Medicine* 34 (8):1342-1346. doi: https://doi.org/10.1016/j.ajem.2015.11.042.

Lenz, T. J., E. A. Kossyreva, and M. R. Colella. 2019. "Helicopter Emergency Medical Services Utilization." *Air Med J* 38 (4):261-265. doi: 10.1016/j.amj.2019.03.004.

Lerner, E. Brooke, Anthony J. Billittier, Jeremy Sikora, and Ronald M. Moscati. 1999. "Use of a Geographic Information System to Determine Appropriate Means of Trauma Patient Transport." *Academic Emergency Medicine* 6 (11):1127-1133. doi: https://doi.org/10.1111/j.1553-2712.1999.tb00115.x.

Lexow, K. 2012. "The Norwegian Medical Dispatch System and the Norwegian Index for Emergency Medical Dispatch." *Notfall + Rettungsmedizin* 15 (4):342-346. doi: 10.1007/s10049-011-1536-7.

Liew, Mei Fong, Wen Ting Siow, Ying Wei Yau, and Kay Choong See. 2020. "Safe patient transport for COVID-19." *Critical Care* 24 (1):94. doi: 10.1186/s13054-020-2828-4.

Liu, Ximan, Steven Day, Janet Godsell, and Wanrong Zhang. 2020. *How different disruptions moderate practices contributing to supply chain resilience*.

Lopez Bernal, James, Steven Cummins, and Antonio Gasparrini. 2016. "Interrupted time series regression for the evaluation of public health interventions: A tutorial." *International Journal of Epidemiology* 46:dyw098. doi: 10.1093/ije/dyw098.

Lopez, Monica, Samuel Luber, Samuel Prater, Luis Ostrosky-Zeichner, Jamie McCarthy, Guillermo Suarez, and Bentley J. Bobrow. 2020. "A sentinel COVID-19 case in Houston, Texas: Informing frontline emergency department screening and preparedness." *Journal of the American College of Emergency Physicians open* 1 (2):92-94. doi: 10.1002/emp2.12068.

Luftambulanse, Norsk. 2021. "LUFTAMBULANSEBASENE." http://www.luftambulanse.no/v%C3%A5re-baser.

luftambulansetjenesten. 2017. "About the National Air Ambulance Services of Norway." luftambulansetjenesten. http://www.luftambulanse.no/about-national-air-ambulance-services-norway.

Luo., Amy. 2019. "What is content analysis and how can you use it in your research?". Scribbr, Last Modified 18.07.2019, accessed 08.11. https://www.scribbr.com/methodology/content-analysis/.

McCombes, Shona. 2019. "How to create a research design." accessed 28.11. https://www.scribbr.com/research-process/research-design/.

Murray, Alan T. 2015. "Maximal Coverage Location Problem: Impacts, Significance, and Evolution." *International Regional Science Review* 39 (1):5-27. doi: 10.1177/0160017615600222.

Nascimento, F. A. C., Arnab Majumdar, and Steve Jarvis. 2012a. "Factors affecting safety during night visual approach segments for offshore helicopters." *Aeronautical Journal* 116:303-322. doi: 10.1017/S0001924000006850.

Nascimento, Felipe A. C., Arnab Majumdar, and Steve Jarvis. 2012b. "Nighttime approaches to offshore installations in Brazil: Safety shortcomings experienced by helicopter pilots." *Accident Analysis & Prevention* 47:64-74. doi: https://doi.org/10.1016/j.aap.2012.01.014.

NOU. 1998. "Luftambulansetjenesten i Norge." accessed 19.01. https://www.regjeringen.no/no/dokumenter/nou-1998-8/id141272/.

Nystøyl, Dag Ståle, Jo Røislien, Øyvind Østerås, Steinar Hunskaar, Hans Johan Breidablik, and Erik Zakariassen. 2020. "Helicopter emergency medical service (HEMS) activity after increased distance to out-of-hours services: an observational study from Norway." *BMC Emergency Medicine* 20 (1):88. doi: 10.1186/s12873-020-00377-0.

Osborn, L., D. Meyer, P. Dahm, B. Ferguson, R. Cabrera, D. Sanger, M. Mock, T. Herrera, S. Mader, and L. Ostrosky-Zeichner. 2020. "Integration of aeromedicine in the response to the COVID-19 pandemic." *J Am Coll Emerg Physicians Open*. doi: 10.1002/emp2.12117.

Østerås, Øyvind, Guttorm Brattebø, and Jon-Kenneth Heltne. 2015. "Helicopter-based emergency medical services for a sparsely populated region: A study of 42,500 dispatches." *Acta Anaesthesiologica Scandinavica* 60:n/a-n/a. doi: 10.1111/aas.12673.

Ozcan, Pinar, Suho Han, and ME Graebner. 2017. "Single cases: The what, why, and how." *The Routledge companion to qualitative research in organization studies* 92:112.

Parsons, Dan. 2020. "Italy using HH-101A helicopters to transport coronavirus patients." https://verticalmag.com/news/italy-aw101-helicopter-coronavirus-patients/.

Pedersen, May Janne Botha, Astrid Gjerland, Bjørn Rishovd Rund, Øivind Ekeberg, and Laila Skogstad. 2016. "Emergency preparedness and role clarity among rescue workers during the terror attacks in Norway July 22, 2011." *PLoS ONE* 11 (6). doi: 10.1371/journal.pone.0156536.

Pelat, Francois, and Patrick Awotula. 2014. "Learning & Benefits of Well-defined and Well-structured Topside Medical Support in the Offshore Drilling Industry based on 10 Years of Global Experience with a Large Offshore Drilling Contractor." SPE International Conference on Health, Safety, and Environment.

Pettit, Timothy, Joseph Fiksel, and Keely Croxton. 2010. "Ensuring Supply Chain Resilience: Development of a Conceptual Framework." *Journal of Business Logistics* 31:1-21. doi: 10.1002/j.2158-1592.2010.tb00125.x.

Ponis, Stavros, and Epaminondas Koronis. 2012. "Supply Chain Resilience: Definition Of Concept And Its Formative Elements." *Journal of Applied Business Research* 28:921-929. doi: 10.19030/jabr.v28i5.7234.

Ponsonby, Will, Frano Mika, and Greg Irons. 2009. "Offshore industry: medical emergency response in the offshore oil and gas industry." *Occupational Medicine* 59 (5):298-303. doi: 10.1093/occmed/kqp075.

Raatiniemi, Lasse, K. Mikkelsen, Knut Fredriksen, and Torben Wisborg. 2013. "Do pre-hospital anaesthesiologists reliably predict mortality using the NACA severity score? A retrospective cohort study." *Acta anaesthesiologica Scandinavica* 57:1253-9. doi: 10.1111/aas.12208.

Raknes, Guttorm, and Steinar Hunskaar. 2014. "Method Paper – Distance and Travel Time to Casualty Clinics in Norway Based on Crowdsourced Postcode Coordinates: A Comparison with Other Methods." *PloS one* 9:e89287. doi: 10.1371/journal.pone.0089287.

Reid, B. O., H. Haugland, M. Rehn, O. Uleberg, and A. J. Kruger. 2019. "Search and Rescue and Remote Medical Evacuation in a Norwegian Setting: Comparison of Two Systems." *Wilderness Environ Med* 30 (2):155-162. doi: 10.1016/j.wem.2019.02.003.

Reid, Bjørn, Marius Rehn, Oddvar Uleberg, and Andreas Kruger. 2016. "Physician-provided prehospital critical care, effect on patient physiology dynamics and on-scene time." *European Journal of Emergency Medicine* 25:1. doi: 10.1097/MEJ.0000000000000432.

Ringburg, A. N., S. H. Thomas, E. W. Steyerberg, E. M. van Lieshout, P. Patka, and I. B. Schipper. 2009. "Lives saved by helicopter emergency medical services: an overview of literature." *Air Med J* 28 (6):298-302. doi: 10.1016/j.amj.2009.03.007.

Robinson, Sarita, Sandra Sünram-Lea, J. Leach, and P. Owen-Lynch. 2008. "The effects of exposure to an acute naturalistic stressor on working memory, state anxiety and salivary cortisol concentrations." *Stress (Amsterdam, Netherlands)* 11:115-24. doi: 10.1080/10253890701559970.

Roislien, J., P. L. van den Berg, T. Lindner, E. Zakariassen, K. Aardal, and J. T. van Essen. 2017. "Exploring optimal air ambulance base locations in Norway using advanced mathematical modelling." *Inj Prev* 23 (1):10-15. doi: 10.1136/injuryprev-2016-041973.

Røislien, Jo, Pieter L. van den Berg, Thomas Lindner, Erik Zakariassen, Oddvar Uleberg, Karen Aardal, and J. Theresia van Essen. 2018. "Comparing population and incident data for optimal air ambulance base locations in Norway." *Scandinavian Journal of*

Trauma, Resuscitation and Emergency Medicine 26 (1):42. doi: 10.1186/s13049-018-0511-4.

Rowe, Stephen, David Howson, and Paul Sparkes. 2005. "Research Improving the Safety of Offshore Helicopter Operations." *Marine Technology* 42:34-42. doi: 10.5957/mt1.2005.42.1.34.

Runeson, Per, and Martin Höst. 2008. "Guidelines for conducting and reporting case study research in software engineering." *Empirical Software Engineering* 14 (2):131. doi: 10.1007/s10664-008-9102-8.

Samdal, M., H. Eiding, L. Markengbakken, J. Roislien, M. Rehn, and M. Sandberg. 2019. "Time Course of Hoist Operations by the Search and Rescue Helicopter Service in Southeast Norway." *Wilderness Environ Med* 30 (4):351-361. doi: 10.1016/j.wem.2019.06.004.

Samdal, M., H. H. Haugland, C. Fjeldet, M. Rehn, and M. Sandberg. 2018. "Static Rope Evacuation by Helicopter Emergency Medical Services in Rescue Operations in Southeast Norway." *Wilderness Environ Med* 29 (3):315-324. doi: 10.1016/j.wem.2018.03.010.

Saunders, Mark, Philip Lewis, Adrian Thornhill, and Alex Bristow. 2019. ""Research Methods for Business Students" Chapter 4: Understanding research philosophy and approaches to theory development." In, 128-171.

Scarpin, Marcia Regina, and Renata Anderson. 2014. "Humanitarian Logistics: Empirical Evidences from a Natural Disaster." *Procedia Engineering* 78:102–111. doi: 10.1016/j.proeng.2014.07.045.

Scott, Gini Graham. 2015. *The Researchers Bible: An Overview of Key Concepts and Methods in Social Science Research (Available on Amazon)*.

Services., Ministry of Health and Care. 2015. "Forskrift om krav til og organisering av kommunal legevaktordning, ambulansetjeneste, medisinsk nødmeldetjeneste mv. (akuttmedisinforskriften). emergency medicine regulations." https://lovdata.no/dokument/SF/forskrift/2015-03-20-231.

Sheu, Jiuh-Biing. 2007. "Challenges of emergency logistics management." *Transportation Research Part E: Logistics and Transportation Review* 43 (6):655-659. doi: 10.1016/j.tre.2007.01.001.

Skjærseth, Eivinn Årdal, Helge Haugland, Andreas Jorstad Krüger, Lars Eide-Næss Pleym, and Oddvar Uleberg. 2021. "Developing Quality Indicators for Helicopter Emergency Medical Services Coordination in Norwegian Emergency Medical Communication Centrals: A Consensus Process." *Air Medical Journal* 40 (1):20-27. doi: https://doi.org/10.1016/j.amj.2020.11.010.

Sohrabi, Catrin, Zaid Alsafi, Niamh O'Neill, Mehdi Khan, Ahmed Kerwan, Ahmed Al-Jabir, Christos Iosifidis, and Riaz Agha. 2020. "World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19)." *International journal of surgery (London, England)* 76:71-76. doi: 10.1016/j.ijsu.2020.02.034.

St.meld. 2000. "Om akuttmedisinsk beredskap [On emergency prepardness]." https://www.regjeringen.no/no/dokumenter/stmeld-nr-43-1999-2000-/id193493/.

Stuhr, M., D. Dethleff, N. Weinrich, M. Nielsen, D. Hory, B. Kowald, K. Seide, T. Kerner, C. Nau, and C. Jürgens. 2016. "Notfallmedizinische Versorgung in Offshore-Windparks." *Der Anaesthesist* 65 (5):369-379. doi: 10.1007/s00101-016-0154-7.

Taber, Michael J. 2013. "Crash attenuating seats: Effects on helicopter underwater escape performance." *Safety Science* 57:179-186. doi: https://doi.org/10.1016/j.ssci.2013.02.007.

Taber, Michael J. 2014. "Simulation fidelity and contextual interference in helicopter underwater egress training: An analysis of training and retention of egress skills." *Safety Science* 62:271-278. doi: https://doi.org/10.1016/j.ssci.2013.08.019.

Taber, Michael J. 2016. "Chapter 10 - Consolidation of Findings and Future Directions for Offshore Helicopter Operations." In *Handbook of Offshore Helicopter Transport Safety*, edited by Michael J. Taber, 207-215. Woodhead Publishing.

Taber, Michael J., Joel Carroll, and Paul Douglas. 2012. "Medical Crew Preparedness for Offshore Helicopter Evacuations: Necessary Skills Training for a Ditching Emergency." International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production.

Taber, Michael John, and Nancy Taber. 2020. "Learning beyond 'hands and feet' in offshore helicopter operations: integrating the individual with the social in CRM and SA." *Theoretical Issues in Ergonomics Science* 21 (5):614-631. doi: 10.1080/1463922X.2020.1729444.

Taylor, Colman B., Mark Stevenson, Stephen Jan, Bette Liu, Gary Tall, Paul M. Middleton, Michael Fitzharris, and John Myburgh. 2011. "An investigation into the cost, coverage and activities of Helicopter Emergency Medical Services in the state of New South Wales, Australia." *Injury* 42 (10):1088-1094. doi: https://doi.org/10.1016/j.injury.2011.02.013.

Taylor, Diana Hopkins, Ralph Casta, Van Walker, Flora Collier, and Robert E. Fromm. 1993. "Air medical transport of patients from offshore oil and gas facilities: Historical Accident Data and Initial Experience." *Air Medical Journal* 12 (1):21-28. doi: https://doi.org/10.1016/S1067-991X(05)80097-5.

Thomas., Anisya. 2003. Humanitarian Logistics: Enabling Disaster Response.

Thomson, David P., and Stephen H. Thomas. 2003. "G UIDELINES FOR A IR M EDICAL D ISPATCH." *Prehospital Emergency Care* 7 (2):265-271. doi: 10.1080/10903120390936923.

Tovia, F. 2007. "An emergency logistics response system for natural disasters." *International Journal of Logistics Research and Applications* 10 (3):173-186. doi: 10.1080/13675560701467177.

Tryba M, Brüggemann H, and Echtermeyer V. 1980. " Klassifizierung von Erkrankungen und Verletzungen in Notartztrettungssystemen." *Notfallsmedizin*:725-7.

Vlok, N., and J. van der Berg. 2020. "Helicopter Emergency Medical Services Response to a Major Incident." *Air Med J* 39 (6):506-508. doi: 10.1016/j.amj.2020.09.007.

Waje-Andreassen, Anne, Øyvind Østerås, and Guttorm Brattebø. 2020. "A prospective observational study of why people are medically evacuated from offshore installations in the North Sea." *BMJ Open* 10 (7):e037558. doi: 10.1136/bmjopen-2020-037558.

WHO. 2015. Framework for a Public Health Emergency Operations Centre.

Wright, Sarah, Bridget C. O'Brien, Laura Nimmon, Marcus Law, and Maria Mylopoulos. 2016. "Research Design Considerations." *Journal of graduate medical education* 8 (1):97-98. doi: 10.4300/JGME-D-15-00566.1.

Yazan, Bedrettin. 2015. "Three Approaches to Case Study Methods in Education: Yin, Merriam, and Stake." *Qualitative Report* 20. doi: 10.46743/2160-3715/2015.2102.

Yi, Jin-Wook, Kyu Eun Lee, Young-Heon Kim, and Yeo Youn. 2014. "Helicopter Patient Transportation Service on the Ulleung Island, South Korea." *Air medical journal* 33:314-9. doi: 10.1016/j.amj.2014.07.005.

Yin, Robert K. 2018. *Case study research and applications : design and methods*.

Young, Richard, and Matthew Peterson. 2014. "Emergency management logistics must become emergency supply chain management." *Journal of emergency management (Weston, Mass.)* 12:171-87. doi: 10.5055/jem.2014.0171.

Zakariassen, E., O. Uleberg, and J. Roislien. 2015. "Helicopter emergency medical services response times in norway: do they matter?" *Air Med J* 34 (2):98-103. doi: 10.1016/j.amj.2014.11.003.

Zakariassen, Erik, Øyvind Østerås, Dag Ståle Nystøyl, Hans Johan Breidablik, Eivind Solheim, Guttorm Brattebø, Vegard S. Ellensen, Jana Midelfart Hoff, Knut Hordnes, Arne Aksnes, Jon-Kenneth Heltne, Steinar Hunskaar, and Ragnar Hotvedt. 2019. "Loss of life years due to unavailable helicopter emergency medical service: a single base study from a rural area of Norway." *Scandinavian journal of primary health care* 37 (2):233-241. doi: 10.1080/02813432.2019.1608056.

Appendix-A

Institution name: Høgskolen i Molde - Vitenskapelig Høgskole i Logistikk.

Supervisor: Antonina Tsvetkova (Associate Professor)

Interviewers: Muhammad Omer Farooq (191344) (Master Student in Logistics HiMolde)
Daud Ahmed (191328) (Master Student in Logistics HiMolde)

Respondent: 1

Interviewee: Gunar Schau Olsen (Volunteer worker in Norwegain People Aid)

Date: 27 March, 2021

Interview topic: The reliability of helicopter medical services and response times in Norway: an institutional perspective on emergency preparedness operational logistics

Topic description: This topic provides deeper insights into how reliable the helicopter is in a particularly difficult to reach area. The placement of emergency medical services is a critical strategic decision that can have a significant impact on the quality of medical assistance to the population and offshore oil platforms in Norway. The topic suggests focusing on logistics operations in emergencies and medical service preparedness to reduce the population's skepticism about reorganizing the local hospitals.

Part 1:

Opening comments

Explaining the purpose of the interview and before going ahead, ask the following questions:

- Do you have any question, should ask before we proceed with the interview?
- Do you mind if I record this interview to transcribe it?
- Would it be okay if your name is mentioned in the thesis?

Part 2:

The Organization and the Interviewee

- Please tell us about your role in the organization you are working with.
    - ➢ Your position!
    - ➢ Your daily responsibilities!
- How long you have been working here?

Part 3:

Helicopter Emergency Medical Services (HEMS)

▪ How closely do you work with HEMS during conducting an emergency operation?

▪ How many persons work in HEMS during an operation?

▪ How many patients a helicopter can carry during a mission?

▪ How does it like to feel for working as a crew member for HEMS?

▪ How do the pilots decide if it is safe to fly in bad weather situation?

▪ Does patient need to bring money or any kind of identification?

▪ Where can my friends & family find information about the status of my transport and my medical condition?

▪ What should a patient wear during the transportation?

▪ Can a family member of any patient be transported by him/her to the hospital?

▪ What kind of situations, in which you need to report the details to the police?

▪ Is there any special kind of training for the doctors working with the HEMS?

▪ How do you ensure the transportation of patient always on time?

▪ Is it possible to give medical treatment during transportation?

▪ How do you handle contradictory or unnecessary demands from a patient and their family members?

▪ What are some of the constitutional rights that patients are often unaware of?

▪ Which factors in your job position motive or attracts to you most?

▪ How many volunteers are currently working in Norwegian people aid and air ambulance service?

▪ Are you working as a member of HEMS crew?

▪ How do you realized during your heart attack that you wanted to be transported by air ambulance?

▪ How much time it took from your home to the hospital.

▪ How are helicopter services organized in Norway to provide medical suppor

▪ What are the benefits of using HEMS instead of using other medical services in Norway?

▪ What do you think are the challenges faced by the HEMS in Norway?

▪ What do you think are the challenges faced by the HEMS crew in Norway?

▪ Who is responsible for deciding the usage of HEMS in any emergency operation?

▪ How do you handle the patient, or their spouse disagree about what is best for the patient?

▪ How the helicopter medical services, policies and regulations are being managed by the Norwegian government?

▪ How do you feel if HEMS are efficient in Norway or not?

▪ Are SAR helicopters different from usual emergency medical helicopters?

▪ For the night mission is there any special equipment?

▪ Norwegian government has ordered new helicopters, how much they are advanced as compared to the old ones?

▪ To what degree, do you think HEMS is playing an important part in transporting patients and conducting search and rescue (SAR) operations in Norway?

▪ Is Norway helping neighboring countries in rescue and transportation activities.

▪ How do you see the future of HEMS developing in Norway?

▪ How do you understand response time?

▪ How HEMS effect yours regular life with your family and friends?

Part 4:

Concluding Interview

▪ Closing remarks/comments

▪ Any potential/additional question for the interviewee

▪ Expression of gratitude

Appendix-B

Institution name: Høgskolen i Molde - Vitenskapelig Høgskole i Logistikk.

Supervisor: Antonina Tsvetkova (Associate Professor)

Interviewers: Muhammad Omer Farooq (191344) (Master Student in Logistics HiMolde)
Daud Ahmed (191328) (Master Student in Logistics HiMolde)

Respondent: 2

Interviewee: Anonymous

Date: 27 April, 2021

Interview topic: The reliability of helicopter medical services and response times in Norway: an institutional perspective on emergency preparedness operational logistics.

Topic description: This topic provides deeper insights into how reliable the helicopter is in a particularly difficult to reach area. The placement of emergency medical services is a critical strategic decision that can have a significant impact on the quality of emergency medical assistance to the population in general, remote areas, and offshore oil platforms in Norway. The topic suggests focusing on logistics operations in emergencies and medical service preparedness to reduce the population's skepticism about reorganizing the local hospitals.

Part 1:

Opening comments

Explaining the purpose of the interview and before going ahead, ask the following questions:

▪ Do you have any question, should ask before we proceed with the interview?

▪ Don't you mind if I use a recorder during our interview?

▪ Would you like your name to be kept anonymous? Or may it be mentioned in our master's thesis?

Part 2:

The Organization and the Interviewee

▪ Please tell us about your role in the organization you are working with.

➢ Your position!

➢ Your daily responsibilities!

▪ How long you have been working here?

Part 3:

Helicopter Emergency Medical Services (HEMS) in Norway

▪ On how many people the crew of one helicopter mission consists of?

▪ Can you give an overview of the mission from the call for help to the final transportation of the patient to the hospital?

▪ During the mission which services are you in contact with?

▪ What are the SOP's which you follow while conducting the mission?

▪ Did covid-19 affected HEMS operations?

▪ To what extent the training of medical staff is different for working in a helicopter as compared to in a hospital.

▪ Who is the responsible person for aborting the emergency/rescue mission?

▪ What are the equipment that is available onboard the helicopter?

▪ How HEMS are organized in Norway to provide medical support?

▪ Is there any difference between civilian air ambulance service and rescue helicopter service?

▪ Is there any difference in treating a patient inside the hospital and on the helicopter?

▪ What are the benefits of using HEMS instead of using other medical transport services in Norway?

▪ What do you think are the challenges faced by the HEMS in Norway?

▪ Who is responsible for deciding the usage of HEMS in any emergency operation?

▪ What situations prohibit or restrict the use of HEMS in Norway?

▪ How do you see the future of HEMS developing in Norway?

▪ How do you understand response time in HEMS?

▪ How does it like to feel for working as a crew member for HEMS?

Part 4:

Concluding Interview

▪ Closing remarks/comments

▪ Any potential/additional question for the interviewee

▪ Expression of gratitude

▪ Permission to be contacted again by email after the interview for new follow-ups