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Doctoral thesis

Bjarne Goksøyr Pareliussen

Maritime organizations facing a new era

-Servitization, technology implementation and professional work

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NTNU
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Science and Technology

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Maritime organizations facing a new era

-Servitization, technology implementation and professional work

Thesis for the Degree of Philosophiae Doctor

Trondheim, December 2022

Norwegian University of Science and Technology
Faculty of Engineering
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Sammendrag

Denne avhandlingen undersøker organisatoriske endringer som en konsekvens av introduksjonen av digital teknologi og nye forretningsmodeller. Denne introduksjonen av teknologi kan sees i sammenheng med at maritim industri møter krav til bærekraftige transportløsninger og dette krever endringer og ny teknologi. Målet med avhandlingen er å identifisere operasjonelle konsekvenser og hvordan dette endrer relasjonene mellom rederi og leverandør.

Data til de to første artiklene ble samlet i en casestudie av to avanserte fraktefartøy i en fraktrute langs kysten av Norge. Disse skipene var de mest avanserte og miljøvennlige når de ble levert og operer med en ny type forretningsmodell som går ut på at leverandør leverer alt vedlikehold som en tjeneste i stedet for å selge deler og utføre service. Slike forretningsmodeller blir ofte kalt tjenestebaserte. Denne tjenesten er betalt gjennom en fast avgift per operasjonstime. Denne studien varte over et år og satte søkelys på endringer i arbeid, arbeidsprosesser og relasjoner mellom organisasjoner.

I tillegg til casestudiet så ble det gjennomført en undersøkelse for å kartlegge forholdet mellom rederi og leverandører og hvordan de forholder seg til forretningsmodeller der leverandør har en aktiv rolle inn mot operasjon og vedlikeholdsstyring av skip. For at slike forretningsmodeller skal bli tatt i bruk så må industrien være åpen og motivert og se fordelene som kan oppnås. Basert på utbredelsen av denne modellen kan det stilles spørsmål med om maritim næring er klar for denne typen forretningsmodeller. Disse spørsmålene var fokus for den andre empiriske studien i denne doktorgraden. Metoden som ble brukt var kvalitative intervju med nøkkelpersoner i rederiene og leverandørene. Denne undersøkelsen resulterte i den tredje artikkelen som setter søkelys på mulighetene for slike forretningsmodeller i maritim næring og hvilke faktorer må være til stede for at den skal bli utbredt.

Avhandlingen identifiserer digitalisering og tjenestebaserte forretningsmodeller som drivende for samarbeid mellom organisasjoner og aktører fra ulike organisasjoner. Dette kan forklares med kompleks og kompetansekrevende teknologi og fjerning av økonomiske barrierer for samarbeid gjennom ny forretningsmodell. Dette fører til at aktører kan skaffe seg kompetanse enten direkte fra andre organisasjoner eller gjennom samarbeid for å skaffe seg kompetansen. I praksis ser en dette gjennom hvordan maskinistene ivaretok sin profesjonalitet ved å tilegne

seg ekspertkompetanse gjennom samarbeid med leverandørene sine eksperter. Denne avhandlingen identifiserer også eksempler på læring mellom organisasjoner. Denne læringen er ikke i slik en ofte ser i organisasjoner som aktivt søker partnere for å lære og skaffe seg konkurransefortrinn. I stedet så skjedde læringen i lavere nivå i organisasjonen for å kunne optimalisere arbeidsprosesser. Dette viser viktigheten av å vurdere motivasjonen for organisasjoner når en skal vurdere hvordan samarbeid og læring utvikler seg.

Utbredelsen av denne forretningsmodellen ser ut til å ta tid i maritim næring. Faktorer som kan påvirke dette kan finnes i reguleringen av forholdet mellom leverandør og rederi. Tradisjonelt er dette forholdet regulert gjennom kontrakter og gjensidig tillit. En spesiell type tillit har vist seg å være viktig når en skal etablere kompliserte samarbeid slik som tjenestebaserte forretningsmodeller. Denne typen tillit er integritetsbasert tillit og for å etablere den så må relasjonene bygges over tid. I maritim næring så vil dette være komplisert fordi der er klare skiller mellom utvelgelsen av leverandører til nybygg og hvordan forholdet mellom leverandør og rederi utvikles gjennom driftsfasen. Dette betyr at skal en integritetsbasert tillit etableres så må begge parter investere tid og ressurser i etableringen av et forhold som kan fungere med en slik forretningsmodell.

Denne avhandlingen identifiserer flere fordeler med denne typen teknologi og forretningsmodell, men skal denne forretningsmodellen bli allment akseptert, så må fordelene fremheves slik at leverandør og rederi er villig til å satse tid og ressurser for å få den etablert.

Acknowledgments

This thesis is written at NTNU campus Ålesund with access to an abundance of knowledgeable colleagues. Without the discussions and the ability to ask questions regarding anything from technology to academic puzzlements, this thesis would not have been the same. Thank you all very much. A special thanks to my fellow Ph.D. candidates, it helps to have somebody to get understanding from and who is willing to listen to complaints.

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Summary

This thesis investigates organizational changes in the maritime industry when introducing digital technology and new business models. The maritime industry is met with demands to provide sustainable transportation for society, and this requires new advanced technology and solutions. This thesis aims to identify these changes' implications for ship operations and maintenance, as well as how the changes affect relationships between shipowner and supplier.

The primary data source for this thesis is a case study of two advanced freight ships operating on a route along the coast of Norway. These ships were operating with a novel servitized business model in which the technology supplier provided service and spare parts for a fixed fee per operational hour. The case study lasted for a year and focused on identifying changes to work, work systems, and the relations between the organizations.

The findings from the case study resulted in a second data collection aiming to investigate the shipowners' and suppliers' relationship in a broader sense outside the case study. Also, it was aimed to identify their views on business models in which the supplier plays an active role in ship operations and maintenance. Through qualitative interviews with key stakeholders among the shipowners and suppliers, the third article examined the acceptance of servitization innovation in the maritime industry and the key factors for success.

This thesis demonstrates how the servitization trend, through new business models, is a driver for increased use of digital technology, creating new roles and relationships within interorganizational collaborations. The result is that organizations can seek outside partners to attain competence or build competence together. This can be seen in the strengthening of the ship engineer profession by embracing opportunities to increase ship engineers' technical expertise and their professional status by collaborating with technology suppliers' experts. The thesis also identifies interorganizational learning between organizations, not as organizations actively seeking partnerships to increase their competitive advantage, but as learning at different organizational levels to improve work quality. The importance of the motivation of partners entering interorganizational relationships and how they learn from each other is one topic investigated in the paper "The whereabouts of interorganizational learning." Factors that explain this business model's proliferation in the maritime industry are found in the regulation of interorganizational relationships. The regulatory mechanisms in such business relationships are contracts and trust. Integrity-based trust has been identified as

important when entering complex collaborations, e.g., servitization as a business model. However, creating integrity-based trust is complicated, as the maritime industry is separated between the construction of new ships and the after-market, which focuses on ship maintenance and operations. Thus, the involved partners must invest substantial time and resources to cultivate a relationship that can sustain such a business model.

The thesis identifies several important benefits from the introduction of this technology and business model but getting the industry to accept this business model requires spotlighting the model's positive effects so that shipowners and suppliers are willing to make the necessary effort.

Abbreviations

IMO – International Maritime Organization

ISM – International Safety Management code

LNG – Liquid natural gas

MARPOL – International Convention for the Prevention of Pollution From Ships

SOLAS – Safety of Life at Sea

STCW – International Convention on Standards for Training, Certification, and Watchkeeping for Seafarers

UN – United Nations

ENMC – European Network of Maritime Clusters

List of included papers

Paper 1

Professions, work, and digitalization: Technology as means to connective professionalism

Authors: Bjarne Pareliussen, Vilmar Æsøy, and Marte F. Giskeødegård

Journal of Professions and Organization, Volume 9, Issue 1, February 2022, Pages 100–114

Paper 2

The whereabouts of Interorganizational learning: A maritime case study

Authors: Bjarne Pareliussen, Marte F. Giskeødegård, Vilmar Æsøy

The Learning Organization – Published 10.11.22 Ahead of print

Paper 3

Servitization and Maritime Relations

Authors Bjarne Pareliussen, Marte F. Giskeødegård

Submitted to: WMU Journal of Maritime Affairs

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Contents

1. Introduction

Rapid technological developments and increasing demands for sustainable solutions are only some of the drivers creating fast-paced change in today's working life. Consequently, organizations and their workers face a complex and unpredictable business environment that fosters new competence demands. New business models and strategies that attempt to remedy the situation are emerging. Servitization, in which the supplier delivers services to the customer's core business, is one of these strategies (Vandermerwe & Rada, 1988). Such business models change structures, roles, and relationships in intra- and interorganizational networks. With interorganizational collaboration comes the need to communicate and coordinate with external actors, often realized with cloud computing and collaborative communication technologies. Similarly, issues concerning responsibility, reliability, and liability across organizational borders have elicited the use of digital technologies—e.g., remote monitoring, Internet of things (IoT), and predictive analysis—to increase control. Such use of digital technologies transforms the business of industrial companies, service companies, and the public sector (Ardolino et al., 2018; Coreynen et al., 2017).

In many ways, digitalization represents a new technological paradigm, and it often is referred to as Industry 4.0, e.g., the fourth industrial revolution (Rüßmann et al., 2015). This could be viewed as a paradigm shift, as digitalization is changing business, facilitating new business models, and changing professions (Brynjolfsson & McAfee, 2012). Such paramount changes must be investigated to identify how work, professions, organizations, and relationships are affected and adapting to succeed in today's working realm.

In the maritime industry, one of the main factors driving the technological evolution is the requirement to deliver sustainable transportation for a global market (Global Maritime Forum, 2021). Sustainable maritime transportation requires developing new technology, and extensive use of digitalization for optimization and efficient operations. This is therefore a good sector through which to explore technology and digitalization's organizational ramifications. One of the maritime industry's solutions to meet the need for sustainable transportation is using so-called green fuels, e.g., LNG, hydrogen, and battery power. For shipowners, this requires investments in new ships or refitting old ones. For organizations, this means acquiring competence in purchasing, operating, and maintaining the technology. These technologies are not covered in the education of the crew on board ships and require other approaches to acquire the necessary competence. One way to solve this is through new policies and requirements, e.g., by changing competence requirements in professional education.

The maritime industry, with its international regulatory body, presents a good case through which to examine the interconnected relationship between policy regulation, technological developments, and organizational implications, e.g., new competence requirements. The world is facing demands for sustainable transportation of goods and people, and technological developments are in motion, but not necessarily at the same speed in different countries and regions worldwide.

The UN's Paris Agreement, which aims to reduce global carbon emissions, is facilitated by the International Maritime Organization (IMO), which is responsible for regulations concerning safety, pollution, and training requirements for seafarers. These requirements are essential to cultivate competence and, thus, are educational priorities. The regulation of education for the maritime industry is known as the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW). The new advanced technology installed on ships today has been challenging for the STCW agenda as it tries to remain relevant in the modern industry, e.g., many ship engineers are educated in countries struggling to meet the demands within today's STCW, much less meet higher requirements (Hand, 2018). This leaves IMO with a dilemma: It either can strengthen requirements, which would risk rendering a substantial number of seafaring nations unable to meet them, or they could do nothing, leaving ships' crews possibly unable to operate and maintain advanced equipment, thereby forcing shipowners to rely on service personnel for operations and maintenance. Whichever solution IMO chooses, many ship engineers will face new advanced technology that their training did not cover.

This competence gap opens up business opportunities for suppliers, which can specialize in performing advanced maintenance for shipowners, offer specialized training courses, or potentially take over all maintenance requirements. Therefore, the supplier's competence in the use of these technologies becomes critical, providing new collaboration opportunities. One example is digitalization and remote condition monitoring, which allow suppliers' experts to oversee equipment maintenance schedules and performance on board ships using data analysis, e.g., visualizing operations through the use of a ship's digital twin. When suppliers have access to this new kind of data, it enables new possibilities as to what they can offer their customers. For example, they can use sensor data and their competence to extend the service interval for components and offer fixed-price service contracts with performance guarantees; thus, it is a driver for developing new business models.

A recent example of suppliers using such business opportunities is the introduction of advanced maintenance contracts for ship technology. The most advanced contracts are output-based (Grubic & Jennions, 2018), i.e., they rely on the supplier's knowledge of ships' equipment and real-time sensor data through fast data transfer links from the vessel to shore for real-time monitoring. This business model shifts the risk of failure from the vessel's owner to the supplier (Selviaridis & Wynstra, 2015). Furthermore, the maintenance cost is included in the fixed charge per operational hour, allowing the ship's owner to develop concise knowledge of the ship's running costs. This business model is an example of servitization, in which suppliers and manufacturers move away from selling products and toward delivering services. Servitization can affect the relationship between suppliers and customers (Hou & Neely, 2018). This business model and accompanying technologies, e.g., remote monitoring, are good examples of the connection between digitalization and new business models based on digital technologies.

Several new questions have arisen regarding work processes, competence requirements, roles, and relationships with the introduction of digital technologies and new business models in the maritime industry.

This thesis focuses on the effects of introducing output-based business models and accompanying digital technologies into maritime organizations.

1.1. Research objectives

The overall research objective of this thesis is to investigate how digitalization changes professions, work systems, and relationships in and between organizations when implementing new technology combined with a new business model.

Barley (2020, p.26) sums up 40 years of studying work, technology, and organizations: "There is only one certainty about technological change: You almost never get only what you expect, and sometimes you do not even get that." Therefore, it is essential to understand the (un)intended consequences of technology implementation, which can elicit positive or negative effects within organization(s). To be able to implement effective measures, an accurate diagnosis is needed. Thus, the objective of this research is to examine the implications of technology implementation on work practice, competence requirements, and relations.

1.2. Research questions

To be able to fulfill the research objectives of this thesis, the following research question, which was divided into two sub questions, has been developed.

- *How does the introduction of a business model using performance-based contracts and remote monitoring affect maritime organizations?*
    - *How will remote monitoring and new business models affect the ship as an organization?*
    - *How is the relationship between ship, shipowner, and supplier changing with the introduction of new technology and new business models?*

1.3. Scientific contributions

The scientific contributions of this thesis concern challenges and opportunities in the implementation of technology by taking a practice-oriented approach to understanding the interrelated relationship between technological and organizational change, with a particular emphasis on work practice in understanding organizational change triggered by technology implementation.

The three papers that comprise the thesis contribute to this insight in different ways.

The first paper provides empirical evidence of how professions can become more connective and increase collaboration with outside actors when faced with challenging technological change. The paper examines how ship engineers maintain their professional expertise and status by collaborating with technology specialists that the technology supplier employs.

The second paper contributes scientifically by identifying interorganizational learning as a key factor for success, but not based on the established definition. The established definition of *interorganizational learning* views it as bidirectional learning between organizations, or as organizations learning together. In this case, interorganizational learning is viewed as learning at the individual and group levels.

The third paper investigates the introduction of servitization into maritime organizations and the factors that contribute to or hinder acceptance of this business model. The findings demonstrate that trust between maritime organizations is necessary, but in the form of integrity-based trust. The studied organizations primarily showed signs of competence-based trust, i.e., considerable changes will be required before this business model is accepted in the maritime industry.

1.4. Industrial contributions

The maritime industry is facing monumental challenges trying to meet the demand for sustainable transportation, consequently dealing with new technology and fast-changing competence requirements.

This thesis demonstrates how the servitization trend, through new business models, is a driver for increased use of digital technology, creating new roles and relationships within interorganizational collaborations. One industrial contribution is to illuminate some of the opportunities and potential pitfalls that come with these developments.

One example entails documentation of closer contact and collaboration between ship engineers and the supplier's technical experts under these new servitized contracts. The thesis identifies some of the benefits of this closer contact, e.g., access to competence and increased potential for learning and innovation.

Thus, the findings from the thesis point to how such business models can help remedy some of the fast-changing competence requirements that the maritime industry is facing, partly because servitization allows organizations to access outside competence. However, the specific contribution of the thesis is to highlight how new roles and relationships in themselves can elicit knowledge sharing and lessons learned through new emerging interorganizational relations.

The thesis also identifies and clarifies some of the industry's challenges regarding advanced machinery and digital technology competence. A direct consequence of the new relationships comprises changes to the roles and responsibilities of operating with such a business model, with subsequent questions concerning rights, responsibilities, and liabilities. Another key challenge is that technology suppliers are delivering services near their customers' core activities. This requires an understanding of the other party's obligations and rights, as well as trust between partners.

The thesis shed light on some of the root causes of obstacles linked to the maritime industry's structure. In this sense, the results contribute by putting key issues on the agenda that need to be addressed for the maritime industry to reap this business model's benefits.

1.5. Structure of the thesis

The thesis follows a traditional structure with an introduction, background information and a theoretical foundation before the scientific method is presented. After the method the results are presented followed by the discussion and conclusion. The background information contains additional information that is necessary for to understand the particulars of the field and topics investigated in the research. In this thesis the background information contains a description of the maritime industry with its governing mechanisms, a description of the technology that is implemented onboard the ships and an overview of the new business model that is introduced into the maritime industry. The theory chapter focus on relevant theories that can shed light on the empirical evidence and answer the research questions. The Method chapter discusses the theoretical assumptions and methods used to collect empirical data. The Result chapter presents a summary of the scientific papers. The empirical data is then discussed against the theoretical foundation. The conclusion sums up the discussion and how the thesis answers the research questions.

2. Background

This chapter provides an overview of relevant topics that is needed for understanding the background situation for the research objective. The history of the maritime industry is presented to highlight the specific traits of this traditional industry that can influence the acceptance of new technology and business models. The international profile of the maritime industry is showed through the organizations that govern the industry, both onboard vessels and the onshore organizations. Also, the organizational structures onboard the ship and the organizations involved with the maintenance of ships are introduced. The details and nature of the technology that is introduced is explained further along with the new business model that is managing the relationship between the shipowner and supplier.

2.1. Maritime industry

The maritime industry is known as one of the most traditional industries. Established terms, e.g., *seamanship* and keeping things *shipshape*, indicate the high standards that anybody choosing this industry as their career must meet. The process of becoming a seaman and obtaining the skills and professionality needed for a successful career has been described in classic fiction since Frederick Marryat wrote his works in the early 1800s. Later publications, e.g., “Enskilment at sea” by Pálsson (1994), investigated seamanship as a success factor scientifically. In this ethnographic study of the fishing industry in Iceland, Pálsson linked the process of becoming a fisherman, a practical process, to the economic success of ships with skilled captains. The maritime identity and the industry’s emphasis on professional competence as a success factor are integral parts of the industry.

The maritime industry is also known as a high-risk/high-profit business. The concept of insurance and insurance companies evolved from the risk of sending expensive ships with costly merchandise out on the oceans with only onboard resources to sustain them. If the ship arrived safely, large profits could be made, but if the ship was lost, the economic loss could be high. This balance between risk and profit has shaped maritime professions and organizations (Tenold, 2019). The maritime industry also has been a continuous source for inventing new technology to harvest from the sea, from fishing technology to offshore drilling operations. Specialized technology was invented to increase efficiency and reduce seafaring risks.

These maritime industry traits are essential to understand how the industry is developing and how the organizations that comprise the industry are adapting to changes. They often work together to develop technology quickly to profit from new business opportunities, e.g., wind farms or aquaculture fish farms. Other times, the maritime industry can be remarkably slow in adapting to changes and keeping traditional methods alive. For instance, the shift from sail power to steam often is described as a rapid transition, but it took more than 130 years from the first Atlantic crossing with steam power to the last commercial sailing ship. Also, the maritime industry's high-risk/high-profit profile influences maritime shipping's organizational structure. For instance, shipowners often do not perform ship operations, instead enter into contracts with management companies that specialize in ship management. Accident investigations have shown that strategies to lessen the economic risks of ownership can make it almost impossible to identify the actual owner of a ship (Schei et al., 1991). Rapid technological development and accidents unfortunately have followed each other through history, as regulations, skills, and training have tried to keep up with technological advancements. For example, the "Safety of Life at Sea" (SOLAS) convention resulted from the Titanic disaster to ensure that ships going forward would meet minimum safety standards in construction and onboard equipment. The SOLAS convention was the first international convention to regulate ship operations. Today, the maritime industry operates under several international shipping rules and regulations.

2.2. International regulatory mechanisms

In 1948, IMO was founded. There had been calls for international regulations regarding maritime safety, but it was not until after establishment of the UN that IMO formally was established. IMO's primary purpose was to ensure maritime safety, but identification of other areas that needed international coordination soon followed, one of which was maritime pollution. The MARPOL Convention in 1973 was established after a series of oil tanker disasters, setting standards for air pollution from hydrocarbon combustion and treatment of ballast water. In the 1990s, other measures were instituted. In 1995, the STCW went into effect, setting training and competence standards for maritime professions and a minimum crew size depending on ship sizes.

IMO also implemented the International Safety Management Code (ISM) in 1998. This amendment to the SOLAS convention was elicited after the realization that accident rates in the 1980s and 1990s did not drop despite increasing efforts. This lack of results led to a new view on safety in which the focus shifted from human error to organizations and work systems' role in accidents. The ISM code's goal was to enforce the use of safety management systems within maritime organizations. It also meant a shift in responsibility from seafarers to shipowners and management to ensure that necessary training and procedures were followed. To comply with the ISM code, the shipowner needed to be audited every five years and designate a person onshore to ensure that the company and ship follow the ISM code. IMO implemented the STCW Convention and ISM code to recognize that an emphasis on the human side of the maritime industry is necessary to meet the industry's goals. One complication of introducing the STCW Convention and establishing global directives for training and competence was the varying degree of compliance from IMO member states (Hand, 2018). It is challenging for a global organization like IMO to meet the requirements for advanced technologies of the future when some of the larger member states are struggling to meet today's training requirements and cannot meet additional demands. The global maritime industry is not developing coherently, with technological developments often occurring in local areas specializing in specific branches of the maritime industry. These areas often are categorized as regional clusters that frequently develop specific traits, and the companies within a regional cluster often develop similar characteristics (Ferreira & Serra, 2009; Pouder & St. John, 1996). Considering that the empirical data used in this thesis were collected within a regional cluster, gathering general theoretical background information on regional clusters and their specific characteristics is justified. Regional clusters will be discussed in the next section.

2.3. Cluster mechanisms

One of the success factors in establishing economic growth in regions is through clusters. Regional clusters have been studied for more than a century (Marshall, 1890) and continue to be a source for empirical studies on value chains and organizations' competitive advantages. Regional clusters can be formed in any industry, but are particularly effective when they can be viewed as complete clusters, containing the entire value chain inside each cluster. The maritime industry is a typical example of a sector that often forms regional clusters. As a result, organizations such as the European Network of Maritime Clusters (ENMC) were established to further European maritime clusters' interests (ENMC, 2022). This organization has regional clusters that comprise members from 20 European nations and contributes by issuing annual reports and other analyses for its members' benefit.

Establishing regional clusters also has been a strategy for governments to strengthen their countries' industries and ensure economic growth. This strategy can be linked to the interest in regional clusters in the 1990s following Michael Porter's (1990) study on regional clusters and companies' competitive advantages. In Norway, this elicited a program to establish regional clusters further—the Norwegian Centers of Expertise—which the governmental organization “Innovasjon Norge” launched in 2006 to advance innovation and industrial growth in Norway. A controversy from campaigns establishing regional clusters is that these clusters often are emergent, and according to Porter (1990), it is better to focus on strengthening emerging clusters than establishing them. An explanation can be found in Porter’s now-famous diamond model, in which the conditions that develop clusters are explained. The four conditions that Porter (1990) used to explain the cluster mechanisms are:

- *Factor conditions*: the availability of resources, e.g., skilled labor and economic incentives
- *Demand conditions:* the availability of a home market to strengthen connections between customers and industry.
- *Firm strategy, structure, and rivalry*: strategies toward competitors and the ability to adapt to competition.
- *Related and supporting industries*: subcontractors and suppliers’ availability.

Establishing clusters in a region where none of these conditions can be found will take substantial effort before the cluster can be functional and competitive. Therefore, establishing these centers in existing or emerging clusters is necessary. One of the established maritime clusters, and the one featured in this thesis, is located in the northwestern region of Norway. The cluster was established as a “Norwegian Center of Expertise,” but became a “Global Center of Expertise” in 2014 as international connections were recognized. The region has been known for its competence and resources in shipbuilding and fishing since the 1700s (Døssland, 1990). Since then, the region has established businesses and followed technological developments as they progressed (Oterhals et al., 2016). The cluster experienced rapid growth since the beginning of the millennium when construction of advanced offshore vessels for the oil and gas industry was booming. The cluster now is viewed as a complete regional cluster, i.e., all parts of the value chain exist within the cluster (Oterhals et al., 2016). The maritime value chain typically comprises shipowners, shipyards, ship designers, technology manufacturers, and subcontractors, i.e., all the necessary functions to design, build, service, and operate ships. This thesis focuses on the ship’s operations and the organizations involved when new technology is introduced, all the organizations involved in this thesis are belonging to this regional cluster and the cluster mechnanisms are important factor to consider when. The next section will present the organizations involved with the ship’s operations, along with an overview of the ship—with an emphasis on the ship engineer, who plays a dominant role in technical maintenance— and an overview of the newly introduced technology.

2.4. The operation of ships, digital technologies, and business models

Building a ship is a complex process, and a simplified explanation of this process starts with the shipowner deciding that they want a new ship. The next step is choosing a ship designer and a shipyard to build the ship. When these decisions are made, the shipyard will take charge of the building process and present the shipowner with several choices regarding technology and which technology supplier should be chosen. Usually, one suppler will be selected as a system integrator, ensuring that all the technology on board is compatible and can be maintained using the same control system. This system integrator will choose the subcontractors that they will use unless the shipowner has specific requirements. Changing a subcontractor is expensive, as it usually requires software and hardware integration to be compatible with the rest of the technology on board the ship. When the ship is completed and the shipowner has accepted delivery, the ship's normal operations will commence. The shipyard and technology supplier write up a maintenance plan for the technology on board. The crew on board conducts part of this maintenance, while the supplier's service engineers perform more challenging maintenance. The primary organizations involved with the ship's operations are provided in Figure 1.

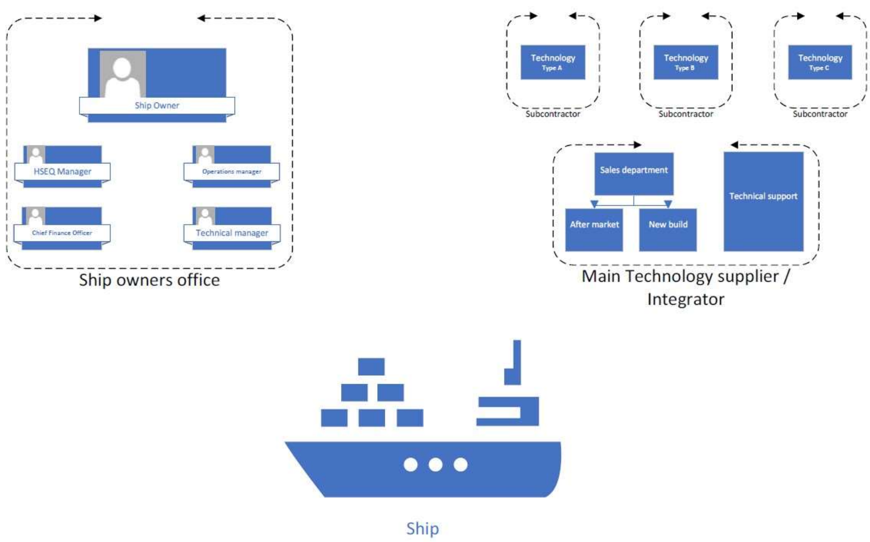

Figure 1. Organizations involved in a ship's operations.

The maintenance and operation of a ship today are taking advantage of communication technology. When a ship engineer is faced with malfunctioning equipment, they can seek help from the technical manager or specialized help from the supplier. However, the ship still is governed by tradition in many ways. The onboard crew have a strong sense of identity tied to their history and traditionally have been forced to rely on their ability to solve problems when the ship is at sea. Goffman (1958) included ships with prisons, asylums, and orphanages in his examples of total institutions due to their strict hierarchical social structures and the isolation that crew members experience. Although the accuracy of this analysis has been debated (Gerstenberger, 1996), a situation may arise in which professionals on board must keep the ship operational and safe with a limited ability to receive outside help.

Isolation and self-reliance are also some of the reasons why a ship is organized under a strict hierarchical structure, as illustrated in Figure 2. The ship master (captain) has full legal authority on board. Under him are the different departments and their chiefs. For example, the chief engineer leads the Engine Department, and depending on the ship's size, he may have engineers under him. These crew members will be, e.g., the second or third engineers on larger ships.

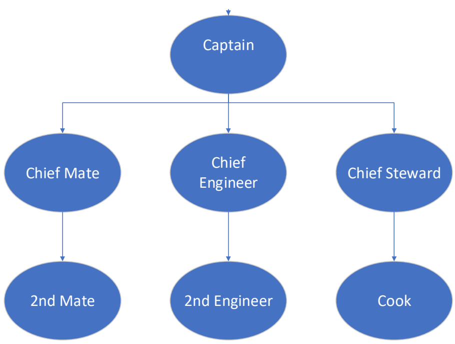

Figure 2. Example of a ship's hierarchy

As discussed in the introduction, the demand for more sustainable shipping requires more advanced technology. The crew will face additional challenges on board to keep the ship operational without more help from outside sources.

As mentioned previously, it is challenging for IMO to meet the training requirements for new technology and simultaneously consider individual member states' needs. New technological training requirements have been recognized under the STCW Convention, updated in 2010, but the gap between official requirements for competence and actual requirements in the maritime industry has widened (Hand, 2018; Nautilus Federation, 2020). For ship engineers, this competence gap means they must rely on external competence when they cannot solve problems or perform required maintenance. Ship engineers traditionally communicate a need for spare parts and service to the shipowner, who then places an order with the relevant supplier. When the ship engineer is forced to use the technology supplier for more work, it can increase tension between the ship engineer and shipowner, who now have increased costs for service and maintenance. The technological evolution on board ships has progressed steadily over the past decade, with the demand for sustainability and profitability as the main drivers. The next subsection presents a short description of technological developments.

2.4.1. Technological developments

The traditional propulsion of a ship comprises a diesel or heavy oil engine driving a propeller. Electricity generators and hydraulic power are driven from the main engine or auxiliary diesel engines. This setup is still typical in many ships, but diesel-electric propulsion (Figure 3) has become the norm to meet the demand for a greener shipping industry. In diesel-electric propulsion, an electric motor drives the ship's propeller, and several diesel generators provide the electricity. Diesel-electric propulsion allows for using the necessary number of diesel generators to provide the required power, instead of running a large engine that wastes fuel. A disadvantage is that the engine room's control system is more advanced to allow automatic starting and stopping of engines depending on the power requirement. Using electrical motors for propulsion also allows for the use of batteries in a hybrid solution in which the ship can rely on batteries when in port. They also can be used to gain extra electric power instead of starting another diesel generator. Greener fuels also have been introduced over the past decade, primarily LNG, a gas cooled down to -160 degrees to become liquid and stored in special tanks on board the ship. Turning liquid gas into fuel for the engine requires a complex automated plant with an advanced control system and safety functions.

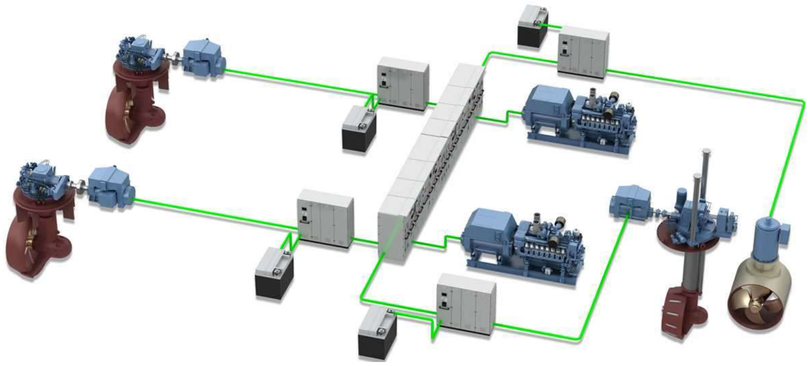

Figure 3. Example of diesel-electric propulsion. Kongsberg Maritime©

Recent developments in digital technology have enabled remote monitoring and predictive maintenance, i.e., work routines on board the ship are changing (Global Maritime Forum, 2018). Remote monitoring involves installing sensors on critical systems that send data to an onshore monitoring center. The data are analyzed and compared with digital models of the expected behavior of the equipment, the results of which are used to predict an optimum maintenance schedule that reduces costs and increases the equipment's service life.

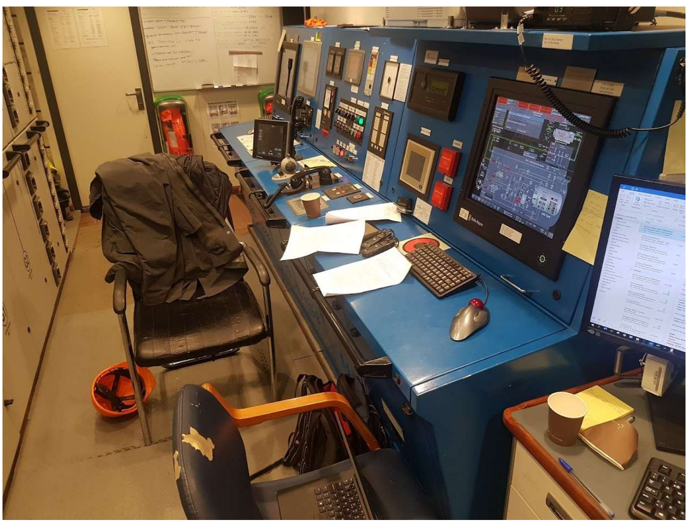

Figure 4. An LNG-powered ship's engine control room.

These new technologies' secondary effects include demands for new knowledge, training, and increased interaction with the supplier to ensure optimal operational performance. These factors can lead to more connectivity, innovation, or even disruption when outside occupations and stakeholders are involved with the ship engineer's work tasks.

2.4.2. Business models and servitization

Power-by-the-hour™ is well-known in the aviation industry, through which servitization facilitated the use of Rolls Royce™ airplane engines since the 1960s. With increased possibilities for remote monitoring and predictive maintenance, this business model also has become relevant in the maritime industry. Output-based contracts are the primary method of delivering services in this business model. In this case, the customer pays a fixed fee for maintenance, which includes all spare parts, labor, and training. This type of contract has potential benefits for both customers and suppliers. Extant research has indicated that customers typically benefit from increased efficiency, improved accountability, innovation, budget flexibility, and value for their money (Selviaridis & Wynstra, 2015). Suppliers can benefit from a steady fixed income as well, but they may be exposed to substantial economic risks (Hou & Neely, 2018; Ziaee Bigdeli et al., 2018), which can be mitigated using monitoring technology that allows suppliers to prevent expensive repairs by identifying equipment failures before they cause damage.

Studies of power-by-the-hour™ and similar business models have found evidence that they can increase a manufacturer's ability to diffuse innovations, as well as increase collaborations between customers and manufacturers on research and development projects (Vandermerwe & Rada, 1988). Interactions and collaborations between customers and suppliers can lead to an increased demand for formal, explicit knowledge when establishing procedures for the operation of new technology. They also increase the potential for cocreation and emergent organizational learning for both customers and suppliers (Ng et al., 2009). Therefore, this business model can narrow the competence gap that ship engineers experience from introducing new technology without making changes to formal training. According to the business model, sending ship engineers to specialized training courses does not incur additional costs for the shipowner. Furthermore, the supplier covers the cost of sending service engineers, and reducing the time they spend on board will cut costs. Therefore, it is in the supplier's interests for ship engineers to gain competence and perform more maintenance work on board. Any changes that the supplier can make to increase ship engineers' competence, e.g., providing the means for frequent communication and consultations with the supplier's technical experts, are in their best interests.

However, some changes resulting from the introduction of this business model may be negative. For instance, utilizing remote monitoring to mitigate risks may require a way for the supplier to influence decisions regarding a product's operation. This will not necessarily be in the customer's best interest or coincide with a ship engineer's professional opinion. For example, imagine a situation in which equipment failure is imminent. In this case, a supplier may want to reduce damages, but the customer needs to complete the operation. As a solution, flexibility and understanding between supplier and customer are necessary and allowed under the service contract. Ng et al. (2009) discussed another example, in which they demonstrated how the relationship between customers and suppliers changes when introducing output-based contracts into the defense industry. They analyzed two military defense contracts: one for fighter jets and the other for a missile system. They found that operators perceived the equipment's value as lower after the introduction of output-based contracts because the repair and maintenance costs were not directly visible in the form of bills for the operator. As a result, this led to them handling the equipment more carelessly, i.e., business models that utilize output-based contracts could influence the relationship between organizations and professional work execution.

3. Theoretical Foundation

The theories presented in this chapter are chosen to shed light on the topic of this thesis, namely organizational changes as a result of digital technology and new business models.

The field of organizational studies that informs the thesis thematic focus is complex and multifaceted. In the preface of the third edition of Charles Perrow's classic text *Complex organizations: A critical essay* (1986), he reflected on the development of organizational analysis. According to Perrow, the important topics in organizational theory in the 1950s and 1960s came from more developed fields. However, by the early 1980s, Perrow alleged that the opposite was now true. Organizational studies influence psychology, social psychology, political science, and economics. The focus on organizational theory as an increasingly important field has not diminished in the years since then. Organizational theory has evolved from attempting to understand complex organizations to becoming a complex field of study. It is therefore necessary to make an informed decision on how to investigate organizational issues and from which theoretical standpoint the research will be founded on.

The following sections will present the theoretical landscape on which this thesis is founded, which can shed light on the investigated organizational changes. The background chapter show the maritime industry as a traditional industry, where seamanship and professional autonomy has a strong position. Investigating organizational changes in such a setting raises questions about how the professional status, work and competence requirements are affected by intra and interorganizational changes due to technology implementation. Theories taking a socio-material perspective are adopted to investigate the micro and microlevel changes the change in technology creates.

Also, as presented in the background information, the introduction of new technology and business model affect several organizations. Theories that can explain the changes in these organizations at different levels are also necessary. A theoretical approach to this is organizational learning. Theories of learning can explain how the organizations can adapt to new technology and new demands to support technologies. These theories must explain how learning can happen between ship engineers and experts from the supplier, but it must also explain the complexity that learning happen between organizations.

The section uses the theory of professions as a point of departure, reflecting the importance of ship engineers and their profession in this thesis. The following section focuses on the work that is affected by digitalization and technology and provides a theoretical foundation for understanding work and work systems. They also demonstrate how standardization and digitalization can change work and the professions performing the work. The subsequent sections outline technology's importance as a change agent within organizations. In this thesis, technology plays a significant role in changing organizations. Organizational learning then is outlined as a theoretical explanation for organizations' ability to cope with changes and use them to improve organizations' outcomes. Two organizational learning concepts are covered in detail: communities of practice and interorganizational learning. Communities of practice explain learning as a situated social process that is important in this thesis as new social arenas manifest themselves. Interorganizational learning is important in this thesis because several organizations are involved, and one of the changes introduced is the removal of economic barriers between organizations. The final theoretical perspective is trust between organizations as a regulatory factor for interorganizational relations.

The starting point in this theoretical foundation is the discussion of the professions. This is mainly because the profession of the ship engineers and their role in the maintenance of ships can be important factors in explaining the organizational changes. The profession of the ship engineers can be traced back to 1862 (Grignard, 2006), and the competence requirements and licensing is managed by international organizations as discussed in the background chapter, this means that ship engineers possess many of the common characteristics of professions. Professions, with their ability to control and gatekeep their work and area of expertise are known for the abilities to protect their professional realm from outside interference and also organizational issues (Noordegraaf, 2011). Therefore, it is interesting to investigate and discuss the theories on professions regarding technology and servitization.

3.1. The profession

A profession can be differentiated from an occupation based on several traits, one of which is the standardization of skills and education that the profession requires. Professions also have protections under regulations and laws to prevent those outside their professions from doing their work. Such protection can give some professions a prestigious role in society and can be an important part of shaping work life and the evolution of the economy and businesses. As a result, professions have become a special field within organizational studies.

The interest in professions' role in society and work life can be found as early as Max Weber's (Ritzer, 1975) early works. A large part of studies on professions in the early 1900s focused on professionals' role within organizations and the authority that came with professional expertise (Perrow, 1986). The traditional view on professionals is that they have a large degree of professional autonomy, and the profession often is self-regulated, i.e., government organizations have little bureaucratic control. This view on professionals was formed in these early years and envisioned a profession as a protected owner of a body of complex knowledge in which professionals gain authority in society by practicing this knowledge. Professions' self-regulating and authoritarian role in society has been challenged over the years, and as society is evolving, one can point to numerous examples of professions that have lost their positions of prestige (Freidson, 1984). Simultaneously, there have been many examples of new professions emerging as technology demands more expert knowledge. The benefits of being part of a protected profession also have led many occupations to claim professional status. This process led Wilensky (1964) to write his seminal paper, "The professionalization of everyone." The title refers to the trend of occupations striving for professional status without attaining the necessary traits or playing an organizational role that allows for professional autonomy. The paper contributed to discourse on professions by exemplifying the nature of professions and has played an important role in diversifying studies on professions since its publication. One of the studies that has shed light on diversified studies of professions is the review and framework presented by Anteby et al. (2016), in which they used the analogy of optical lenses to divide the research of occupations and professions into becoming, doing, and relating. These three lenses can be used to categorize and understand previous research and as a guide for future research. Furthermore, these three lenses are meant to place the various approaches of studies on professions in a historic perspective.

The *becoming* lens refers to the process of adding a new member to a profession, which can include sharing cultural values, norms, and worldviews. It can be divided further into becoming *socialized, controlled*, and *unequal*. These three filters for the becoming lens describe aspects of the process of becoming a professional. Becoming *socialized* describes how new members' thoughts and actions are transformed by becoming part of a profession. The becoming *controlled* filter describes how new professionals must surrender personal autonomy concerning how to behave and respond, so they can adopt common professional behavior. The *unequal* filter describes how an occupation can end up with a distribution of workers segregated by occupational socialization. This segregation of workers can be done along gender, social status, or other lines. In this thesis, the *becoming socialized* filter is the most relevant and describes the shaping and reconstruction of the professional identity when faced with new technology.

The *doing* lens on occupations focuses on what professionals actually do in their work and can explain changes in organizational practices, as well as how jurisdictions might impede collaboration between occupations and professions. The *doing* lens might be well-suited to explain how the introduction of technology can create challenges by altering work practice and creating interference between occupational groups claiming the right to perform specific work tasks (Barrett et al., 2012; Håland, 2012).

The *relating* lens explains occupations in how they relate to other groups using the collaborating, coproducing, and brokering filters, which identify how occupations can use different relations with other groups to obtain complementary goals. Occupations can choose to collaborate when their work tasks overlap with their occupational boundaries. Coproducing as a filter on the relating lens describes how occupations relate to stakeholders that have a common interest in the occupation's work tasks. These stakeholders can be any actors outside of the occupation, technical specialists, and management that have interests in the outcome of work processes. According to Anteby et al. (2016), the brokering filter describes how an occupation can connect and include new occupations in a network of relations. When a new occupation can fill a critical gap in this relating network, spanning different occupations and organizational boundaries, brokering and negotiating will occur between existing and new occupations to establish a working relationship within the network. When brokering occurs, the occupations view the new occupation's contribution as more important than strengthening their own occupation or profession.

Anteby et al. (2016) framework provided a solid overview of studies on professions and occupations, and how they have evolved. It also encompassed mostly how studies on professions can shed light on the changes that this thesis exemplifies. However, other discourse on digital technology and professions has surfaced over the past decade that has elicited debate in both academic circles and the general media, the essence of which will be provided here as a reference and as a contrast to how digital technology can change organizations, as exemplified in this thesis.

This debate is rooted in digital technology's effects on society, specifically how technology, particularly digital technology, threatens professionals' status in the future. Prominent scientific works in this discussion include those of Frey and Osborne (2017) and Susskind and Susskind (2015). These works picture a future in which jobs and professions have been made redundant by increasingly complex and capable digital technologies.

In their book, Susskind and Susskind (2015) divided the transformation of professions by technology into automation and innovation and asserted that automation often is used to streamline routine work and improve inefficient manual activities. Most workers are accustomed to automation, as it does not change how people work or how a business delivers services fundamentally. However, the transformation of professions through innovation describes how technology makes it possible to deliver services that were impossible before introducing this technology, or eliminate tasks that workers previously performed. Innovative transformation impacts work more significantly than automation and is the type of transformation that changes professions (Susskind & Susskind, 2015). Such digital technologies are present in today's businesses and organizations, but it is unnecessary to look far into the future to find examples of technologically driven changes to various professions.

In a study on information technology (IT) professionals' professional work, Trusson et al. (2018) described an example of this in the context of the degradation of IT professional work. In their article, they demonstrated how IT professionals experience managerial control through digital technology and the commodification of their knowledge through new business models. In this situation, transformation primarily uses automation, but signs of innovation also have been detected (Trusson et al., 2018). For example, the new technology that IT professionals use is more automated and keeps track of work cases and best-practice solutions to standardized problems. However, innovation occurred using new technology to commodify the IT professionals' professional expertise. Although the attempted commodification of IT professionals' expertise was unsuccessful, their work was transformed into a self-help service. Consequently, IT professionals' job quality, according to Trusson et al. (2018), has been reduced.

An alternative to Susskind and Susskind (2015) bleak portrait of technology's influence on the professional domains can be found in the theoretical discussions of connective professionalism (Noordegraaf, 2020). The concept of connective professionalism was introduced as an explanation of how professionals are responding to the increasing amount of digital technology and possibilities for communication and work systems across organizational boundaries. According to Noordegraaf (2020), connected professionalism focuses on professionalism as a continuing process of relating to outside actors. Therefore, connected professionalism goes beyond what Anteby et al. (2016) described in their relating lens. Noordegraaf (2020) used community judges, medical doctors, and academics as examples of professions becoming connective. In these examples, he demonstrated how actors relating to other groups to strengthen the quality of their work, change three defining aspects of professionalism: expertise; authority; and autonomy (Noordegraaf, 2020). The introduction of connective professionalism (Noordegraaf, 2020) has elicited a debate on connective professionalism as an idealized type of professionalism and how it relates to other idealized types of professionalism, e.g., protected professionalism. Since the publication of Noordegraaf (2020), two essays have been written with input on the theoretical foundation of connective professionalism. These essays, by Adams, Clegg, et al. (2020); Adams, Kirkpatrick, et al. (2020), raised several issues, particularly the presentation of connective professionalism as an ideal type. However, even if connective professionalism is not covering all aspects of the changes to professionalism in today's work life, most contributors in the essays recognize the paper's contribution in understanding the importance of connectivity in today's digital and related world.

This section has presented a theoretical overview of research on professions and how technology can affect professions and professionals, including ship engineers. One of the aspects that discussions on professions and technology raises is the changes it brings to work and work processes. These changes are direct through new technological possibilities using automation and indirect through allowing other occupations and organizations to take part in the work processes and control the outcomes. This make it necessary to investigate how work and work systems are changed by technology but also how existing organizational factors influence these changes. The maritime setting investigated in this thesis include ships with their own organization working together with the shipowner and the technology supplier. This means factors like physical distance, reliance on communication technologies and different organizational goals are influencing the changes to the work system for ship maintenance and operation. The next section focuses on work, work systems, and how standardization and digitalization affect them.

3.2. Theories on work and work systems

Work is a word that almost all adults understand and use in their daily conversations. It describes an activity that is essential to keeping society operational and is the most common method of providing the essential resources for sustaining people. It is how people use their talents and fulfill their dreams. It is also a resource that companies use to create wealth, seek returns on financial investments, and attain success in their businesses. These differing perspectives have resulted in a diverse field of studies on work throughout history. Early examples of work studies include Taylor's (2004) research on scientific management in the early 1900s and Elton Mayo's (Mayo, 1949) Hawthorne experiments. Both of these seminal studies view work from the employer's perspective, and the studies' goal was to increase the efficiency of work processes. One result of the Hawthorne experiments was the realization that workers' motivation and satisfaction substantially influenced their performance.

This led to the human relations school, and investigations into human factors in management studies. Another change in the view on work occurred in what is now called sociotechnical systems in the 1950s and 1960s (Trist, 1981). Sociotechnical systems emerged after the realization that work processes could become more efficient when workers' perspectives and their situations were considered when designing the work systems. According to sociotechnical system theory, work systems' success is found in the optimization of both the human sociological and technical systems and viewing it as one system. One aspect of sociotechnical systems is the "responsible autonomy" of workers and "autonomous groups," highlighting the view that workers perform better when they can influence decisions and the organization of their work (Trist & Bamforth, 1951). Extant studies on sociotechnical systems have exerted a substantial influence on organizational theory since they emerged in the 1950s. For instance, the Scandinavian model of work organization (Gustavsen, 2007), and Modern Socio-technology in the Netherlands (Benders et al., 2000). The next subchapters present several theories on work and processes that have emerged in the last decades. These theories focus on work and situated practice.

3.2.1. Representations of work

Research into work-related issues has proceeded in many directions, including learning and knowledge. While learning and knowledge have been the focus for many scholars, studying how people work has faded into the background somewhat (Barley & Kunda, 2001). One exception can be found in studies at Xerox's Palo Alto research center. Researchers such as Julian Orr, John Sealy Brown, and Lucy Suchman have published seminal papers on work and situational practice (Brown & Duguid, 1991; Orr, 1986; Suchman, 1995). Suchman's (1995) paper, "Making work visible," highlights the importance of perspective in understanding work discussions in organizational theory. Suchman (1995) demonstrated that representations of work can function as work substitutes, emphasizing that these representations will differ depending on who is discussing the work. For instance, how work is represented is highly dependent on the observer's interests in and distance from the work practice, i.e., managers and other supervisors view work differently than workers. The result is that the work, performed in a specific context using skills and experience, will be represented in several ways within an organization depending on perspective and distance. Representations viewed from a distance typically will be normative and idealized, and do not contain the detail and situational context that the workers who perform the work would use to describe their work. When these representations are used in making decisions regarding the organization of work or designing work systems, the outcome might not serve workers' interests or the design's purpose. According to Suchman (1995), the representation of work must consider the use of the representation and to who's interest the representation is constructed.

As an explanation for conflicting representations of work, Suchman (1995) drew attention to invisible work. The term *invisible work* describes work that is not noticed/recognized. Invisible work can be defined as work that is not documented in routines and work descriptions and often is unpaid. Invisible and visible work should not be viewed as absolutes, but as endpoints of a continuum, i.e., work can be more or less visible. Examples include housework and caring for the elderly, the charging of batteries for electric tools, or cleaning paintbrushes (Star & Strauss, 1999). It is essential for plumbers and electricians to have operational tools to perform their work, but it is not something written on the invoice and visible to somebody from outside the profession. Similarly, the painter needs to clean their brushes and tools to be ready for the next customer, but this is also not visible to the customer or business manager. Invisible work that is not visible to outside viewers and includes small details not directly connected to the work's outcome, yet are crucial for success, often is referred to as *articulation work* (Strauss, 1985). Articulation work and invisible work are factors that influence the design and function of work and work systems. For example, one can imagine optimizing a work process that entails a substantial amount of articulation work needed to ensure the outcome of the process. Considering that articulation work is invisible—and, therefore, unknown to the person conducting the optimization—a discrepancy in the allocated resources for this process, compared with the actual resources needed, would be the outcome. Also, if a work process or system is not developed using sound procedures, or uses inefficient technological aids, a substantial amount of articulation work would be needed for a successful outcome—a major Star and Strauss (1999) argument for keeping track of visible and invisible work.

The arguments presented in this subsection highlight the importance of the work perspective and how it is represented. The division of work into visible work and invisible work emphasizes a key point in understanding the organization of work and how it is affected. There is a difference between work as it is actually done and work as it is imagined done. The differences between these concepts can substantially affect work procedures, work efficiency and relationships between workgroups and organizations. One field of research that has investigated this is safety research. This is because these factors, like the organization of work, the complexity of work systems, and how work is done in practice, directly impact safety in organizations. Discussing these topics from a safety point of view brings valuable insight.

3.2.2. Work as imagined and work as done

This subsection's title is an expression frequently used in safety science, particularly when discussing resilience engineering's theoretical foundations (Hollnagel et al., 2006). The first reference to *work as imagined* and *work as done* can be found in the design of man-machine systems. In the design process, the difference between the system tasks (*work as imagined*) and the cognitive task (*work as done*) becomes apparent when the machine takes over some of the human operators' work tasks (Hollnagel & Woods, 1983). In safety science, the difference between *work as imagined* and *work as done* becomes important when rules and regulations are based on expert opinions on what actions should be allowed and how they should be performed. This expert view on work is usually "*work as imagined*." Quite often, this will differ from the natural way that an operator performs the work, or what can be viewed as *work as done*. The traditional approach to safety has been a clear responsibility to enforce rules, with no room for interpretation or adaptation. An excellent example of *work as imagined* and its use in safety can be found in Haavik (2014, p. 290): "If I was told that an accident was to happen in a month's time from now, I would say it would most probably be because someone didn't follow the procedures." This quote from a drilling supervisor demonstrates the problematic use of *work as imagined* as a basis for work regulations. The procedures could be written in such a strict and regulatory way that it would be virtually impossible to perform the work without violating the procedures.

An alternative approach, in which those who actually perform the work have more input on procedures and work practice, can be found in Hale and Borys (2013) paper, “Working to rule, or working safely?“ in which they presented Models 1 and 2. Model 1 represents the traditional method outlined above, but Model 2 emphasizes that no rule or procedure can cover all situations that can occur and that the procedures must contain some room for adaptation and interpretation. One can say that Model 2 considers *work as done* as a basis for the procedures. Similar to Hale and Borys (2013) models, Hollnagel (2013) presented the concept of Safety I and Safety II, which focus on the difference between *work as imagined* and *work as done*. The difference between these models seems to be that Hollnagel (2013) presented a dichotomic view of the two systems, whereas Hale and Borys (2013) argued more for using both models to improve safety.

Resilience engineering also is related closely to the concepts that Hollnagel, Hale, and Borys presented. The idea behind resilience engineering is to focus on work performed successfully, instead of focusing on accidents and near misses. Resilience engineering encompasses multiple branches of research and practice, including complex systems, human factors, and sociotechnical systems, among others. Furthermore, resilience engineering, as in resilience from accidents when subjected to influences that can disrupt workflows, is viewed as a promising method for improving safety (Haavik et al., 2019).

Complexity is one of the dimensions in the discussions around *work as imagined* and *work as done*, chiefly because complexity is known to cause accidents (Haavik et al., 2019; Perrow, 1986). An appealing approach is to try and lessen complexity through reductionism. Often, this is a reason for using *work as imagined* as a basis for safety regulations and procedures, as it is a simplified, imagined view of work. Work processes are split into standardized tasks, with complexity appearing to be reduced (Almklov & Antonsen, 2019). This standardization leads to an imagined work process in which causes and effects are easier to understand and resolve. As discussed above, the results are not always as intended, but the standardization concept merits further discussion.

3.2.3. Standardization and digitalization

The concept of standardization has been a part of society from the beginning of the Industrial Age. Manufacturing using assembly lines with standardized parts, globalization, and efficient travel across continents all required standardized organizing. Standardization has been viewed as an integral part of the concept of bureaucracy since Weber (Perrow, 1986).

Standards can be defined as generalized and formalized rules that serve to prescribe and document efficiency and control within and across organizations (Antonsen et al., 2012). Thus, *standardization* can be defined as the process of implementing these rules. Using standardization as a tool to increase efficiency and cut costs has been practiced since Taylor's (2004) scientific management in the early 19th century. Taylor divided work practice into standardized tasks that could be optimized, so that management could control and monitor execution easily. The increased use of standardized work tasks is a major driver for bureaucracy, but standardization also can be used to simplify rules and regulations, which can lessen bureaucracy within organizations (Perrow, 1986). The use of standards in today's organizations is common and viewed within organizational structures, work procedures, and organizational members' formal competence.

The use of standards is a necessary part of work within organizations. Although challenges surface when standards are used in work descriptions (as imagined), some room for adaptation usually is included, often using articulation work. As Star and Strauss (1999) remarked, the less accurate a job description is, the more articulation work is necessary for successful completion. However, this situation changes when the standardization is enforced through digital tools. Digitalization elicits a whole new method of ensuring standardized procedures and that work processes are followed. Written procedures that could be interpreted as a guide for successful operations now must be ticked off step by step before the operator is allowed to continue. This is discussed in Almklov and Antonsen (2019), in which increased performativity in digital systems often leads to less room for situational adaptation. Also, the increased possibility of control in digital systems can lessen the operator's ability to perform work in accordance with situational requirements. The increased use of digitalization, whether through automated systems or artificial intelligence (AI), impacts the involved organizations, including work systems, structures, competence, and safety within organizations.

The theories presented in this chapter up to this point has focused on work, work systems and what can influence the changes digital technology bring to the maritime organizations. There are, however, a rather large body of literature investigating the role technology play in organizations. This literature brings new aspects into the discussion on organizations, both on what technology is and how technology can change the organizations. A selection of these theories that can contribute to this thesis and further explain the implications of digital technology is presented in the next chapter.

3.3. Technology and organizations

Technology impacts organizations and society tremendously, and when reflecting on technology's historical impact, it is difficult to find examples of radical societal changes that were not the result of technological breakthroughs, e.g., the wheel, sails, roads, steam, cars, airplanes, and the Internet. Modern society is almost impossible to imagine without technology, and both science fiction authors and inventors are trying to figure out what will be the next technological breakthrough. In organizational theory, technology is naturally an important place in the topics of interest. The definition of technology in organizational studies has been broad and beyond the commonplace definition of machines and artifacts. According to (Perrow, 1986), *technology* in contingency theory is defined in the context of tasks and techniques that can be programmed and standardized, as opposed to tasks that cannot be defined and are nonroutine. Contingency theory contends that technology should or will change organizational structures. This creates a dichotomic definition of technology that can be divided into a routine/nonroutine view, eliciting the question of whether technology should be organized with a more bureaucratic structure. Technology and organizational structure also were discussed in Barley's (1986) seminal paper, which contended that technology changes organizational structure, but that it depends on the contextual situation and social interactions. Barley concluded that to understand how technology changes organizations, one must view technology as a social object, not a physical one. Therefore, to study technology and organizations, a method that considers social interactions is necessary. This can be viewed as a turning point in the discussions on technology within organizations by focusing on the social aspects.

3.3.1. Technology as a change agent

Researchers have been focusing on technology and organizations increasingly over the past few decades, and a substantial part of this research lies in the social constructionist paradigm. One reason that this paradigm has been influential in technology discussions concerns a gradual recognition of the importance of human actions and social interactions around technology. A traditional view of technology within organizations can be divided into three parts: technology as an external force; technology's human action aspect; and technology's impact as an external force moderated by humans and organizational context. An approach that explains technology while allowing for varying views can be found in Orlikowski (1992), who used Giddens' (1984) structuration theory in her model of technology within organizations. A short version of Giddens' structuration theory can be formulated as follows:

Structures enable and constrain human actions, and these structures result from previous actions, comprising rules and resources that humans use in everyday interactions. Humans' role in the theory is important, as they are aware of their knowledge and how they apply it. They are also reflexive, i.e., constantly monitoring physical and social contexts and activities. Humans' interactions within an organization become standardized practices and again will reinforce the organization's institutionalized properties. This is known as the duality of structures. According to Orlikowski, the duality of technology concerns how technology is created and changed through human action, then used to accomplish some action. Simultaneously, Orlikowski (1992) contended that technology is interpretively flexible, i.e., how technology is used within organizations depends on the actors involved and the sociohistorical context in its development and use.

Analyzing human action is how Barley suggested one can understand how technology changes organizations (Barley, 2020). In his book, in which he reflected on studying technology, he returned to the method he used in his first paper (Barley, 1986), in which he utilized scripts to understand organizational structuring. *Scripts*, as used by Barley, are dramaturgical descriptions of how humans understand situations and how they should act, and the roles that they play in these actions. Furthermore, outside forces, e.g., technology, can influence and change these scripts. Barley argued that the precursor to organizational change can be seen in the relational exchanges in scripts as they are changed. Thus, by changing the focus from technology to the human behavior around the technology, one can observe changes in roles and relations and, by extension, the organizational structure.

This section has discussed how technology changes organizations, but a substantial amount of extant research has focused on how organizations themselves can change. These changes do not necessarily need to respond to outside forces, e.g., technology. They could be the result of, e.g., continuous improvement. These theories commonly are referred to as organizational learning and will be discussed in the next section.

3.4. Organizational learning

Organizational learning has been a central part of organizational theory over the past 50 years. According to Popova-Nowak and Cseh (2015), a starting point for organizational learning can be found in Cyert and March (1963) "behavior of the firm." Since this seminal paper was published, a substantial amount of research has been conducted on organizational learning, providing the discipline with flexibility and diversity, but also presenting challenges for researchers.

One challenge is the lack of shared meaning in the various theoretical frameworks (Crossan et al., 1995), which can exist at different organizational levels and even be based on differing ontological and epistemological foundations. Metatheoretical approaches to organizational learning even talk of different organizational paradigms and problematize that the scholars in the organizational field often mix articles with different ontological and epistemological foundations in their work (Popova-Nowak & Cseh, 2015; Rowlinson et al., 2010; Tsoukas & Knudsen, 2005; Ulrich et al., 1993). Popova-Nowak and Cseh (2015) argued that while different perspectives through different paradigms provide valuable insights, it is not unproblematic to try to work across them/combine them—a helpful reminder when conducting an analysis.

Popova-Nowak and Cseh (2015) defined *organizational learning* as: "a learning process within organizations that involves the interaction of multiple levels of analysis (individual, group, organizational, and interorganizational)" (Popova-Nowak & Cseh, 2015). The different analytical levels are necessary to grasp organizational learning's complexity, from individuals learning to operate technology to organizations that find new ways to achieve their goals.

In this thesis, two concepts, i.e., two levels of organizational learning, will be discussed in detail in the following subsections. The first is communities of practice, in which learning at the group level is described as a socially situated process in which workers find new ways to solve problems through collaborations and social interactions. The second is interorganizational learning, which describes situations in which organizations can learn from each other or together. Theories of communities of practice are presented her because of the possibility that they can explain learning mechanisms that can emerge when the ship engineers and the technical experts of the supplier have increased ability for interaction and collaboration.

3.4.1. Communities of practice

Lave and Wenger (1991) book on situated learning and legitimate peripheral participation has influenced organizational theory substantially. Their main point is that situated learning is not individual, but occurs in the community. In Koliba and Gajda (2009), it is described as "relational structures that are mediated by and through the social construction of knowledge."

The same year Lave and Wenger published their book, Brown and Duguid (1991) published an article on communities of practice.

This article—on a unified theory of work, learning, and innovation—helped highlight how intertwined organizational learning is with work practice. A central point in the article was how knowledge about work is divided into explicit and tacit knowledge, and the connection to learning and innovation. The authors highlighted three features of work practice in the article: narration; collaboration; and social construction, which were derived from the work of Julian Orr (1986, 1990). Narration is an essential feature that workers use to make sense of complex experiences, and as a method of accumulating "wisdom" among workers within the organization. Collaboration views work as a communal process, not an individual one. Both individual and collective learning are inseparable in work practice, and any accumulated insights are constructed and shared socially among workers.

Brown and Duguid (1991) explained learning following (Lave & Wenger, 1991) legitimate peripheral participation principle, in which knowledge is not viewed as a transfer of knowledge from one individual to another, but rather as more like learning to function in a community. Members of this community of practice are not learning expert knowledge, but rather how to tell community stories, and by doing so, learning how to become practitioners. In creating these stories and analyzing community members' stories, innovative processes are created, and situated organizational learning takes place.

In both Lave and Wenger (1991) and Brown and Duguid (1991), the concept of communities of practice is not defined accurately, and others have defined it over time. According to Koliba and Gajda (2009), it is difficult to operationalize and measure an organization's ability to support and use communities of practice as a means of organizational learning. Thus, they came up with the following starting point for empirical dimensions that can lead to the operationalization of variables that support or hinder the development of communities of practice:

1. goals and relationships for learning

2. mode and quality of knowledge transfer

3. degree of formalization

4. strength of coupling

From these four dimensions, we can identify two factors that impact the development of communities of practice: communication and collaboration. This is supported by Dubé et al. (2005) in their research on creating virtual communities of practice in which managing communication and collaboration using digital technology was identified as key in successfully establishing virtual communities of practice.

Virtual communities of practice have become important in the discourse on communities of practice in general. For instance, within many international companies in which collaborating workers are spread out geographically over large distances, understanding how they can work together is important. Ardichvili (2008) identified factors that either motivated, hindered, or enabled the use of virtual communities of practices. Motivational factors included personal benefits, e.g., developing expertise and professional reputation. Barriers to forming virtual communities of practice included a lack of technological skills, procedures regarding security and confidentiality, and cultural differences. However, trust was highlighted as an important enabler of virtual communities of practice.

In the 30 years since Lave and Wenger (1991) introduced the term, attempts have been made to use communities of practice as a tool—developed and shaped to specific needs, e.g., as communities of participation and communities of innovation (Agarwal & Agarwal, 2016). However, whether these attempts successfully tailored communities of practice to accommodate specific business strategies has been debated (Pyrko et al., 2017; Waring et al., 2013). In this thesis, the view on the role of communities of practice in organizational learning follows the original idea of Lave and Wenger (1991) and Brown and Duguid (1991), in which communities of practice are a process, as discussed in Pyrko et al. (2017), not an entity that can be set up when needed.

Another interesting view on this discussion is found in Ribeiro (2013). In this paper, tacit knowledge management is seen as a battle between the epistemology of possession and the epistemology of practice. The epistemology of possession views knowledge as something people possess, and the epistemology of practice focuses on knowing as action. This discussion corresponds with the discussion on communities of practice as a possession or something that emerges. This attempt at using communities of practice as a tool for specific organizational learning or as a repository for storing organizational learning reflects Morgan (1980) concern that metaphors from the functionalist paradigm are used to shape the orthodox view on organizational learning. This can explain the lack of success because it is a functionalist approach to communities of practice, a theory that originated in the constructivist paradigm.

An important part of the literature on work, situated learning, and communities of practice has been Julian Orr's (1986, 1990; 1998) work, which is important in defining how individual learning is linked to collective learning. Orr (1998) made a point that collective learning does not equal organizational learning. Orr (1998) explained the difference as a discontinuity within organizations caused by management bureaucracy's "history, structure, and focus that encourages ignorance of work practices" (Orr, 1998:451). Orr's most intriguing point is that this discontinuity can explain "how technicians can practice their trade as they do in the same organization in which their management believes in the abstraction of techniques, their formulation into directions, and their application through machine-like behavior on the part of normal human beings" (Orr, 1998, p. 451:452). This quote from Julian Orr can act as a conclusion on the topic collective learning and communities of practice. The following section focuses on interorganizational relations. These theories are chosen because of the increased interactions between the maritime organizations presented in this thesis. The involved organizations also have different areas of expertise and different agendas. The next step is to investigate how such organizations can learn from each other and what hinders or enables learning between them.

3.4.2. Interorganizational learning and boundaries

Interorganizational learning investigates how learning takes place across organizational boundaries and how an organization can create knowledge through collaborations with other organizations. Mariotti (2012) defined three perspectives on interorganizational learning: the creation of collective knowledge; the creation of network rules of interaction; and knowledge acquisition and transfer. By dividing interorganizational learning into these three perspectives, the added complexity became apparent. Not only will knowledge creation be necessary, but the interaction rules between organizations also must be defined. This is particularly important if the organizations have commercial relationships because competitive barriers often preserve competitive advantages (Dyer & Hatch, 2006). The final perspective, knowledge acquisition and transfer, demonstrated the difference between organizations that create and share knowledge freely between them or organizations that gain access to other organizations' complementary capabilities. The first can be exemplified through network learning, as discussed in Gibb et al. (2017), in which learning took place in a horizontal network of organizations with a common interest in defining key problems in their business sectors. A different scenario is discussed in Rosenkopf and Nerkar (2001), in which organizations crossed organizational boundaries to achieve technological evolution. The question of how learning takes place across these boundaries needs to be examined, according to Mariotti (2012). One proposed method is to view interorganizational learning as a multilevel concept in which learning occurs in networks of relationships between individual, group, and organizational actors. An example used is the theory around communities of practice (Lave & Wenger, 1991), as discussed earlier in this section, in which learning is influenced by the social and physical context in which it happens.

One of the aspects of the boundaries discussed in Langley et al. (2019) is how boundaries in collaborations between organizations do not always function as barriers and can function as junctions, i.e., entities that can function as enablers of collaboration and not inhibitors. Sometimes a collaboration needs to overcome boundary rigidity, which can be accomplished through collaborative boundary work. This concept describes the negotiations between particular people to “get things accomplished” or “make them work” (Langley et al., 2019). When boundaries separate different organizations, in some cases, the boundaries are downplayed purposefully and ignored to serve interests, e.g., to enhance competitiveness in seeking partnerships.

Interorganizational learning often has been studied within these organizations that actively seek partners for collaboration. In these situations, learning from each other is the main driver for entering into such relationships, as it is thought to increase competitiveness (Anand et al., 2021; Rajala, 2018). Interorganizational learning in this context is defined as knowledge transfer from one organization to another, knowledge transfer between organizations, or the creation of new knowledge as a result of mutual knowledge exchange (Rupčić, 2021). A central question is whether positive effects in such relationships are transferrable to other contexts, as interorganizational learning processes depend on the type of relationship and organization involved (Rupčić, 2021). Boundary work’s importance might be more prominent when the collaboration is less grounded in mutual commercial interests. Organizations in a joint venture that actively look for collaborations and opportunities will have different motivations and possibilities than organizations entering collaborations in which learning is less emphasized as a motivation (Inkpen & Crossan, 1995).

One of the factors that can decide an organization's willingness to commit to collaborations is interorganizational trust. Earlier research has indicated that trust is particularly important when the partners are not equal, or the collaboration requires a commitment that is difficult to regulate through contracts.

3.5. Interorganizational trust and regulating relationships

The official method of regulating business relationships between organizations has been through contracts. However, it has been recognized that trust is a significant regulatory force in these relationships (Zaheer et al., 1998). The number of studies on trust has increased in response to recognizing that collaborations and partnerships are necessary for organizations to remain competitive, particularly in knowledge-intensive businesses. The concept of trust has been studied, resulting in trust being divided into several types (Blomqvist et al., 2005; Seppänen et al., 2007). Two relevant types are competence-based trust and integrity-based trust. Existing research has indicated that trust can be defined as competence-based when partners believe that each other's competence, technical skills, and experience meet their expectations (Lee, 2004). Integrity-based trust is based on the partner's motives, honesty, and character (Svare et al., 2020). These two types of trust have been demonstrated to exert different effects on relationships, in which perhaps the most important is how integrity-based trust exerts more influence on relationship performance than competence-based trust (Connelly et al., 2018). Other studies have indicated that competence-based or ability-based trust significantly influences the selection of potential collaboration partners (Shazi et al., 2015). Regarding contracts and relationships, integrity-based trust has been identified as more critical than competence-based trust as a complement to complex contracts (Connelly et al., 2018).

The theories presented in this chapter provided a detailed and comprehensive landscape through which to frame this thesis. The theories presented encompass a broad scientific area attributed to the emphasis on work practice's role in understanding learning in and between organizations, as well as the relationships between organizations. This chapter aimed to provide the necessary theories to interpret, position, and understand the empirical data collected in this thesis. The next chapter presents the methods used to collect the empirical data.

4. Method

This chapter explains the methodological choices and decisions made in the design of this thesis. When initial research objectives are formulated, the next logical step is to consider possible methods to meet these objectives as effectively as possible. The main research objective of this thesis was to investigate organizational changes within maritime organizations after introducing remote monitoring technology and a new business model. For instance, these organizational changes could affect individuals within the organization, or they could be changes in relationships or organizational structures. Therefore, the research objective is open and requires an explorative research strategy. At this stage, it became clear that the appropriate method for acquiring empirical data would be qualitative, primarily because the explorative and open research objective requires in-depth data to analyze the organizations involved. However, even after deciding to conduct a qualitative study, there are several possible methodological approaches with different philosophical assumptions that can be chosen.

4.1. Philosophical assumptions and Interpretive frameworks

All scientific research is based on a set of beliefs and philosophical assumptions. In some studies, these are provided explicitly and stated directly, i.e., they can be interpreted from the choice of theories and methods used. This section will clarify the philosophical assumptions that are part of this study's basis.

Researchers studying organizations often need to be aware of the philosophical assumptions behind the theories used in their studies. Morgan (1980) classified organizational studies into four paradigms under their ontological and epistemological premises. The four paradigms – functional, interpretive, radical humanist, and radical structuralist are separated by their assumption of science as either subjective or objective and their ontological assumption of either a sociology of regulation or radical change. Also, Popova-Nowak and Cseh (2015) division of ontological and epistemological assumptions into organizational learning helps divide the theoretical foundation for organizational learning into functionalist, constructionist, critical, and postmodernist paradigms (Figure 5).

Choosing a methodology for acquiring empirical data also means making decisions from a philosophical perspective. In Creswell and Poth (2018), several interpretive frameworks used in qualitative research are mentioned and divided into postpositivism, social constructivism, transformative frameworks, and postmodern perspectives. Some assumptions are already made when choosing specific methodologies, e.g., ethnography or phenomenology. For instance, ethnography requires an understanding of a group's social behavior, linking it to an interpretive framework, e.g., social constructivism or interpretivism. Using case study as a methodology does not link it with a specific framework, as it depends on the case studied and the chosen analytical methods. In the case study presented in this thesis, one of the defining features is the emphasis on work practices to identify changes in maritime organizations. Changes to work practice can be direct, driven by practical needs to achieve results. Such changes can be interpreted in a functionalist paradigm as changes to functions in a real, observable world. They also can be interpreted as changes in social networks, in which workers find new ways of resolving issues together. Such changes can be understood better in a constructionist or interpretive paradigm. Introducing new technology into a workplace with established social and cultural rules requires a theoretical foundation that can explain an organization's response. For instance, theories on structuration (Orlikowski, 1992) and sociomateriality (Orlikowski & Scott, 2008), as well as actor-network theory (ANT) (Latour, 1992), can shed light on this. Theories on structuration are situated in the constructionist paradigm, but sociomateriality theories and ANT can be positioned in the postmodernist paradigm.

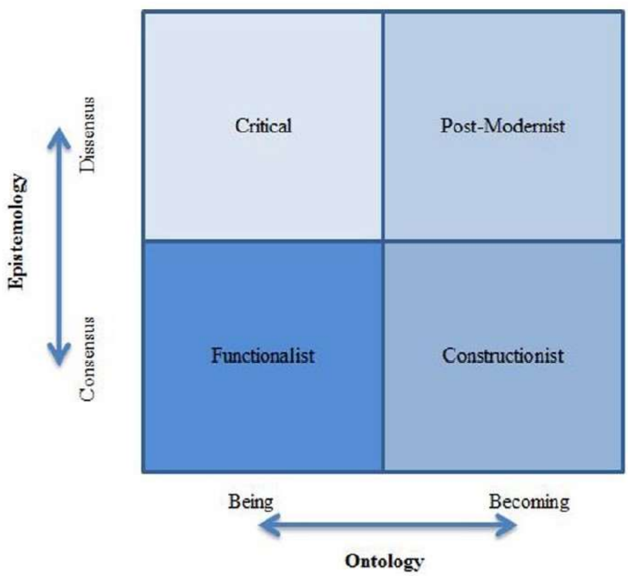

Figure 5. Paradigms in organizational learning. © Popova-Nowak and Cseh (2015)

As discussed, empirical findings in this thesis can be understood through several interpretive frameworks, but the constructionist paradigm is most representative as an interpretive framework in this thesis, explaining how work and work systems are linked to changes in organizations and interorganizational relations.

4.2. Strategies for collecting empirical data

The empirical data in this thesis were collected in two separate data collections. The first data collection was a case study of the operation of two advanced freight ships on a freight route along the coast of Norway. The data collected in the case study served as the empirical basis for paper one and paper two. The second data collection is a qualitative study of the shipowners' and suppliers' relationship in a regional cluster in the west coast of Norway. The data collected in this study was the empirical data for paper three. The relationship between research questions and research papers are shown in table 1

How does the introduction of a business model using performance-based contracts and remote monitoring affect maritime organizations?		
SQ 1	**How will remote monitoring and new business models affect the ship as an organization?**	
Papers contributing to the SQ 1	"Professions, work, and digitalization: Technology as a means to connective professionalism"	"The whereabouts of interorganizational learning"
SQ 2	**How is the relationship between ship, shipowner, and supplier changing with the introduction of new technology and new business models?**	
Papers contributing to the SQ 2	"The whereabouts of interorganizational learning"	"Servitization, trust, and maritime relations"

Table 1. Relationship between research questions and research papers.

4.3. The case study

The choice of research design happened after evaluating several approaches. A case study was chosen because of its flexibility in empirical data types and method of analysis, as well as the ability to study one case bound in time and place.

Case studies can entail concrete cases, e.g., an individual, group, or organization. They also can be used in less-concrete contexts, e.g., when the case entails a relationship or decision process (Creswell & Poth, 2018). Compared with the previous examples concerning phenomenological and ethnographic studies, the term *case study* does not refer to a methodology, but to the choice of what is studied (Stake, 1995). Furthermore, it also is challenging to find a *case study* definition. According to Creswell and Poth (2018), a case study is bound in time and place, focusing on a real-life system. Gerring (2004) defined it as "an intensive study of a single unit for the purpose of understanding a larger class of units." This definition encompasses several definitions in other scholarly works and covers the term's use in this thesis. Notably, the case is located within a bound system and, thus, can be studied under certain parameters (Creswell & Poth, 2018), e.g., time and place, as in this thesis. These parameters, or limits, allow for generating an in-depth understanding of the case without needing to consider examples outside of the case.

In this thesis, the case study is meant to be an illustrative case of how new digital technology is changing maritime organizations. Using case studies in this manner is called a single instrumental case study, according to Creswell and Poth (2018). Stake (1995, p.3) described an instrumental case study as "having a research question, a puzzlement and feel that we might get insight into the question by studying a particular case." Using a case study as an instrumental case study means that two criteria must be met before the study can meet the research objective. The first criterion is that the chosen case must be illustrative and represent the topic or research objective. The second criterion is that the collected empirical data must provide an in-depth understanding of the situation.

Concerning the first criterion, i.e., whether this case is representative of introducing digital technology into the maritime industry, a more detailed presentation of the chosen case is appropriate.

The case investigates the operation of two freight ships, running a freight route along the coast of Norway. The case study began in October 2019 and lasted until December 2020. When the data collection for this case study began, the two five-year-old ships had been operating under the new business model for almost three years. During the first two years of operation, the vessels operated traditionally, i.e., the shipowner was responsible for maintenance, service, and acquiring spare parts. The two vessels were constructed with advanced machinery and used LNG as fuel. They were the world's most environmentally friendly freight vessels when they were launched. These ships are the only ones in the shipowner's fleet with this business model. To a large extent, control of the fuel system and main engine is automatic and operated through an advanced control system. During the first years of operation, both ships had technical issues that resulted in costly yard stays. The first ship had two cases of total loss of power, resulting in the ship running aground. These expensive technical issues led the shipowner to sign a new contract with the supplier to operate the ships under a new business model comprising a performance-based contract and remote monitoring technology, allowing the supplier to control the ship's engine and auxiliary equipment operations. The performance-based contract comprised a fixed fee per operational hour that covered all spare parts, service costs, and personnel training. It also covered the costs of a service breakdown up to a predetermined amount. This business model was the first offered to the maritime industry, in 2014, and these ships were the first to sign the contract. At the time of this writing, only one other company, with four vessels, has signed such a contract.

The concept of remote monitoring contains several aspects that make it interesting to study, including a substantial number of sensors being installed on board the vessels. This information is sent to onshore processing, where experts from the technology supplier use AI to detect whether the equipment is being operated optimally or whether signs of deteriorating performance are present. This technology involves advanced digital techniques to aid decision-making. The decisions are made onshore with the supplier, disrupting the traditional decision-making process. The technology is also a key part of using performance-based contracts, giving the supplier a new role in ship operations, in which they can make decisions about maintaining and replacing parts. These arguments point to this case being a potent example of digital technology being introduced into the maritime industry. However, this case has negative points as well. This business model, with its performance-based contract structure, is novel, and few shipowners use it. The shipowner chosen for this case study was the first to operate under this type of business model and had been using it for approximately three years when the case study began. Therefore, the shipowner and the two vessels are the business model's only data source. Consequently, the case is limited to investigating changes at one shipowner, but one of the strengths of a case study is that it can utilize several data collection methods to provide a solid foundation for investigating the changes within these limitations.

4.3.1. Data collection

According to Creswell and Poth (2018), case studies commonly use several forms of qualitative data to gain the necessary in-depth understanding. The most common forms of data are interviews, observations, and documents. Using documents was considered, particularly the actual contracts between shipowner and supplier, but after initial discussions with the supplier, it was decided not to use the contracts, which could be business-sensitive. In this study, data were collected using interviews and observations simultaneously, i.e., the data were collected during port calls and yard stays, where observations were made before and after the interviews.

Informant/Observations	Experience (Total/These vessels)	Number of interviews	Duration	Location
Chief Engineer 1	30+/5	1	34'	On board ship
Chief Engineer 2	10+/5	1	28'	On board ship
Chief Engineer 3	8/4	1	19'	On board ship
Chief Engineer 4	15/1	1	34'	On board ship
Ship Engineer	7/3	2	21'+25'	On board ship
Suppliers PBH Service Coordinator		1	52'	Video interview (COVID restrictions)
Suppliers' Technical Manager		2	54'	Suppliers' office
Sales Manager, PBH		2	94'	video interview (COVID restrictions)
Shipowner's Technical Superintendent	40/5	1	30'	Video interview (COVID restrictions)
Shipowner's Technical Superintendent	20/1	1	54'	Shipowner's office
Observation sales meeting			120'	Office of potential customer
Observation five-year certification (Vessel 1)			180'	Vessel 1 shipyard
Observation five-year certification (Vessel 2)			90'	Vessel 2 shipyard
Observation Service Engineer visit			50'	Vessel 2

Table 2. Interviews and observations conducted in the case study

4.3.2. Data analysis

To choose a method for data analysis, we turned to Stake (1995) and employed two forms of data analysis recommended in his handbook for case study research. The first is direct interpretation, in which single instances are found to be important and give meaning to the case. The second, categorical aggregation, is similar to thematic analysis, i.e., the first stage in phenomenological analysis. This analysis followed the principal steps in a thematic analysis (Clarke & Braun, 2014), comprising identification of “codes” in the data. These codes will be aggregated and clustered into larger themes that can be compared with the whole data set to determine whether they present a representative picture of the data. This recursive process continues until the themes that provide a good representation are chosen and named appropriately.

An example of findings from the direct interpretation is one informant describing why remote monitoring is helpful—that it could identify root causes more efficiently. From the thematic analysis, an example can be the “competence and connectivity” theme, in which different mechanisms that lead to more connections between ship engineers and the supplier were identified. The theme contains information such as: a lack of digital competence that requires seeking help; attending courses to gain competence; and newly acquired competence that allows for discussing advanced technical questions with service engineers, etc.

The final step in a case study analysis, according to Stake (1995), is presenting the findings as a “naturalistic generalization”, which allows readers to learn from the case and compare it with similar cases or contexts. Furthermore, it is recommended that a detailed description of the “facts” in the case be provided to give readers more chances to judge the case's relevance to other cases or contexts (Creswell & Poth, 2018).

Figure 6. The engine room during an engine overhaul (Vessel 1).

4.4. The second empirical data collection

To answer the research question, a second data collection was initiated to investigate further the relationship between shipowners and suppliers. This came as a natural evolvement and as a realization that the case study would not give the necessary information to investigate how the relationship affect the adoption of servitization business models.

4.4.1. Data collection

The participants in this study were also selected from the regional cluster in western Norway, described in the background section. The main reason for choosing this regional cluster is to strengthen the link between the data collections, as all involved organizations in both studies are located here.

Since the research goal in this data collection was to investigate relationships and servitization, the participants had to have experience with servitization or have been contemplating adopting this business model. This selection of participants is called criterion sampling (Creswell & Poth, 2018). In order to increase the number of participants, the participants were asked if they knew of other companies that used or contemplated servitization. This sampling strategy is called snowball sampling(Creswell & Poth, 2018).

The data collected for Paper 3 came from semi-structured and focus group interviews. An overview of the interviews is presented in Table 3.

	Companies	Focus groups	Individual interviews	Number of Informants
Shipowner	8	1	8	10
Supplier	4	2	2	6
Total	12	3	10	16

Table 3. Showing the overview of interviews for the second data collection and the distribution of individual and focus group interviews.

The interviews lasted 35–105 minutes, with an average time of 53 minutes. The interviews were face-to-face when possible; however, eight were conducted digitally, as the COVID-19 pandemic prevented in-person meetings. The interviews were analyzed together and treated as equivalent sources of information.

4.4.2. Data analysis

The analysis of the interviews followed the same structure as the thematical analysis in the case study. Thematic analysis is considered a flexible analysis method and does not depend on a single theoretical foundation (Clarke & Braun, 2014). The process is often referred to as a data analysis spiral (Creswell & Poth, 2018). The initial codes contain the meanings and information from the informants; when new codes emerge from the data, the process must start again until all the relevant data is coded. The initial codes were grouped into expanded codes based on their relationships and context. These expanded codes were then used to form the final themes in the thematic analysis. These themes, along with citations, form the result of the analysis.

4.5. Ethical considerations

Conducting research in an ethical manner is a priority and a necessity for most researchers. Furthermore, several institutions enforce ethical research, e.g., funding institutions, academic journals, government requirements for data protection and personal privacy, and organizations that protect vulnerable groups' rights. Conducting ethical research can be divided into two dimensions: procedural and practical (Guillemin & Gillam, 2004). The procedural dimension describes the plan for conducting the research, i.e., ethical considerations must be considered starting at the study's planning stage, then followed up throughout the study (Creswell & Poth, 2018). The other ethical research dimension concerns how the researcher conducts ethical research in practice.

As an example of the procedural dimension, ethical considerations when choosing a research method are important during the study's planning phase. If interviews provide adequate data, it might not be necessary to conduct observations, which require researchers to be present over time, watching informants in a setting in which they might forget that they are being observed and disclose information that they would not disclose during an interview. How questions are phrased also can require ethical considerations, e.g., it would be unethical to ask for personal or sensitive information if it were not necessary for the research. If interviews or observations are recorded digitally, the processing and storing of data files must be in accordance with the law, and all permits from government agencies must be obtained. It is also essential that the informants provide study informants with a written consent form, in which the informant's legal rights are stated clearly, along with the study's aim and research goals.

The practical dimension of ethical qualitative research describes how a researcher continuously must consider the ethical questions that arise during the research. Conducting qualitative research through case studies with interviews or observations will bring the researcher closer to the informants (Creswell & Poth, 2018), allowing for trust to develop through their relationships, but the researcher must take precautions not to betray this trust. The researcher is invited into the informants' life and work situations, takes information from this setting, and makes it public. Some of the information might be interesting to the researcher, but could be information that the informant did not foresee being made public, e.g., conflicts or examples of mistakes or misunderstandings. This could happen if the informant and researcher have contradictory views on research goals and aims because they were not explained well enough to the informant. It is also possible that the researcher might obtain sensitive information clearly outside the scope of the research, e.g., business-sensitive information or personal information about the informants. It is of utmost importance that the researcher not betray informants' trust in such cases. Ethical practical dilemmas for the researcher might happen during stages other than the data collection stage. During the analysis, findings and insights might take the research in new directions. This can raise ethical questions regarding how the researcher presents the information and how the informants intended the information to be understood. Also, during the writing phase, ethical considerations can surface regarding transparency and a precise and accurate description of the research.

The research process used in this thesis followed the requirements for conducting research, and the necessary permissions for recording interviews and data storage were obtained from the Norwegian Center for Research Data (NSD Ref. No. 575487). The practical research has been conducted as transparently as possible for the informants, emphasizing their rights and offering to inform them of the research and publications.

4.6. Validity in qualitative research

Validity in qualitative research has been subject to considerable debate (Whittemore et al., 2001), a large part of which entails using validity and reliability concepts from quantitative research as benchmarks for qualitative research. Qualitative researchers largely have abandoned this approach, as most qualitative research is based on different ontological and epistemological assumptions (Whittemore et al., 2001). The qualitative research in this thesis is interpretive and acknowledges that results from the empirical study were constructed socially and do not represent any universal truths. This does not mean that no considerations exist for validity or quality in this type of research. As outlined in the method chapter, two criteria must be present in an instrumental case study. The first is choosing a case that is illustrative of the chosen phenomena or research object. The case study's validity will be affected if the chosen case is not applicable or too undefined to provide insight into the research topic. The second criterion requires data acquisition and analysis to accentuate the informants' meanings and perspectives. This second criterion is also relevant in evaluating the validity of the third paper's empirical research. Therefore, a detailed description of the data acquisition and analysis is necessary to evaluate the validity of a qualitative study. Also, the presentation of the results must contain rich and detailed information allowing the reader to understand and interpret the informants' meanings.

5. Empirical studies

5.1. Paper 1 – "Professions, work, and digitalization"

This article examined how the implementation of new digital technology affects a profession. The empirical data came from a case study on the maritime industry that focused on the ship engineer profession and the implementation of an advanced sustainable fuel system and subsequent new business model to enable its operationalization. Our findings indicate that digital technology presented challenges for the profession when their existing competencies did not cover this new technology. The shipowner's solution to narrow this competence gap was more digital technology, specifically technology that enabled more connectivity to the outside world. This paper demonstrated how the ship engineer's profession could connect to outside partners to gain competence and incorporate the new digital technology into their professional work. These relations shaped the ship engineers' professional work and moved the profession toward connective professionalism. This paper's contribution comprised the identification of mechanisms, e.g., connecting to outside actors, removing barriers, and the observed value of professional work. These mechanisms are essential to understanding connective professionalism.

The research question was divided into two subquestions:

1) Does implementation of digital technology elicit connective professionalism, and if so, how?

2) Which mechanisms contribute to this development and how?

5.1.1. Main findings

This paper contributed to the discussion on connective professionalism by identifying mechanisms and processes that shape professional work. It was instrumental in providing examples of mechanisms that allow a profession to become more connective and relational in response to outside pressures, e.g., the introduction of digital technology. The theoretical contribution demonstrated that connective professionalism is a process dependent on several mechanisms and that the process is vulnerable to organizational factors.

The first identified mechanism is that pressure placed on a profession can be solved by relating to other occupations. This pressure can be something that threatens the profession, e.g., new technology or business models, or it might be something that the professionals view as beneficial to their professional work. The second mechanism entails establishing a method of crossing barriers, which often can hinder the formation of relationships, particularly if the partners are located in different organizations. These barriers are often economic, but also can be any form of organizational or managerial mechanisms that prevent necessary relating processes from occurring. The final mechanism for advancing connective professionalism is the presence of a genuine benefit for the involved professions and partners, so that the value of connective professional work produced between them is enough to maintain the relationship. This value could be, e.g., increased efficiency, exploited synergy effects, or improved performance.

Connective professionalism can be viewed as a continuous process that is vulnerable to outside forces, e.g., demands to be economically viable. Therefore, it is essential that the increased value of the connected professional work be visible to outside stakeholders; otherwise, it is difficult to maintain the relations and connective activities across organizational boundaries.

5.2. Paper 2 – "The whereabouts of interorganizational learning"

This paper investigated interorganizational learning as a buyer-seller relationship that focuses on the operation of two advanced ships using a business model that relies on servitization. The study focused on work practice and how interorganizational learning occurs in this context. The paper also addressed the relationship between intra- and interorganizational learning.

The case identified interorganizational learning within the organizations at the individual, group, and organizational levels. However, few signs of learning can be viewed as bidirectional interorganizational learning that can create knowledge and competitive advantages for the organizations. This is explained in the context of interorganizational learning and the organizations' motivation for learning at a strategic level.

Two research questions were presented:

(a) How do changes in buyer-seller relationships due to new business models and new technology influence the actors' learning processes?

(b) How can studying changes in work practices help increase understanding of the relationship between intra- and interorganizational learning?

5.2.1. Main findings

The literature on interorganizational learning often discusses the concept on its own, separate from intraorganizational learning. From such a perspective, the presented case would not necessarily be evaluated as successful because few observable signs of bidirectional learning are present within the organizational systems. However, when approaching this case with an emphasis on work practices and processes, it becomes evident that interorganizational collaboration elicits intraorganizational learning that is critical for operational success.

For example, individual learning primarily results from direct learning from courses and skills obtained by increased contact and communication. Group learning results from the new business model eliciting collaboration and other collective activities. Learning at the organizational level is also present, but less apparent. Most of the observed learning within the organizations can be linked to interorganizational influence and, therefore, is defined as interorganizational learning. Thus, this case identified interorganizational learning, but not the type often sought after in interorganizational business strategies.

Part of the explanations of why bidirectional learning is less visible might be that the organizations entered the collaboration with an emphasis on resolving technical issues, i.e., interorganizational learning's potential was not an articulated motivational factor. Nevertheless, the case demonstrates that this collaboration has generated intraorganizational learning between both organizations. Suppose the organizations had entered the partnership with the intention of gaining a competitive advantage through collaboration. In that case, it is likely that capturing and implementing learning at the organizational level would be more prominent. It is also likely that learning at the organizational level will happen over time as the relationship matures.

5.3. Paper 3 – "Servitization, trust, and maritime relations"

This paper investigated the maritime industry's adoption of servitization business models, which suppliers and manufacturers introduced to aid competitiveness and reduce the effects of market fluctuations that are common in the maritime industry. For these business models to succeed, several conditions need to be present. For instance, these business models' benefits must be visible to the customers, and any added cost must be in proportion to the perceived benefits. Also, trust between supplier and customer will impact such business models' success. However, adopting these business models has not been an immediate success in the maritime industry; therefore, this paper investigated this situation through the relationship between shipowners and their technology suppliers by conducting qualitative interviews and a thematic analysis.

5.3.1. Main findings

Maritime suppliers contemplating a servitized business strategy must consider the extent of the changes that it would bring to their organizations. The gains from using performance-based contracts and focusing on delivering services instead of products are considerable. This is particularly the case if it allows for combining suppliers' strengths in the aftermarket with the selling of new products. The organizational changes that suppliers need to undertake rimarily are related to delivering services to shipowners' core businesses. The suppliers also need to show the shipowners them servitization's benefits, either through lower costs or other benefits. Suppliers also will need to invest time and resources to become trusted suppliers of services, which might be challenging because the findings indicate that trust between suppliers and shipowners is a complex construct. The shipowners' trust in the suppliers primarily is based on their competence, and they need to build trust based on their integrity, which might take time and effort; therefore, the suppliers will need to evaluate the costs/benefits for the individual company. For the maritime industry, the increased use of performance-based contracts can increase collaboration between suppliers and shipowners and, thus, the industry's innovative abilities.

6. Discussion

The discussion focuses on the main topics that arch the scientific papers and contribute to achieving the research objectives of the thesis. The topics that emerge from the research are: How work and work systems are influenced by digitalization and business model and how work systems influence organizational change. How technology, in this case, digitalization and remote monitoring, can change organizations. Specifically, how aspects of the technology implementation like timing and the motivation behind influence the changes in organizations. The last topic is how technology and business models lead to more connectivity between organizations. The increased connectivity happens directly as new roles are introduced in the different organizations and indirectly in pursuit of competence and knowledge. Work and work systems are chosen as the starting point of the discussion as it is a significant part of the explanation for organizational change in this thesis

Early in writing this PhD thesis on organizational change, the significance of studying work practices in the involved organizations became apparent. Barley(1986) advocated for studying work and what he called scripts, i.e., dramaturgical descriptions of workers' roles and actions to understand how technology affected organizations. The data collected in the case study took advantage of studying actual work, particularly the observations on board the ships. The ship engineers were interviewed in the engine control room, making topics and examples from their workplace readily available for discussion. An interesting finding in these discussions and observations is how the ship engineers viewed their work and the interactions with the supplier. The ship engineers had a more positive view of their work after introducing the new technology and observed the benefits of contributions from the monitoring personnel. In this case, the ship engineers saw how the work of the monitoring personnel positively influenced their work, resulting in more optimized ship operations.

The ship engineers' favorable view of the work of the monitoring personnel can be connected to invisible work. For instance, considering the time and effort the ship engineers invest into monitoring the engine and equipment for deteriorating performance, i.e., work not visible to outside observers. This normally invisible work will make sense to the monitoring personnel as they are monitoring the same equipment through their sensors. The ship engineers will see the work of the monitoring personnel as recognition and an opportunity to improve their work. This is important if the ship engineers' professional work is articulation work, meaning work that can be crucial to the technology's successful operation, but it is not part of the written procedures and, therefore, not recognized. As a result, the introduction of technology changed the work systems by allowing monitoring personnel a role in this work. Consequently, the important invisible work of the ship engineers, came into focus when the remote monitoring personnel used technology to observe the ship engine.

These changes to the work systems led to discussions and collaboration that have signs of learning as a community, where the practical knowledge of the ship engineers is connected to the expert knowledge of the supplier. Such examples of technology-driven changes to work systems are quite contradictory to common expectations of digital technology like remote monitoring, where the ability to automate is expected and sometimes sought after, i.e., as discussed by (Susskind & Susskind, 2015). One of the findings in this thesis is these observations of work systems and how the ship engineer and supplier's experts found common sense in each other's work and saw how they contributed to the operation. As Suchman (1995) argued, these benefits of their cooperation can easily go unnoticed from a managerial point of view as they will be focusing on the direct effects of remote monitoring i.e., the automated identification of deteriorating performance.

Similarly, this thesis shed light on the status of the profession of the ship engineer. This profession has a key role in the maintenance and operation of technology onboard ships but as the case study showed their abilities to keep the ship running are often taken for granted when introducing new technology. The ship engineers' use of their relations and connections to the supplier's experts to strengthen their own profession came as a response to the lack of training and competence. The ship engineers, therefore, reached out to obtain the competence through training and discussions. The connected professionalism, as discussed in paper 1, solved these issues for the ship engineers involved in the case, but there are questions that arise when considering these issues in general. However, the insights gathered from the interviews with key stakeholders for article three, suggest that there are obstacles for the widespread use of such business models in the maritime industry. Since the requirements for advanced technology onboard ships remains, the ship engineers and shipowners will have to find other means of acquiring the necessary competence to operate the advanced technology. Solutions could be changing ship engineers' professional training and competence requirements, leaving it up to the individual shipowner to establish a solution, or hiring external competence from the suppliers when required. Whichever solution is chosen, an understanding and acknowledgment of the ship engineers' work are needed if efficient work processes around new technology are to be established.

The work studies also demonstrated how the work as imagined was dominant when the ships' work systems were designed. Operating the advanced technology onboard using digital control systems can appear trivial when following standardized procedures and manuals but the necessary skills to understand and troubleshoot problems were not matched by the ship engineers' competence and training and therefore created challenges in performing their work as they wanted. Only when the remote monitoring technology and new business model were implemented were ship engineers able to compensate and create work systems the way they thought they should be. Now they could contact the supplier's experts directly and discuss the operation of the ship engine without worrying about paying consultancy fees. Previously, they had to discuss the situation with the shipowner and get permission to contact the supplier. This illustrates how designing work systems around digital technology must take into account how work is performed and the ability the workers have for adapting and their possibilities for learning.

Digital technology has been viewed as impacting work and professions in ways that are not always beneficial to all parties (Almklov & Antonsen, 2019; Susskind & Susskind, 2015). In this case study, signs of work and digital performativity standardization can be seen in the control systems and remote monitoring of the equipment when AI is identifying abnormal behavior or responses. Standardized solutions and control mechanisms generally should reduce the possibility for situational adaptation, but the inclusion of performance-based contracts changed the situation. The new technology allowed the ship engineers to include the supplier's competence directly in their work and increase their situational adaptation ability, providing another opportunity to stress contextual differences in the organizational changes that technology elicits. There are, however, reasons to consider how work performance and situational adaption are changing when introducing digital technology. One way of addressing this question is viewing it from a safety standpoint. For instance, one approach could be to view the introduction of digital technology in relation to Hollnagel's (2013) concepts of Safety1 and Safety 2.

The increased communication and discussions between ship engineers and supplier's experts suggest that there will be room for more flexibility in the decisions. Both sides have similar interests in the successful operation and when there are rigid procedures that seem counterproductive to the operation, they can agree on alternatives through their discussions.

Similar one can argue that the digital technology and new business model can foster resilience in operations. For instance, including the knowledge and experience of both ship engineers and the supplier's experts can increase flexibility in finding solutions for unexpected situations. However, several factors can also reduce flexibility, such as digital performativity, Almklov and Antonsen (2019). Digital performativity has the potential to overrule flexibility and situational adaption. Even if the ship engineers and supplier have new knowledge enabling new solutions, digital performativity will only allow one of the predetermined solutions to be chosen. Also, the increased collaboration through digital tools in virtual teams can positively affect the work and operation. In this thesis, the increased communication and connections between organizations and actors is a defining aspect of the technology and business model. One word that can describe this is connectivity.

The term connectivity in this context means connecting to outside actors. These actors can be other professions, occupations, or entire organizations. The drivers for the connectivity seem to be both direct and indirect. Digital technology can connect directly, like the remote monitoring of equipment by suppliers, linking ship to shore, or indirectly where the competence needed to operate technology is found in other organizations and with other occupations, and therefore requires a relationship to gain access. Implementing this technology along with a servitization-based business model seems to remove barriers to these mechanisms. This can, as an example, be free courses and technical support included in the base fee removing the economic barriers. The positive effects of connecting to outside actors have been described in the first two papers in this thesis. The first paper showed the professional work and expertise of the ship engineers incorporate the skills and competence of the supplier's experts into "connective" professionalism. The second paper showed interorganizational learning happening between the involved organizations. This interorganizational learning acted out not as specific bidirectional learning to gain a competitive advantage, but as learning at the different organizational levels in both organizations to improve the operation of the two ships. The third paper put a new perspective on the increased connectivity between organizations and actors when using a servitization business model. The organizations must be ready to commit to changes to accommodate a servitizing business model and evaluate the costs economically and in terms of accepting the risk in trusting other organizations.

Overall, the introduction of digital technology and business model in this thesis is presented primarily positive. The ship engineers' profession is strengthened by their ability to discuss and collaborate with the supplier's experts, and both organizations use their interorganizational relations to strengthen the operation of the two ships. One question that arises from these findings concerns how representable this is when introducing remote monitoring and digital technology into a maritime setting. Are the changes observed in this case, one of a kind, or is this a common result of digital technology in maritime organizations? One of the theories that can shed light on this is interpretive flexibility as presented by Orlikowski (1992). According to Orlikowski (1992), technological change depends on technology's interpretive flexibility, i.e., interactions between technology and organizations will depend on the actors involved and the sociohistorical context in the use and development of the technology. Thus, organizational changes will manifest differently depending on why the technology was implemented, who implemented it, and when it was implemented.

The main reason for implementing remote monitoring and the business model was to improve the ships' reliability and cut maintenance costs. The shipowner did not expect that this would change its organization and give the technology supplier a new role in the ships' operations. If the shipowner had realized this consequence, control measures likely would have been initiated, and the changes to the organization would be different. Also, whoever initiated the implementation is essential, and in this case study, it was the technology supplier; thus, it had a good opportunity to tailor the technology to its needs. Therefore, including advanced training courses and upskilling the ship engineers would benefit the supplier, but not the shipowner, who would prefer that the supplier's service engineers do most of the work to reduce their expenses. Upskilling the ship engineers' competence benefited the ship engineers as well, but this was not the supplier's primary goal, which was to cut costs by letting the ship engineers perform more advanced work.

The timing of the technology's implementation also influences organizational changes. The two ships had been in operation for two years before the shift was made to remote monitoring and a new business model. During that time, the ships had several breakdowns, and both ships' engineers and the shipowner were unhappy with the situation. Introducing this technology to rectify the situation would increase the chance that the technology would be viewed as a success. If the technology had been implemented when the vessels were first launched, it might have met more challenges when the shipowner and supplier had to change their organizations. Also, the two ships were the first to operate with this technology, i.e., no reference cases were available to guide them, e.g., learning from others' past mistakes. Everything was a first for the shipowner, ship engineers, and supplier.

These contextual factors have an influence on the organizational changes according to Orlikowski (1992). Particularly the novelty of the technology and business model is a factor that is likely influencing the organizational changes observed in this case. If this business model becomes a success and is implemented with other shipowners, other changes will likely need to be accounted for. These changes can be the type of ship and type of operation and the size of the shipowner's organization.

The final reflection in this discussion is how the maritime industry compares with other industries that have implemented such technology and business model. The most likely industry to compare with is the aviation industry, where this business model has been used for decades. In this industry, the mechanics have additional specialized training that allows them to work on technology from one supplier (Walter, 2000). If they change company or work with other types of technology, they will have to retrain. If the technological development continues in the maritime industry, using a servitized business model with similar certifications is a plausible future scenario.

7. Conclusion

This thesis investigated the introduction of advanced technology and a new business model into the maritime industry and how this has influenced the involved organizations. The thesis answered three research questions.

The main research question: How does the introduction of a business model using performance-based contracts and remote monitoring affect maritime organizations?

One of the main changes to maritime organizations is that both professions and organizations became more connected to other occupations and organizations. An example is how the ship engineers strengthen their professional expertise by attending courses with the supplier and discussing technical issues with their experts. The business model led to the supplier becoming more involved in ship operations and spending more time discussing and collaborating with the shipowner. Also, the business model removed economic barriers to collaboration between the organizations.

The first sub-research question: How will remote monitoring and new business models affect the ship as an organization?

The changes to the ship as an organization primarily happen as a result of the ship engineers gaining access to training courses and discussions with supplier's experts. The ship engineers have strengthened their profession and have more influence on their work and how it is organized.

The second sub-research question: How is the relationship between ship, shipowner, and supplier changing with the introduction of new technology and new business models?

The relationship between the ship, shipowner and supplier in the case study is strengthened by the increased connectivity. Several organizational changes are made in both organizations to allow the supplier a closer involvement with ship operations and the shipowner's core business. One result of this involvement is that the organizations focus on the optimal operation of the two ships, not the economic side of their relationship. The increased connectivity between organizations can lead to enhanced performance, but it also requires substantial organizational changes that are not necessarily straightforward. These changes, particularly those tied to the also will require more integrity-based trust between the organizations, which takes more time to build. Therefore, introducing this business model into the maritime industry most likely will take time. Even though this business model's benefits seem worth the extra effort, each supplier and shipowner must consider this individually and determine whether they should implement this business model.

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Scholarly Article

Professions, work, and digitalization: Technology as means to connective professionalism

Bjarne Pareliussen*, Vilmar Æsøy, and Marte F. Giskeødegård

Department of Ocean Operations and Civil Engineering, Faculty of Engineering, NTNU, Norwegian University of Science and Technology, Pb 1517, Ålesund 6025, Norway
*Corresponding author. Email: Bjarne.Pareliussen@ntnu.no.

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ABSTRACT

Developments within digital technology are often seen as an enabler, allowing professions to connect to outside players for competence and new ways of performing their professional work. At the same time, it is often seen as a threat, challenging professional claims to competence and status. This article explores how the implementation of new digital technology affects a profession. The empirical data are from a case study from the maritime industry that focuses on ship engineers and the implementation of an advanced sustainable fuel system and a subsequent new business model to enable its operationalization. Our findings indicate that digital technology created pressure on the profession when their existing competencies did not cover the maintenance of this new technology. The solution for the shipowner to mend the competency gap was more digital technology, specifically technology that enabled more connectivity toward the outside world. This article shows how the profession of the ship engineer was able to connect to outside partners so they could gain competence and incorporate the new digital technology in their professional work. These relations shape the professional work of the ship engineers and move the profession toward connective professionalism. The contribution of this paper is the identification of mechanisms like the pressure to connect to outside actors, removal of barriers, and the observed value of the professional work. These mechanisms are essential to understanding connective professionalism.

KEYWORDS: profession; new technology; digitalization; servitization; maritime; work

INTRODUCTION

The introduction of digital technologies has challenged many professions. In some cases, professions have tackled the challenges and capitalized on the new possibilities opened up by technologies such as information and communication technologies (ICTs), automation, and artificial intelligence in the new digital world (Brynjolfsson and McAfee 2012). However, there are some cases where the transition to a more digital world is far more challenging and conflicting (Hinings, Gegenhuber, and Greenwood 2018; Trusson, Hislop, and Doherty 2018; Lester 2020). This study explores mechanisms and processes that allow professions to tackle challenges posed to their professional practice by technological development through connecting with outside actors. The profession of ship engineers is used as an empirical case to investigate the processes, mechanisms, and situations that facilitate a profession becoming connective.

This case from the maritime industry investigates the introduction of remote monitoring of ship engines and a novel business model called ‘power by the hour’, where the cost of service and maintenance is paid for by the operational hour. The introduction of digital technology to ships has been occurring for some time (Global Maritime Forum 2018). A primary driver has been the global incentives to reduce pollution, which has led to the adoption of new technology onboard ships. At the same time, the industry’s global competitiveness creates demands for increased efficiency and cost reduction. The solution is often to rely on ICT to manage the resources better onboard ships and minimize crew size. New technologies often depend on advanced control systems and sensor technologies, which are changing the work practices of the professionals operating these systems. For instance, ship engineers are seeing the introduction of digital innovations such as predictive maintenance using big data algorithms, fully automated control systems that can be remotely operated from land, and ICT systems, which are shaping their daily work routines.

The profession of the ship engineer has a strong identity and a long history of professional expertise shaped by the need to keep ships and crews safe. The advancements in technology have steadily progressed over the years, and ship engineers have dealt with any technical issues on board. The emergence of the ship engineer profession can be traced back to 1862 when the British Marine department started issuing Certificates of Competence for merchant ship engineers (Grignard 2006). Previously, there were conflicts between educated ship engineers and those with only practical training, often referred to as ‘shovel engineers.’ Now, with formal certificates, the criteria were set, and their profession became formalized and protected. Today, the profession is protected through international regulations and standardized requirements for education and experience. However, a challenge is that the ship engineer’s education primarily involves mechanical engineering, and the new technology is digital. The profession’s standardized education is regulated by a global organization. This makes adaptability to new competence requirements to a slow and tedious process. This bureaucratic organization consists of member countries with various abilities to meet the current requirements and keep up with new technology (Hand 2018; Nautilus Federation 2020). When the professional education does not cover the advanced digital technology in detail, the shipowners find themselves dependent on technical assistance from suppliers for necessary maintenance (Hand 2018; Nautilus Federation 2020). This poses challenges for ship engineers as a protected profession and shipowners who need operational expertise to capitalize on new technological developments.

The research published on professions and how they are changed by technology points toward two distinct possible futures of the ship engineer as a profession. One possibility is that organizations will take control and recruit the necessary competence and services. This could lead to professional down skilling and redundancy for ship engineers, where expert decisions are made onshore by different professions or by automated routines, as described by Frey and Osborne (2017) and Susskind and Susskind (2015). A second possibility is for the ship engineer profession to become more relational and connective. In this setting, the competence of the new technology can be located in other organizations, such as the supplier or manufacturer of the technology, and become available to professions through collaboration and relations. This means that professionals can find new ways to keep up with rapidly changing technologies. Relations and collaborations seem to be a trend in today’s theoretical discussions on understanding the complex mechanisms that shape society and work-life (Anteby, Chan, and DiBenigno 2016). This article aims to contribute to this discussion on professions and how they relate and connect to outside actors.

Theoretical discussions point to several factors that influence the situation of the ship engineers. These include how professions work in organizations, coping with managerial control mechanisms (Noordegraaf 2015, 2011), and maintaining their professional expertise, authority, and autonomy through connecting to other occupations (Noordegraaf 2020). However, there is little research on how professions become connective. One could argue that professions have always connected to outside players, but what is the process that makes professions in some relationships connective? Furthermore, is it a temporary process that happens when professions come under pressure from outside forces, or is it a permanent condition that is necessary to keep up with the rapidly changing world? This article aims to understand better the processes, mechanisms, and situations that facilitate a profession becoming connective. The research question is divided in two and phrased as:

1. Does implementation of digital technology stimulate connective professionalism, and if so, how?
2. Which mechanisms contribute towards this development and how?

This is investigated through a case study of the introduction of digital technology in the maritime industry. The case shows how the ship engineers focus on their professional role and see the necessity of using the supplier's experts to perform the maintenance. Their concern or struggle is related to the economic pressure to use the supplier's experts as little as possible. In this situation, the ship engineers feel that their professional expertise, authority, and autonomy are challenged. Their options to rectify this situation are limited by the standard of their professional education, the cost of special training courses, and their physical location on the ship. To address this, the shipowner and supplier introduce remote monitoring and the new power by the hour business model. This creates possibilities for the ship engineer to develop relations and connect to the technology supplier's experts. By entering into connective relations, ship engineers can mend the competency gap created by new technological developments, which change work processes and the professional practice of this traditional profession.

DIFFERENT VIEWS ON PROFESSIONS

In their review of occupational studies, Anteby, Chan, and DiBenigno (2016) suggest that the literature can be understood through distinguishing between three overall categories, or lenses, of study. They divide the studies into those focusing on how one becomes a member of a professional community (becoming), those addressing various aspects of practicing professions (doing), and those aimed at understanding the relationship between a given profession and its surroundings (relating). The authors show how the respective categories of studies illuminate different key questions about professional work (at the expense of others) and enhance our knowledge of occupational communities. The authors, therefore, suggest that these categories can be helpful as lenses to guide future work. They use lenses and filters as metaphors to show how new studies can draw on this categorization of previous studies to ask key questions. Thus, the most relevant lens and filter depends on the angle of the study. The 'doing' lens on occupation might be well suited to explain how the introduction of technology can create challenges by altering work practice and creating interference between occupational groups claiming the right to perform specific work tasks (Barrett et al. 2012; Håland 2012). According to Anteby, Chan, and DiBenigno (2016), one of the limitations of the 'doing' lens is the tendency to focus on conflicts between occupational groups instead of the possibilities for collaboration between them. Collaboration is a key word in the 'relating' lens on occupations that Anteby, Chan, and DiBenigno (2016) suggest in their framework. This lens explains how occupations relate to other groups using the filters collaborating, coproducing, and brokering. The filters identify how occupations can use different types of relations to other groups to obtain complementary goals. Occupations can choose to collaborate when their work tasks overlap their occupational boundaries. Coproducing as a filter describes how occupations relate to stakeholders that have common interests in the work tasks that the occupations perform. These stakeholders can be anyone outside the occupation, such as clients and user groups interested in the outcome of the work processes. According to Anteby, Chan, and DiBenigno (2016), the brokering filter describes how an occupation can connect with and include new occupations in a network of relations. When a new occupation can fill a critical gap in this network of relations spanning different occupations and organizational boundaries, there will be brokering and negotiating between existing and new occupations to establish a working relationship. When brokering occurs, it is a result of the occupations considering the contribution of the new occupation as more important than strengthening their own occupation or profession.

These three lenses describe much of the discussion that has shaped the study of professions, but they can also help identify trends and when they appeared. For instance, many of the seminal papers using the relating lens were written in the 21st century, according to Anteby, Chan, and DiBenigno (2016). This correlates with the advancements in digital technology that enabled the many platforms for communication and collaboration that are shaping today's working life. Whether this is a case of cause and effect is not discussed in this article. Still, the importance of how professions relate and connect to outside professions and occupational groups is highlighted by several scholars (Waring 2014; Noordegraaf 2015). Technology's role in changing organizational structures, influencing human operators, and becoming institutionalized is described and explained well in Barley (1986), Bechky (2003), and Orlikowski (1992). However, the role of technology in making professions and occupations more relational is less explained, although examples are found in the studies of boundary work (Eriksson-Zetterquist, Lindberg, and Styhre 2009; Lindberg, Walter, and Raviola 2017). These examples show how technology makes professions cross boundaries by creating new means of connecting to the outside world and demand for knowledge that is only available outside the protected professional realm.

The relating lens that Anteby, Chan, and DiBenigno (2016) presented shows how professions can collaborate, coproduce, and perform brokering when they connect and relate to outside players. One approach that goes further in the use of relations as a means to handle external pressure, such as that brought about by technology, is connected professionalism Noordegraaf (2015, 2020). Noordegraaf introduced connective professionalism as a response to outside pressures on traditional protected professionalism. These external pressures can be in the form of societal pressures, like finance and cost–saving measures, removing the protective barriers of professions. Another example is technology in the form of social media, artificial intelligence, and automation that directly impact professional practice and the professional boundaries between professions and occupations.

According to Noordegraaf (2020), connected professionalism focuses on professionalism as a continuing process of relating to outside actors. Connected professionalism, therefore, goes beyond what Anteby, Chan, and DiBenigno (2016) describe in their relating lens. Noordegraaf (2020) uses community judges, medical doctors, and academics as examples of professions becoming connective. In these examples, he shows how actors relating to other groups to strengthen the quality of their work changes three defining aspects of professionalism: expertise, authority, and autonomy (Noordegraaf 2020). For outside mechanisms, like the introduction of new digital technology, the professions will need to find which relationships are beneficial for the use of these technologies. Suppose the possibility to capitalize on big data is used as an example. In that case, the professional can use experts in systemizing data to access the information and thus strengthen his professional judgment. Through these connections, the authority is maintained as it shows the necessity of professional experience in interpreting the big data information in a professional context. Their professional autonomy is strengthened, as the professional actor takes ownership of the information by connecting with outside actors, which allows them to include it in their professional expertise. According to Noordegraaf (2020), connective professionalism thus exists between and among connected actors rather than within a given profession. The professionalism is found in the work that is created through relational processes. This brings connected professionalism to a level where it can be separated from traditional professionalism, commonly known as protected professionalism (Wilensky 1964; Freidson 1984; Noordegraaf 2020). Following Noordegraaf, such a distinction can be vital to capture new defining developments within the realm of professions. Others, commenting on the fact that professionals have always been collaborating and relating to outside professions and occupations, question the value of this term (Adams et al. 2020). This discussion on protective versus connective professionalism and if they can or should be considered a dichotomy is elaborated in Faulconbridge, Henriksen, and Seabrooke (2021) and Alvehus, Avnoon, and Oliver (2021). To better understand whether connective professionalism captures something qualitatively new in how professions work, and the distinction between connective and protected professionalism, we need to develop our understanding of how and why professions become connected. This can distinguish connective professionalism from the examples of relationships in Anteby, Chan, and DiBenigno (2016) relating lens and seeing if connective professionalism ties into known protective mechanisms.

To understand this process of becoming connected and the transformation of the professional expertise, autonomy, and authority, Noordegraaf (2015) suggests focusing on the work processes carried out by professionals rather than on the professionals as individuals. Other studies support that observing work processes is a promising method of identifying how professions become more relational. For instance, the operation of technology is argued to have a substantial influence on work in service networks (Akaka and Vargo 2014). Remote monitoring and predictive analyses of operations can increase connectivity between organizations and professions, moving and changing work processes by increasing both cooperation and competition between professions (Ardolino et al. 2018). These examples show digital technology changing work procedures and moving professions in a more connective direction that involves discussing and sharing information with outside players, where previously, this discussion was limited to their own realm. In addition, introducing new technology can have other effects aside from the intended use. For instance, a lack of competence in using new technology can move professions in a connective direction to acquire competence through outside partners (Lyridis et al. 2005). Discussing how professional work is changing seems to be a necessary step to see how professions can relate and become connective.

DEVELOPMENTS IN SHIP ENGINEERING PROFESSIONAL WORK: STANDARDIZATION AND DIGITALIZATION

Ship engineers' work may be affected by new technology in several ways. Now, their work is monitored from onshore control centers, and the decisions made on board can be questioned by outsiders from other occupations. This is a new situation for ship engineers, who are used to having substantial autonomy in their work, relying on their expert knowledge to handle situations that arise when the ship is at sea, far from assistance. The combination of the ship engineers' work performed as experts and how their work onboard can be seen and understood by outside suppliers can create a complex work relationship between ship engineers and the suppliers of digital technology.

In Lucy Suchman's article *Making Work Visible* (1995), she explains that work seen from the outside is represented by stereotypes, and the further away the observer is positioned, the more stereotyped the representations of the work become. These representations of work serve the interests of the outside viewer and can challenge the relationship between the outside viewer and the performer of the work. Suchman (1995) argues that specific knowledge of how people work is crucial to the design of work systems, and problems arise when stereotyped representations and normative descriptions observed from a distance are used instead of the working knowledge of the people who do the work. This is described by Suchman (1995: 58) as 'the better the work is done, the less visible it is to those who benefit from it'.

Similarly, Orr (1998) describes the work of service technicians at Xerox, comparing their actual work to the service procedures described in maintenance manuals. Orr (1998) finds that the technicians' maintenance work is situational and interpretive and cannot be contained in written documentation and procedures. Therefore, the technicians' work, known as 'work done', may be quite different from what service manuals describe and what managers think they do, known as 'work imagined' (Almklov and Antonsen 2020).

Almklov and Antonsen (2020) discuss the increasing amount of standardization in modern organizations and its implications for 'work as imagined' and 'work as done'. The authors show that an increase in standardization makes situational adaption difficult, and the performativity of digitalization further complicates this. As an example of digital performativity, they use the term 'the tyranny of the drop-down menu', describing how it is impossible to move on in a computer task without choosing one of the predefined choices. Digital representation of the operation of an engine, for instance, through sensor data, is necessarily decontextualized and standardized (Østerlie and Monteiro 2020). This again reduces situational adaptation when making decisions based on digital technology (Almklov and Antonsen 2020). As Almklov and Antonsen (2020: 14) state, 'situational adaption is a key to successful operations'. However, they also state that digitalization and the interpretation of new data produce knowledge in an emergent manner. New knowledge can expand and evolve the ship engineer profession but can also reduce ship engineers' ability to perform their work in the way they think is best. That is, 'if sharp-end decision-making in normal operations is replaced with "computer says no" scenarios, the room for gaining experience and training on situational adaption may be very limited' (Almklov and Antonsen 2020: 14).

A theoretical link between connected professionalism and theories of work systems is an essential part in the identification of mechanisms that support connective professionalism. Connective professionalism results from combined work efforts from several actors with different viewpoints and stereotyped representations of each other's work. Introducing digital technology as a factor into this setting creates further complications. Therefore, empirical data on how actual work practices are influenced by collaboration with outside actors through digital technology is necessary.

METHOD

To answer the research question and contribute to the discussion on professions, a suitable method of acquiring empirical data had to be found. Both qualitative and quantitative methods were considered, but the method chosen was a case study investigating a case from the maritime industry, where the profession in question faces new digital technologies and a new business model. A case study is bounded in time and place, focusing on a real-life system (Creswell and Poth 2018). If the goal of the case study is to illustrate a specific phenomenon or situation, it can be called an instrumental case study (Stake 1995). The objective of an instrumental case study is to gather in-depth data using all available research methods (VanWynsberghe and Khan 2007; Creswell and Poth 2018).

The main reason for choosing a case study is that it allows choosing a limited case, where the professions are affected by known mechanisms and processes. A case study also allows multiple methods to identify the central elements in the study. This makes it easier to see the new connections, evolution, and relations and connect them to the introduced ongoing processes (Crowe et al. 2011). The limited size of a case study lessens the possibilities of outside biases and effects that can interfere with the identification and analysis (Stake 1995). This is especially important when the professional work involved is observed from the outside and over a distance, with different interests and viewpoints, as discussed in Suchman (1995). One weakness with a case study is that it may be small and illustrate a case that is too special to be used as an instrument representing a profession in its entirety; this can be mitigated by being transparent and explicit on the case selection criteria (Crowe et al. 2011). However, the benefits of using case studies to establish in-depth information in complex cases and extending the readers' understanding of a phenomenon are substantial (VanWynsberghe and Khan 2007). For this study on digitalization and identifying how it can lead to connective professionalism, a case study is expected to provide valuable information and identify essential processes involved using several methods of data acquisitions. The main research methods in this case study were semi-structured interviews and observations.

The case study started in October 2019 and ended in December 2020. During this time, the operation of two advanced freight ships was studied, including their main supporting organizations (the shipowner's office and the engine supplier's office). This case was chosen because the ships involved had installed advanced technology and were operating with a new business model that took advantage of the technology. The case can be seen as a state-of-the-art pilot on green fuel solutions in the maritime industry and these are the only freight vessels fully operative with this new business model. Also, the ships were operating on a freight route along the coast of Norway, making it possible to visit the ships when they had nearby port calls. The first step in this study was to obtain background information on the case. This consisted of talks with key persons involved in educating ship engineers and technical managers at the supplier's office. After these discussions, it was decided that the first author should complete a course in advanced machinery systems to understand the technology and be able to ask relevant questions of the ship engineers and other informants involved.

A total of 10 interviews were included in the thematical analysis. The informants were five ship engineers, three of the supplier's experts, and two technical managers at the shipowner's office. The ship engineers included in the analysis were all the chief engineers on the two vessels and one second engineer that had extensive experience on the two vessels. This selection was chosen after discussions with the ship engineers where they stated that it was the chief engineers who would be responsible for the contact with the supplier and communications with the shipowner. The informants from the supplier and shipowner were selected because they are working closest to the ship engineers.

The service engineers from the supplier have an essential role in the work processes studied in this case. However, they are part of a large pool of service engineers sent out to all customers, and it is therefore difficult to identify who has been on board these vessels. It is also worth mentioning the background of the service engineers. Their background can vary from practical experience from manufacturing technology to computer analysts with master's degrees. They are not a homogenous group with a common identity. The informants from the supplier chosen for interviewing are the people who have daily contact with the ship engineers in either a leading technical role or are responsible for organizing the work the service engineers are performing. The details of the interviews are presented in Table 1.

The transcribed interviews were thematically analyzed using the NVivo software. A thematic analysis was chosen to be able to identify underlying themes and meanings in the data. Thematic analysis is flexible and direct and has no strict method of collecting data or a specific theoretical foundation (Clarke and Braun 2014). This made it easier to connect the results of the interview data analysis with the results from the other data collected in this case study.

Observations were also used to collect data. Observations were primarily taken to understand the relationships between ship engineers, shipowner, and the supplier's service engineers. One observation was carried out during maintenance stay in a shipyard when the main engine was overhauled. The work involved ship engineers and participants from the shipowner's office and the supplier's office. The observations lasted for three hours and included work and informal situations such as lunch breaks. Data were gathered primarily using notes. Observations were also made before and after interviewing the ship engineers. The interviews were conducted during port calls. There were usually service engineers onboard at the same time, allowing for informal discussions on the performance of the equipment and ship. In total, the ships were visited five times over 1 year. One sales meeting between the supplier and a potential customer for the power-by-the-hour business model was observed. The meeting consisted of technical discussions and contractual details on how this business model would compare with a traditional service agreement.

The data were collected over a year, and several of the informants were contacted for additional information. During this period, two major maintenance projects were ongoing on these two ships. Both went through a regulatory 5-year reclassification and replacement of the gear for the main propeller. The fact that data were collected over time made the study more resilient to being colored by events happening by chance at the time of the interviews.

RESULTS

The case

In this section, the case chosen for the study is presented. The background information obtained from discussions with the supplier, shipowner, and ship engineers are described. References are included when they are considered relevant to the case but are not suitable for the theoretical discussion.

The two vessels in this case study were built to take advantage of the new technology that has been developed to reduce pollution in the maritime industry, and they were the world's most environmentally friendly freight ships when they were built. The pollution requirements for shipping are regulated by the Protocol of 1978 (MARPOL) convention. These

Table 1. Overview of interviews and observations

Informant/observations	Experience (total/these vessels)	Number of interviews	Duration	Location
Chief Engineer 1	30+/5	1	34′	Onboard ship
Chief Engineer 2	10+/5	1	28′	Onboard ship
Chief Engineer 3	8/4	1	19′	Onboard ship
Chief Engineer 4	15/1	1	34′	Onboard ship
Ship Engineer	7/3	2	21′+25′	Onboard ship
Suppliers PBH Service coordinator		1	52′	Video interview (COVID restrictions)
Suppliers' Technical manager		2	54′	Suppliers' office
Sales manager, PBH		2	94′	Video interview (COVID restrictions)
Shipowner's Technical super intendant	40/5	1	30′	Video interview (COVID restrictions)
Shipowner's Technical super intendant	20/1	1	54′	Shipowner's office
Observation Sales meeting			120′	Office of potential customer
Observation 5-year certification vessel 2			180′	Vessel 1 shipyard
Observation 5-year certification vessel 2			90′	Vessel 2 shipyard
Observation Service engineer visit			50′	Vessel 2

requirements are enforced by the International Maritime Organization. They have led to the introduction of several new technologies, such as diesel-electric propulsion and new types of fuel, such as liquid natural gas, which requires complex automatic systems to operate and control. The two ships that are part of this study are examples of ships running on liquid natural gas. The fuel is filled in a gas plant in Northern Norway in liquid form, cooled to −160°C. From then on, the liquid starts to heat up and transform into a gas. It needs to be fed into the engine before the pressure increase forces the gas to be vented into the atmosphere. This means that the engine cannot be stopped for extended periods without causing a discharge of harmful greenhouse gas emissions. Normally, the technology is run by an automated and controlled process, but it needs to be run in manual mode when sensors malfunction or there are any special circumstances. The technological evolution has increased the demands on ship engineers, who must operate, maintain, and troubleshoot these complex technologies that rely on digital technology. This has been recognized to a degree in the updated international training requirements for ship engineers, the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers in 2010. However, the gap between official requirements for competency and actual requirements in the maritime industry has become increasingly apparent (Hand 2018; Nautilus Federation 2020).

This case study took place in the fifth year of operation. During the first 2 years of operation, there were substantial technological problems concerning the technology installed onboard the ships. This led the company that operated the vessels to change the operation of the ships to a new type of business model offered by the supplier of the ship engine. These two vessels were the first in the world to be operated with this business model. This business model, called power by the hour, consists of paying a fixed fee per operating hour. This fee covers the cost of maintenance, repairs, and spare parts of the main engine and the major technical installations on board. Training courses are also included in the operational fee. This business model focuses on delivering services instead of selling products (Vandermerwe and Rada 1988; Coreynen, Matthyssens, and Van Bockhaven 2017). This is often referred to as servitization, and the contracts that regulate the relationship between the customer and supplier are called output-based contracts. This type of contract has been shown to have potential benefits for both customers and suppliers. Customers can typically benefit from increased efficiency and improved accountability, innovation, budget flexibility, and value for money (Selviaridis and Wynstra 2015). Suppliers can benefit from a steady fixed income; however, they may be exposed to substantial economic risk (Hou and Neely 2018; Ziaee Bigdeli et al. 2018). Therefore, suppliers need to take precautions and risk-mitigating actions. In this case, the risk is mitigated using remote monitoring technology and predictive maintenance, allowing suppliers to prevent expensive repairs by identifying issues before they become failures. The use of predictive maintenance, which applies machine learning algorithms to sensor data obtained from remote monitoring to predict when maintenance work needs to be carried out, brings the supplier's technical experts into the professional domain of the ship engineers. They must agree on when maintenance should be done and align it with other work taking place onboard. The technical experts need the ship engineers' practical experience to troubleshoot and perform mechanical work. Several scholars have studied the effects of remote monitoring on work performance, where one monitors the work of others, have been studied by several scholars. Remote monitoring can motivate for increased performance and interest in improving work routines; however, hidden costs can lead to negative effects depending on the relationship and social distance between the observer and the observed (Frey 1993; Dickinson and Villeval 2008).

There are also other mechanisms in this business model that connect the work of the ship engineers to the supplier's work. For instance, the communication channels between ship engineers and the supplier were found to have become more direct. Previously, before introducing power by the hour, the supplier's services were ordered through the shipowner, who approved the order if they agreed on its necessity. This limited the relationship between ship engineers and the supplier to a conventional customer–supplier relationship that can highlight competency gaps in ship engineers. For instance, when a competency gap requires ship engineers to order costly services from a supplier, the shipowner may question the ship engineers' assessment that service is needed. This could change the relationship between the actors, as the ship engineer who has traditionally enjoyed significant autonomy may interpret the shipowner's questions as distrust of his skills and professionality. It was found that after introducing the new business model, there was no longer a need for the shipowner to control the use of services from the supplier. The ship engineers and the supplier can discuss the need for maintenance and spare parts and to what extent the supplier's service engineers need to be involved in the maintenance. For the supplier, a new situation emerges: the more the ship engineers can do on their own, the more the supplier can save money by not sending service engineers. Therefore, the supplier has an economic incentive to upskill and train ship engineers to perform as much of the maintenance work as they can on their own. The sales manager described it as 'We can probably train five or eight of the crew for a week for the cost of sending two service engineers to Rotterdam during a weekend'. He also explained why they had included more advanced technology in the courses 'If you want people to fix things on their own, they need a complete understanding of what goes on, including the digital part'. In other words, the supplier has an interest in strengthening ship engineers' expertise, autonomy, and authority.

RESULTS OF THE THEMATIC ANALYSIS

In this section, the empirical findings of the thematic analysis are presented. The results were divided into themes that emphasize the ship engineers' views of their profession, which were then divided into the following main categories:

- automation, innovation, and the transformation of work;
- shifting patterns of interaction and professional autonomy; and
- competency, training, and the skill gap.

Automation, innovation, and the transformation of work

When ship engineers were asked how their work has changed over the years, they brought up computerized control systems to oversee and operate the machinery as the most important change. Ship Engineers explained how their work situation changed gradually over the years as technological systems used to perform daily maintenance activities were introduced. One informant said, ‘Today, the ship engineer’s main tool is a keyboard more often than a wrench’. This was echoed by all informants, who stated that the introduction of automated and digitized systems resulted in more time spent using information and communication technology (ICT) and less time operating mechanical systems. ‘Everything is so much easier now; all the fumes and noise we had to endure in the engine room are now removed. We do everything from here’, stated an experienced ship engineer. This was discussed among the ship engineers. One experienced ship engineer expressed concern that practical knowledge was already suffering, saying, ‘I’m not sure if they know where the valves they are remotely operating are physically located’. He was unsure what would happen if they needed to locate them in an emergency.

Besides the concerns for losing practical knowledge, there were arguments for greater ICT competency. One of the younger and less experienced ship engineers mentioned that it was often challenging for the more senior ship engineers to learn new systems and new versions of software installed onboard. Ship engineers said that the introduction of new technology was something they neither liked nor disliked. None of the ship engineers was against the technology introduced onboard, and none of them would have preferred to work onboard a ship with older technology. They accepted the new technology as part of their work and recognized that it brought benefits as well as side effects. ‘It is just the way it is; it’s the future’, the most experienced ship engineer stated. Both positive and negative aspects of the new technology were mentioned in relation to the introduction of power by the hour. The majority of the comments were positive. One ship engineer stated, ‘It makes everything so much easier. Now we can call and ask if we are unsure of something; previously we had to send mail after mail to get an answer’. The negative aspects mentioned primarily concerned their fear of not being able to override automatic shutdowns and operating the machinery without adequate training before the introduction of power by the hour.

It was expected that the supplier’s remote monitoring of the operation of the machinery would be a technology that would cause negative reactions, but this technology did not seem to make a significant impression on ship engineers. When asked directly if they felt under surveillance when the supplier’s experts monitored their system, one of the ship engineers replied that he had noted lights flashing when monitoring personnel was accessing the system. None of the informants mentioned that they felt the remote monitoring was invasive, and none described feeling under surveillance. The supplier’s access to their control system was mentioned as a benefit by ship engineers. There were several incidents where remote monitoring identified signs of early deterioration in the equipment. In most cases, the crew was aware of the deterioration before monitoring engineers notified them, but this was not always the case. The ship engineers mentioned two issues where failures were avoided due to early identification.

In summary, ship engineers strongly reported that their professional goal is to keep the machinery operational at all times. They were concerned that mechanical knowledge would be lost in favor of competence in using the new digital technology. Nonetheless, they thought that the evolution of their profession was positive, and they still felt that they were responsible for solving any issues if the technology should break down.

Shifting patterns of interaction and professional autonomy

The ship engineers interviewed described their relationships with the supplier as closer than before introducing remote monitoring and power by the hour. Previously, they ordered spare parts and service through the shipowner’s office, and the shipowner had the final say in what to order and when. Therefore, contact with the supplier was limited to planning maintenance before the ship went into the yard or dealing with specific problems that needed to be discussed before a solution could be found. After introducing the new technology and business model, all communications regarding maintenance and spare parts for machinery included in the fixed hourly operating cost of power by the hour occurred directly between the supplier and ship engineers onboard the ships. All ship engineers interviewed were satisfied with this arrangement where their professional autonomy was reinstated.

Ship engineers described their relationships with monitoring engineers as relaxed and requiring little or no extra work on their part. If the status of equipment was considered normal, then monitoring personnel sent out a monthly report of the equipment status to the relevant parties, including the supplier, shipowner, and engineers. If there were any changes from earlier reports, the ship engineers usually received a phone call from the shipowner to discuss onboard maintenance. About remote monitoring, one ship engineer said, 'It is useful; we can identify many things out here, but they have access to more information than we do, and they are much better at identifying the root cause of a problem.' The ship engineers did not feel that the latter led to certain parties being blamed. One of the ship engineers said, 'They never point any fingers; they are just focused on the operation of the machinery, same as we are. If they spot something we have missed, it is good for everybody.' All interviewed ship engineers stated that they wanted more interaction with monitoring personnel to verify and discuss their observations and thoughts on the best way to operate monitored machinery.

When maintenance should be carried out and what spares should be onboard were decided more by professional than economic considerations. One ship engineer stated, 'There are almost no limitations from the supplier when we ask for spare parts.' Another said, 'We have never asked for something that wasn't justified. This works really well in my opinion.' They also highlighted the different relationship they had with service engineers who came onboard when specialized tasks needed to be performed. Previously, this was stressful for ship engineers because they had to do as much preparation as possible before service engineers arrived to minimize the time they were kept onboard. In addition, the ship was kept in port and out of service when service engineers were on board, which increased expectations that ship engineers would finish the work in the shortest time possible. After the introduction of power by the hour, their routines changed. Work that involves service engineers is planned differently, and service engineers often sail with the ship, arriving at one port and departing from another when the job is done. The ship engineers now look forward to this, as they have time to 'do things properly', and often, service engineers have time left to discuss and possibly help with other tasks that the engineers are doing.

To summarize, ship engineers felt they had a more active role in ship maintenance. The organizational mechanisms that controlled much of their activity have been replaced by professional autonomy. They can work more freely and perform the work as they see fit. They felt there was trust between the ship engineers, supplier, and shipowner.

Competency, training, and the skill gap

Training courses for ship engineers are included in the contract, which informants highlighted as one of the benefits of power by the hour. Previously, training was paid for by the shipowner, and there were discussions about who was entitled to training. Some courses were restricted to chief engineers, and there were expectations that the chief engineer should arrange further training onboard for the rest of the engineers. Now, ship engineers can sign up for courses by themselves. Ship engineers said that they found these courses attractive, and although they said it was a nuisance to take courses during time off, it was a significant bonus of power by the hour. Ship engineers mentioned the status and recognition associated with taking courses more than their opportunity to acquire new knowledge. One change in acquiring knowledge that ship engineers mentioned was discussing incidents or situations with the supplier's technical experts. The ship engineers also mentioned the dedicated contact that the supplier set up for power by the hour as helpful in getting expert help from the supplier's organization. This was reflected in their desire to get all equipment onboard on a power-by-the-hour contract, as for them, it is much easier to relate to one system and one supplier. As one ship engineer explained, 'If we have problems, we have a contact number, and they ask what our problem is. Is it the main engine, bow thruster, or winches? The only problem is that power by the hour does not include all the equipment onboard. Power by the hour is great for us ship engineers. It is 24/7; if you have a problem, they are obligated to help you.' According to the ship engineers, close cooperation between themselves and the supplier's service personnel was essential. When asked whether ship engineering students' formal education and training were suited to modern ships and technology, ship engineers said that basic mechanical knowledge was still necessary and could not be replaced with digital technology competency. According to the ship engineers, the necessary competency for nontraditional technology must be acquired through special courses from the supplier, or the supplier's service engineers must handle the maintenance for this equipment. One example of this was the use of liquid natural gas as fuel. The control mechanism for this fuel system is complex and, to a large degree, autonomous. If there is a gas alarm on board, the engine automatically shuts down, and the backup diesel generators take minutes before they can be used to generate electricity and emergency propulsion. One ship engineer said, 'If we get one alarm, we can bypass it, but it shuts down automatically if we get two alarms. I can't entirely agree with this as the sensor could be located in a well-ventilated area, and the danger is far greater in shutting down everything.'

In summary, the ship engineers were satisfied with the training and courses and saw them as necessary additions to their professional training. They felt that their professional status had been increased by attending additional courses and that they were more attractive to employers.

DISCUSSION

The introduction of remote monitoring has the potential to be a serious threat to the ship engineer profession. It brings other professions and occupations into the ship engineer's realm and, with performativity and decontextualization, this digital technology can reduce ship engineers' ability to perform the work with the required situational adaption (Almklov and Antonsen 2020). The information from the ship engineers paints a different picture; they seem to welcome the professional discussions with the supplier's experts and are interested in a closer relationship. Noordegraaf (2020) argues that connective professionalism means the outside actors, or suppliers' experts in this case, continuously work together with the ship engineers to create a new connective professionality of their work. Remote monitoring, in this case, brings together the complex, digital, and analytical knowledge of the supplier's experts and the situational and experience-based knowledge of the ship engineers. By creating a work system that combines these dissimilar knowledges they can bridge the physical distance and stereotyped images of each other's work as described by Suchman (1995) and overcome negative effects of digital performativity and create situational adaptivity. This can be seen as a strong argument for development toward what Noordegraaf terms connective professionalism. It also illustrates clearly how connective professionalism goes beyond what Anteby, Chan, and DiBenigno (2016) characterize as relational. If that were the case, they would collaborate to solve acute problems rather than seek long-term professional work relationships. In other words, connective professionalism manifests itself as an efficient and flexible operation of the vessels with a maintenance schedule that combines input from remote monitoring with the ship engineers' experience and practical knowledge.

In this empirical example, the ship engineers do not see the involvement of the supplier's experts as a threat to their profession, or, at least, that the benefits of the new relationship outweigh the potential negative effects. It also means the ship engineers believe the input from remote monitoring advances their profession and increases the quality of their work, and they feel obligated, as professionals, to regard it as favorable. There is also the fact that the supplier's experts are from an outside organization and cannot use the monitoring as a managerial control mechanism in the same way as the shipowner can and sometimes does.

The involvement of the shipowner in running the ship engine was considered negative, but further involvement of the supplier was considered beneficial. This showed ship engineers' views of the different roles of the shipowner and supplier regarding the ship engineers' work. It could also show how differently these collaborators view the work of ship engineers. Lucy Suchman (1995) discusses views and representations of work and how these can serve different interests. Traditionally, the primary interest of the shipowner in the work of the ship engineer is to keep the ship running and do the necessary maintenance work in a cost-efficient manner. The ability of the shipowner to control ship engineers' work is, therefore, an important aspect of its representation. Additionally, the less complex and demanding the representation of the work required to keep the ship running is, the easier it is to stereotype and rationalize cost savings. Ship engineers' discussions of work with the shipowner often strengthen the hierarchical differences between them.

According to Suchman (1995) theories on the representations of work, the supplier aims to make the highest possible profit through the power by the hour contract, while minimizing economic risk. The income generated by the power by the hour contract is fixed, so the main interest of the supplier is to cut costs. Thus, the interest of the supplier coincides with that of the shipowner, so the more work ship engineers can perform, the less costly it is for the supplier. The shipowner's and supplier's representations of ship engineers' work appear to be different, judging by how they get ship engineers to take on a larger share of the maintenance work. The supplier offers training courses and counseling to upskill and reskill ship engineers, which implies a representation of the work of ship engineers as an essential part of the work system necessary for the successful implementation of the power by the hour business model.

Since the introduction of this business model, ship engineers have noted that the external resources to operate and maintain the ship are available, and outside players are interested in contributing to and collaborating with their professional work. Now, the ship engineers include the supplier's work in their professional domain, while before the new business model, hiring external help was seen as detrimental to their professional autonomy. The removal of this economic barrier seems to be decisive in the evolution of the professional relationships in this case and the continual absence of this barrier seems essential in the relations between ship engineers and supplier. There is also most likely a dependence on digital maturity and skills for this business model to function that are present in some maritime countries in the western world, such as is the case in Norway, but not in the global maritime industry in general. Therefore, it is debatable whether the new situation for the ship engineers in this case study can be considered an example of the future of ship engineers as connected professionals. However, the case contributes to our understanding of professionals and connectivity by showing the mechanisms, situations, and processes that changed the situation for the ship engineers. This shows the importance of connectivity in today's world, especially when considering the effects of digital technology.

For the ship engineers, the main reason for connecting to the supplier's experts was their inability to solve their lack of competence in maintaining the advanced digital control technology. This created a tension that was released partly by the remote monitoring; the ability to discuss performance and maintenance needs with the supplier, and most importantly, the new business model that lowered the economic barriers to the supplier's experts. Removing an economic barrier is not enough to establish any of the three types of relating filters, namely collaborating, coproducing, and brokering (Anteby, Chan, and DiBenigno 2016). A mutual interest in the work or the professional domain must be present. For the ship engineers, this was created by the new business model that needed input from remote monitoring to reduce risk and upskill the ship engineers to perform more of the work so the supplier could save money. The last mechanism that seems to be present in this case is the ship engineers' favorable view of their new situation and their relations with the supplier. This is important as it means that the process of connective professionalism is driven by the ship engineers' perception that it is beneficial for their profession.

This case study has identified mechanisms that can move a profession in a connective direction. There must be some kind of pressure on the profession that can be solved by relating to other occupations. This pressure can be something that threatens the profession, such as new technology or business models, or it might be something that the professionals see as beneficial to their professional work. There are often barriers that can hinder forming relationships, especially if the relating partners are located in different organizations. These barriers are often economic but can be any form of organizational or managerial mechanisms that prevent the necessary relating processes from occurring. There must also be a genuine benefit for the involved professions and the partners, so the value of connective professional work produced between them is enough to maintain the relationship. This value could be, for instance, increased efficiency, exploiting synergy effects, or improved performance.

The presented mechanisms show connective professionalism as a continuous process that is vulnerable to outside forces, such as demands to be economically viable. This means that an essential factor in connective professionalism is to be able to show the increased value of the connected professional work to outside stakeholders. Otherwise, it is difficult to maintain the relations and the connective activities across organizational boundaries.

CONCLUSION AND FUTURE WORK

This case study contributes to the discussion on connective professionalism by identifying mechanisms and processes shaping professional work. It is instrumental in showing examples of mechanisms that allow a profession to become more connective and relational in response to outside pressures, such as the introduction of digital technology. The theoretical contribution shows connective professionalism as a process dependent on several mechanisms and the process's vulnerability to organizational factors.

The case presented in this article is a limited case study. There are uncertainties concerning what will happen over time, related to the novelty of the business model, scale, and technological development. The case study shows that the ship engineer's profession will move in a connective direction when rapid advancements in technology become the industry's norm. However, several factors are influencing how this will happen. Ship engineers come from various nations with different abilities to meet competence requirements, and the strategies of shipowners will also include advances in technology in varying degrees. This means the profession of the ship engineers will likely be in a transition for a time where protected professionalism and connected professionalism are both defining characteristics of the ship engineers' professional body.

There is a need for further studies on the ship engineers' profession to see whether the profession continues to evolve in a connective direction when more advanced technology becomes the norm. For further research in connective professionalism, there is a need to study the processes and mechanisms in other professions that face outside pressure.

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The whereabouts of interorganizational learning: a maritime case study

Bjarne Pareliussen, Marte Fanneløb Giskeødegård and Vilmar Æsøy
Faculty of Engineering, IHB, Norwegian University of Science and Technology, Ålesund, Norway

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Abstract

Purpose – This paper aims to present the results from a case study that investigated interorganizational learning in a buyer and seller relationship in the context of the maritime industry. This examination emphasized unraveling how the buyer and seller in the case study interacted and transferred knowledge when using a new business model that relied on servitization. Furthermore, this paper also addresses and discusses work practices, and the relationship between intra- and interorganizational learning.

Design/methodology/approach – A case study entailing the introduction of digital technology and a new business model into the maritime industry was used as an empirical example of interorganizational learning. The case study was conducted over a period of over one year and focused on a buyer of freight ships and a seller of servitized technology used on the ships. The organizations involved were the ships, the shipowner's office and the ship engine supplier. The primary data acquisition methods comprised semi-structured interviews and observations.

Findings – The case identified interorganizational learning within the organizations at the individual, group and organizational levels, but only a few learning signs could be viewed as bidirectional interorganizational learning that can create knowledge and competitive advantages for the organizations. This is explained by the interorganizational learning context and the organizations' motivation for learning at a strategic level.

Originality/value – This paper addresses an identified need for empirical studies on how interorganizational learning unfolds within organizations and connects to intraorganizational learning. Interorganizational learning studies often examine partnerships and joint ventures, in which partners have entered into these relationships with learning as a specific goal. By choosing a case in which interorganizational collaboration is anchored in operational matters, the study demonstrates the importance of motivation and agenda when entering into partnerships, concerning how inter- and intraorganizational learning develops within organizations. Furthermore, approaching these levels from an interrelated and practice-oriented perspective challenges established success criteria for interorganizational learning.

Keywords Interorganizational learning, Learning, Organizational change, Working practices, Maritime organizations

Paper type Case study

Introduction

This article investigates the implementation of digital technology and the subsequent change in business model within a maritime context in Norway. The maritime industry is

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developing technology for greener energy and is experiencing demands for innovation and change. As digital technologies have been known to impact and stimulate learning processes at different levels (Belinski, Peixe, Frederico, & Garza-Reyes, 2020; Ingvaldsen, 2015), as well as alter relational ties between organizations (Selnes & Sallis, 2003), this paper presents a case study to unravel and discuss further how technology-induced organizational change impacts intra- and interorganizational learning.

The introduction of digital technologies is a research context often used to illustrate how organizational learning can aid organizations (Belinski *et al.*, 2020; Ingvaldsen, 2015; Tortorella, Vergara, Garza-Reyes, & Sawhney, 2020). For instance, digital technologies can elicit added connectivity, information sharing and new business opportunities to organizations that can make the necessary adaptations to harvest these possibilities. Recently, discussions about interorganizational learning have become increasingly important, adding new dimensions to the theoretical foundations of organizational learning. Interorganizational learning focuses on how organizations can learn from each other and collaborate in dyadic relationships, networks, partnerships and supply chains.

Intraorganizational learning refers to learning within organizations using a process involving the individual and the collective (Popova-Nowak & Cseh, 2015), in which learning ideally takes place at different levels. Interorganizational learning in this context is defined as knowledge transfer from one organization to another or between organizations, or creation of new knowledge as a result of mutual knowledge exchange (Rupčić, 2021).

Interorganizational learning often has been studied within organizations that actively seek partners for collaboration. In these situations, learning from each other is the main driver for entering into such relationships, as it is thought to increase competitiveness (Anand, Kringelum, Madsen, & Selivanovskikh, 2021; Rajala, 2018). A central question is whether positive effects in such relationships are transferrable to other contexts, considering that interorganizational learning processes depend on the type of relationship and types of organizations (Rupčić, 2021). Organizations in a joint venture that actively look for collaborations and opportunities will have motivations and possibilities that differ from organizations entering into collaborations in which learning is less emphasized as a motivator (Inkpen & Crossan, 1995). This paper demonstrates interorganizational learning in a context that focused on two ships' operations. Understanding the motivation for the partner organizations to collaborate can be a key issue in understanding how learning within and between these organizations unfolds.

For example, Peronard (2021) argued that learning requirements depend on service networks' interactive complexity. Peronard's (2021) typology demonstrated that service networks with loose couplings and linear interactions can manage with passive learning, viewed as learning from seminars, consultants and printed materials. Networks with tight couplings or complex interactions require active learning, e.g. learning by observing competitors. Lane and Lubatkin (1998) demonstrated that these definitions of *passive, active* and *interactive* learning are different ways in which interorganizational learning can occur. Interactive learning is the most effective and allows firms to learn the more complex aspects of knowledge, i.e. the "how and why" knowledge, from other firms (Lane & Lubatkin, 1998). Interactive learning necessarily will require a close and dedicated commitment from both parties.

This paper's case study focused on a shipowner operating two advanced ships using a novel maritime industry business model that uses performance-based contracts as the basis for operation. These contracts transform the onboard technology supplier into a service provider, delivering services closely related to the shipowner's core business, which is the operation and maintenance of ships. The case study lasted for a year, comprising interviews and observations, and focused on the work processes on board the ships, at the shipowner's office, and at the supplier's office. Such a study can be instrumental in describing learning at different levels within the organizations and observing the effects of organizations learning from each other or together. Analyzing these effects of digital technology and business models can benefit the industry and contribute to discourse on intraorganizational and interorganizational learning.

This investigation adopted a practice-oriented perspective; therefore, the research questions grounding this study were structured to assess the impact of both technology and new business models on learning processes and work practices. Building on this, the research questions comprising this study include:

RQ1. How do changes in buyer–seller relationships due to new business models and new technology influence the actors' learning processes?

RQ2. How can studying changes in work practices contribute to understanding the relationship between intra- and interorganizational learning?

The paper is structured by first presenting the theoretical foundation for analyzing organizational and interorganizational learning used in the case study. The method for gathering the empirical data then is presented, followed by the case study results in two parts: first, the description of the case and the situation in which interorganizational learning took place, and second, the results of the individual interviews. A discussion of key findings follows. The paper concludes with how this case study can increase understanding of intra- and interorganizational learning, as well as contribute to the maritime industry's use of digital technology and servitization as a business model.

Theoretical background

Work practice and learning within and between organizations

Using intra- and interorganizational learning as analytical frameworks to explain the successes and failures of organizations' adaptation to technology and business models is not straightforward. Intraorganizational learning's complexity starts with the concept of learning, originally thought of as an individual learning process (Crossan, Lane, White, & Djurfeldt, 1995). It is now used in a broader context at the individual, group. and organizational levels. A strategy for linking learning and technology entails understanding work practices as manifested evidence of learning. Adopting such a practice-oriented perspective on learning and work has methodological and theoretical implications. According to Barley (2020), the organization will change from the ground up if new technology changes workers' roles and relationships, leading to organizational change, as workers' actions elicit new interactions with other workers, altering social structures. Understanding the intricate and interrelated processes of change at different organizational levels is imperative. Advocating for an emphasis on practices also entails taking an epistemological stance on how to understand knowledge creation and learning. Therefore, the following theoretical discussion includes an introduction to academic debates on the different levels of organizational learning, what is required to focus on work practice, and how to understand learning and knowledge as phenomena.

Levels of learning

The first level of intraorganizational learning is individual-level learning, which refers to learning that each individual organizational member does. At this level, learning is explained using common theories, e.g. cognitive or experimental learning. The second intraorganizational level refers to the group or collective level. Groups can be defined formally within an organization structure, or they can emerge in an organization. Here, the focus is on learning as a collective process. Learning at the group level can happen in communities of practice, which Brown and Duguid (1991) exemplified as the mutual knowledge-creation that takes place in the interactional space where one learns to become a community member instead of understanding learning as a transfer of knowledge. Learning at the organizational level can be defined as learning done by the organization, implemented by systems, and influenced by or influencing organizational structures, procedures and systems (Crossan *et al.*, 1995). It also has been described as "encoding inferences from history into routines that guide behavior" (Levitt & March, 1988, p. 320), highlighting that learning at the organizational level is independent of the organization's individual members.

However, theories with different epistemological foundations and even paradigms are necessary to explain how learning occurs at various organizational levels (Crossan *et al.*, 1995; Popova-Nowak & Cseh, 2015). This makes intraorganizational learning a challenging concept to use as a research framework and for comparing findings from different studies (Crossan, Maurer, & White, 2011).

One approach to grasping the difference between intra- and interorganizational learning is to understand them as learning at different levels, in which interorganizational learning is presented as a fourth level (Crossan *et al.*, 1995). The authors recognized the growing research area of organizations learning in networks and partnerships, and viewed this as the fourth level of organizational learning. In this context, *interorganizational learning* is defined as "learning between organizations at predominantly the individual, group, or organizational level" (Crossan *et al.*, 1995, p. 346). This definition views the interorganizational level as a source or origin of learning that can occur at intraorganizational learning levels. A challenge with this definition is understanding what this fourth level means concretely, i.e. is it a fourth level separate from the other three, or does it stimulate the other three, but is difficult to single out as a separate dimension?

Linking interorganizational learning to intraorganizational learning and the typology of learning at different levels has become scarce in the organizational learning debate (Anand *et al.*, 2021). Interorganizational learning has been studied as a concept on its own, separate from intraorganizational learning, often focusing on the possibilities of gaining a competitive advantage by establishing relationships for learning. Important research themes in interorganizational learning have included assimilation of new knowledge (exploration) or using existing knowledge (exploitation) (March, 1991). These terms were used in a study by Holmqvist (2004), in which interorganizational learning benefitted from combining the learning methods of exploration and exploitation. Interorganizational learning then can be viewed as either extension or internalization. *Extension* is viewed here as intraorganizational learning that generates interorganizational learning. However, *internalization* is the opposite, in which interorganizational learning generates intraorganizational learning. There also has been an emphasis on organizations' ability to learn from other organizations, i.e. their absorptive capabilities (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998).

Questions also have been raised about the disadvantages of studying these concepts separately from each other. For instance, Choi, Jean, and Kim (2019) studied absorptive learning capacities within individual organizations and as a joint capability between business partners. Their findings indicate that an individual organization's learning capability and a partnership's joint learning capability affect innovation and should be studied together. Also, Hallikas, Karkkainen, and Lampela (2009) called for research on the definitions of *intraorganizational* and *interorganizational* learning, particularly regarding learning that can happen only in networks because the learning depends on interactions between organizations. Several scholars have voiced the need for research to study how intraorganizational learning and interorganizational learning are related (Anand *et al.*, 2021; Larsson, Bengtsson, Henriksson, & Sparks, 1998; Mariotti, 2012). One approach to studying intra- and interorganizational learning is to focus on the work practices within individual organizations when they enter into partnerships and networks. According to theory, work practices will change because they are affected by inter- and intraorganizational learning.

Emphasis on practice

Barley and Kunda (2001) used the introduction of digital technologies as an example of how work practice will change. The consequences of introducing digital technologies include the creation and elimination of jobs, leading to work becoming enskilled, deskilled and reskilled. Using this example, Barley and Kunda (2001) pointed out that work is important in deciding how technology (or other environmental factors) can change an organizational structure. This can be explained by how changes at the macro-organizational level always are linked to changes in micro-organizational processes. Events, e.g. the introduction of new technology, in an organization's environment necessarily will generate, or fail to generate, a response from human actors who comprise the organization. To understand organizational change – and, thus, learning – we need to understand the processes that occur at the micro- and macro-levels. Therefore, work practices must be a central part of the analysis (Barley & Kunda, 2001).

A starting point for understanding work practice and organizational learning can be found in Argyris and Schön's (1974) early work. Their theories on action explain the difference between how individuals perform actions (*theory-in-use*) and how we explain them to others (*espoused theory*). These two contrasting theories set up a foundation for discussing what it means for organizations when practical, tacit actions differ from explicit, spoken descriptions of the same actions. Argyris and Schön (1974) emphasized that the outspoken and explicit espoused theory can be changed and adapted easily when challenged. However, for an individual to change their actions, they need to change the theories in use that govern their actions. This requires that the individual reflect on the governing factors, action strategies and consequences of the actions. According to Argyris and Schön (1978), these actions' consequences often are unintentional. The discussion of consequences of theories-in-use and espoused theory also can be found at the group level and in communities of practice.

Communities of practice and theoretical peripheral participation were put forth as theoretical explanations of situated learning in a study of several practical-work cases (Lave & Wenger, 1991). Since then, they have gained popularity, becoming a natural part of the vocabulary in education, management and social sciences (Barton & Tusting, 2005). Brown and Duguid (1991) proposed a unified theory on work, learning and innovation, highlighting how intertwined organizational learning is with work practice. Brown and Duguid (1991) emphasized how knowledge of work is divided into explicit and tacit knowledge, and how this is connected to learning and innovation. The three features of work practice that the authors highlight – narration, collaboration and social construction – are taken from the work of Julian Orr (1986, 1990). Narration is an essential work feature that workers use to make sense of complex experiences and accumulate "wisdom" among workers and within an organization. This aspect of collaboration points to the fact that work is a more communal process, not an individual one. Therefore, both individual and collective learning are inseparable from work practice, and accumulated insight is constructed and shared socially among workers in their communities. This explains how work, learning and innovation occur in communities. Brown and Duguid (1991) connected learning in communities to learning within organizations as a community of communities that share knowledge among them. Brown and Duguid (1991) also recognized the difficulties in achieving this shared knowledge in "real" organizations, in which knowledge is viewed as more of a commodity. The commodification of knowledge is a major aspect of how knowledge is created and shared within organizations. It has been described as a battle between the epistemology of possession and the epistemology of practice, in which the former views knowledge as something that people possess, while the latter views knowledge as action (Ribeiro, 2013).

The battle between these epistemologies explains some of the difficulties that organizations face in facilitating organizational learning and integrating it into structures and management systems. Suppose that "new" knowledge and learning occur in communities as a shared communal process or construction: in that case, it becomes difficult to incorporate or even acknowledge the learning in organizations' written explicit regulative systems, i.e. the possibility of an organization harvesting from this type of learning without acknowledging the need for changes in the written and explicit systems is limited. An interesting perspective on intraorganizational learning and harvesting knowledge from the individual and group levels can be found in Orr (1995). In the case presented, service technicians were given portable radios to use for professional discussions and to enhance their collective learning. In the beginning, the organization recognized that radios were used to increase learning at the group level. It was not something that the organization should use for cost reduction or as a control mechanism. The radios led to an increase in work satisfaction and learning among the service technicians. Eventually, management decided to use the radios as an excuse to downsize the number of technicians on staff, and the company switched to cheaper radios with limited functionality. These changes at the organizational level conflicted with work practice and diminished the radios' benefits. This example demonstrates that intraorganizational learning's benefits might exist on one organizational level, but not necessarily on all levels.

This challenge for organizations to understand learning and shared knowledge can be explained by returning to Argyris and Schön (1978) theories on single-loop and double-loop learning. These theories have been influential in organizational learning because they were first published (Smith, 2001). In short, single-loop learning responds to problems by following governing variables, e.g. rigid, written, regulative systems. Double-loop learning responds to problems by questioning these governing variables. Argyris (1982) argued that double-loop learning is necessary if practitioners and organizations are to make informed decisions in rapidly changing circumstances.

A logical extension to the discussion of double-loop learning is the concept of deutero learning, or simply learning to learn (Argyris & Schön, 1978; Schön, 1975). Argyris and Schön used the term "deutero learning" to describe how organizations can learn how to use single-loop and double-loop learning. The concept of deutero learning also has been used to describe interorganizational learning processes. Mariotti (2012) used three deutero learning processes to define interorganizational learning: learning to collaborate; learning to share knowledge; and learning to create interorganizational knowledge. By determining these three deutero processes, Mariotti (2012) described interorganizational learning as several processes in which the success of one process depends on the other processes' results. This points toward interorganizational learning as a slow and complex endeavor.

Several scholars have recognized interorganizational learning's added complexity compared with organizational learning. For example, Holmqvist (2009) connected the "slow" rate of interorganizational learning to how interorganizational decisions are usually a result of "bargaining" between partners – not an analytical process. A consequence is that interorganizational learning's efficacy largely will depend on the involved organizations' relationships and how their collaboration is regulated. Therefore, interorganizational learning between organizations in an *ad hoc* relationship likely will take time because few mechanisms facilitate the decision process. The absence of mechanisms that aid decisions can shift the focus toward potential gains for individual organizations, rather than creation of mutual learning and shared profit.

The present study investigated how the introduction of technology and business models instigate intra- and interorganizational learning. The aforementioned discussions demonstrated that we need a better understanding of the interdependent relationship between intraorganizational and interorganizational learning processes. This study aims to address this gap. Emphasizing work practices provides a theoretical framework that necessarily also will be a methodological guide. The next section discusses the study's methodological choices and reflections.

Method

An instrumental case study was chosen to investigate intra- and interorganizational learning in the maritime industry. The case study focused on two advanced ships operating in a freight route along the coast of Norway. The case study lasted from October 2019 to December 2020. In addition to the ship engineers, technical staff at the shipowner's office and the main engine supplier were included in the study.

An instrumental case study is bounded by time and place, allowing data to be gathered over time and in depth (Creswell & Poth, 2018; Stake, 1995). The data were acquired through semi-structured interviews and observations to establish the necessary in-depth understanding of the case (Creswell & Poth, 2018; Van Wynsberghe & Khan, 2007).

Three interview guides were developed to reflect the different organizations to which the informants belonged. The interview guides focused on ship operations and whether the work processes required to keep the ships running have changed since the introduction of the technology and business model. The interview guide for the ships' engineers was developed first and piloted by a ship engineer with knowledge of the relevant technology beforehand. The other interview guides comprised similar topics, but were developed further using information gathered from the interviews of the ship engineers and targeted for their respective organizations/positions. The questions in all three interview guides were intended to be open and allow the informants to answer the questions freely and use examples and stories. Observations also were used to observe the work processes and compare them with the information provided in the interviews.

The participants were selected based on how much they were involved with ship operations and whether they were able to observe any changes. On board the ships, the chief engineers were chosen because they have technical responsibilities on board and handle most of the communications with the shipowner and suppliers. From the supplier side, a technical advisor, service organizer and sales manager were interviewed. Information from service engineers was included in the observations, as well as informal discussions from yard stays. To represent the shipowner, two technical managers who were involved with these ships were interviewed.

One observation was conducted during a maintenance stay in a shipyard when the main engine was overhauled. The work involved ship engineers and participants from the shipowner and supplier. The observations lasted for 3 h and included work and informal situations, e.g. lunch breaks. Data were gathered primarily by taking notes. Observations also were made before and after interviews with the ship engineers. The interviews were conducted during port calls, and service engineers usually were on board at the same time, which allowed for informal discussions on equipment and ship performance. Altogether, the ships were visited five times over a one-year period. A sales meeting between the supplier and a potential customer regarding the new business model also was observed. The meeting comprised technical discussions and contractual details on how this business model would compare with a traditional service agreement.

Several informants were contacted for additional information. Also, during this period, two major maintenance projects were taking place on these two ships: a regulatory five-year reclassification and replacement of the main propeller gear. Collecting data over time gave the study more opportunities for authenticity, with events happening by chance at the time of the interviews. This is particularly important considering the relatively few participants in this case study. An overview of the interviews and observations in the study is provided in Table 1.

The interviews were conducted in person, except for one technical manager, who was interviewed by phone. The interviews were recorded digitally and transcribed with the approval of the Norwegian Center for Research Data (NSD Ref. No. 575487).

The interviews were analyzed thematically using NVivo software. Thematic analysis was chosen to identify underlying themes and meanings in the data, as thematic analysis is flexible and direct, with no strict data collection method or specific theoretical foundation (Clarke & Braun, 2014). This made it easier to connect the results from the interview data analysis with the results from the other data collected in this case study.

The themes identified in the data analysis were as follows: traditional work; new digital work; teams; new possibilities; communication; technical problems; and business-related. These themes' content was analyzed further, and examples of learning were identified, divided into organizational levels, translated into English, and presented in the results section below.

Results

This case study's results are presented in two parts. The first part describes the case being studied, including information gathered on the technology, shipowner's business model, and the overall maritime industry in which the case is situated. The second part comprises the results from the interviews with the key personnel involved in this case study.

The case

When the data collection for this case study began in October 2019, the two five-year-old ships had been operating with the new business model for almost three years. During the first two years of operation, the vessels operated traditionally, with the shipowner responsible for maintenance, service and spare parts. The two vessels were constructed with advanced machinery and used liquid natural gas as fuel. They were the world's most environmentally friendly freight vessels when they were launched. The two ships are the only ones in the shipowner's fleet with this business model. Control of the fuel system and main engine largely is automatic and operated with an advanced control system. During the first years of operation, several costly technical issues with both ships led to the shipowner signing a new contract with the supplier to operate the ships with a new business model.

The background for introducing this business model includes advancements in digital technology that allow the supplier to monitor the operational performance of the equipment installed on the vessels. Digital sensors monitor the ships' engines and other vital equipment, i.e. the supplier can access operational data from the engines and identify when maintenance is needed using big data and artificial intelligence. This is known as predictive

Table 1. Overview of interviews and observations

Interviews/observation	Location	Duration	No. of interviews	Experience in total	Experience these ships
Observation sales meeting	Office of potential new customer	2 h			
Observation yard stay Ship 1	Ship 1	1 h 30 m			
Observation yard stay Ship 2	Ship 2	3 h			
Observation service engineer visit Ship 1	Ship 1	50 m			
Interview chief engineer 1	Ship 1	34 m	1	30+	5
Interview chief engineer 2	Ship 1	28 m	1	10+	5
Interview chief engineer 3	Ship 2	19 m	1	8	4
Interview chief engineer 4	Ship 2	34 m	1	15	1
Ship engineer	Ship 1	46 m	2		
Supplier service coordinator	Video interview (COVID-19 restrictions)	52 m	1		5
Suppliers technical manager	Suppliers office	54 m	2		5
Sales manager	Video interview (COVID-19 restrictions)	1 h 34 m	2		5
Shipowners technical superintendent	Video interview (COVID-19 restrictions)	30 m	1	40	5
Shipowners technical superintendent	Shipowner's office	54 m	1	20	1

maintenance. A secondary effect is the possibility of introducing new business models, in which the supplier can use these data to offer new services to the shipowner.

This type of business model, often referred to as performance-based contracting (PBC), is well-known in aviation, in which the servitization of Rolls Royce™ airplane engines has been in use since the 1960s. In the present case, the shipowner pays a fixed hourly fee for use of the engine, and all spare parts, service, labor and training are included. The supplier also covers the cost of breakdowns and failures up to a specified value. This type of contract has been demonstrated in other business sectors to offer potential benefits for both the customer and supplier. Customers typically can benefit from increased efficiency, improved accountability, innovation, budget flexibility and cost-effectiveness, and the supplier can benefit from a steady fixed income (Grubic & Jennions, 2018; Selviaridis & Wynstra, 2015). The downside for suppliers is that they will be exposed to substantial economic risk (Hou & Neely, 2018; Ziaee Bigdeli, Bustinza, Vendrell-Herrero, & Baines, 2018). In our case, the increase in risk for the supplier is mitigated by using remote monitoring technology to avoid expensive repairs by identifying failures before they cause extensive damage.

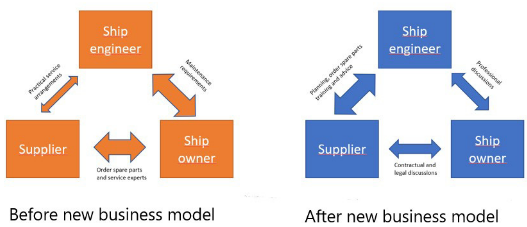
This business model elicits other important effects as well. Remote monitoring creates a communication channel between the supplier and ship engineer regarding equipment performance, which can be a source of new insights for both parties. Also, as shown in Figure 1, communication between a ship and its supplier traditionally goes through the shipowner, with limited direct communication between the ship and supplier. This restricts the relationship between these organizations to a customer–supplier type of relationship. However, with a PBC contract covering the cost of maintenance, spare parts and training, most of the communication can be executed directly between the ship and supplier, creating the possibility of a different type of relationship in which the focus can be on improving operations. As the arrow of the figure indicates, the frequency of direct interactions between supplier and ship has increased significantly.

Interviews

The empirical data from the interviews are presented here using the different organizational levels as a structure, which will make identifying examples of learning at the various levels easier.

Individual level

Over the past few decades, technological advancements have impacted ship engineers' work situation and learning methods. The use of automation and control software has transformed the work from traditional mechanical work to operating computers. "Everything is so much easier now. All the fumes and noise we endured in the engine room



Note: Size of arrows indicate the frequency of communications

Figure 1.
Communication between ship, shipowner and supplier

are now removed. We do everything from here (the control room)," an experienced engineer noted. Engineers with more experience adopted a more pragmatic and hands-on approach toward learning. The younger engineers possessed higher levels of knowledge about advanced systems, with comparatively restricted levels of hands-on learning, and the experienced engineers were concerned about this lack of mechanical training and the fewer possibilities for hands-on learning in modern engine rooms. One of the senior ship engineers expressed doubts about younger ship engineers' abilities: "I'm not sure if they know where the valves they are remotely operating are physically located." Still, the advanced systems' advantages seem clear to the ship engineers, who are proud to work on this type of ship and learn through practical experience and attend the required advanced training courses.

The possibilities for learning in the PBC contract are essential for the ship engineers. Furthermore, the ability to acquire training beyond the required courses is important. One engineer stated, "I have taken the required courses for the gas system twice since I started, but this is the new contract – if we did not have it, nobody would tell us to go to courses. It would have to be the shipowner who decided it would be beneficial and pay for it. Now, if you need a hydraulics course, you just sign up for it." The number of training courses that the engineers take is also very individualized. One of the engineers said he was only taking the required courses to maintain his certification: "There is just too much going on at home to go to extra courses now."

Group level

The PBC contract with the supplier's service engineer has been a significant change for the ship engineers and their opportunities to learn by discussing issues and concerns directly with the supplier. One engineer noted, "If we have problems, we have a contact number, and they ask what our problem is: Is it the main engine? Bow thruster? Or winches? The only problem is that PBC does not include all the equipment on board. PBC is great for us engineers. It is 24/7. If you have a problem, they are obligated to help you."

A monthly status report is sent out to the ship engineers and shipowner that provides current operational trends in the machinery. Discussions sometimes are held between the shipowner and ship engineers on the execution of maintenance after a report is released. Still, the view generally is that it is a beneficial feature, as one of the engineers noted: "It is useful. We can identify many things out here, but they have access to more than we do and are much better at identifying a root cause of problems."

Maintenance and ordering of spare parts have changed substantially since the introduction of the PBC contract. Previously, the ship engineer and technical superintendent at the shipowner's office would discuss maintenance and when components needed changing. Also, the number of spare parts kept on board had been a question of economy vs contingency, but since PBC was introduced, the ship engineers order spare parts and services from the supplier directly with a written justification for needs, with the shipowner copied on the order. This makes a substantial difference in ship engineers' daily work. They now can use their knowledge and what they have learned to justify the need for service or spare parts. When asked whether the supplier ever rejected one of their orders, one of the engineers stated, "No, but we have never asked for something that wasn't justified either. This works really well, in my opinion."

The ship engineers viewed this remote interaction with monitoring personnel positively. As one engineer noted, "They never point any fingers. They are just focused on the operation of the machinery, the same as we are. If they spot something we have missed, it is good for everybody." All the interviewed engineers stated that more interaction with the monitoring personnel was positive, as they could verify and discuss their observations and thoughts on the best way to operate the monitored machinery.

On the supplier side, the contact personnel described the introduction of PBC as a continuous learning process. One technical staff member said, "We need to think completely differently regarding PBC. We are not earning money by selling parts anymore." The supplier said that it has taken some time to adjust to this change in mindset from merely selling parts and services to being more involved with ship operations. One of the technical staff described it this way: "It is difficult to keep the customers that have a PBC contract separate from the ordinary customers, especially for the departments that have infrequent contact with the PBC customers." Also, the additional work for the supplier in a PBC contract has increased workloads for key personnel. However, the supplier does not view this extra work as entirely negative because they can learn more from their customers, but the increased interaction was not expected: "We expected an increase in communication and contact at the manager level, but not that the ship engineers should be that interested in contact with us," a PBC sales representative said.

Organizational level

The shipowner's technical managers were disappointed somewhat in the results from the remote monitoring. They had high expectations that this would benefit maintenance planning, but few practical benefits were observed. They believe the reason for this concerns the resources required for continuous monitoring of engine parameters. They receive reports in retrospect, but using the information for learning in daily operations is difficult. They said that the solution would be for the supplier to use more resources for monitoring and be more involved in day-to-day operations. The technical managers also commented on the technological solutions used on these vessels, including the use of liquid natural gas for fuel. They feel that the supplier should handle large maintenance operations. Thus, the technical management recognized the PBC's role and usefulness in these major maintenance operations, but questioned its usefulness in daily operations and maintenance. They concluded that managing the vessels is confusing and challenging when only part of the operation is covered under the PBC contract; therefore, they must keep track of all the maintenance on board, including what PBC covers.

According to the supplier, most of the daily communication takes place between the ship engineers and supplier. Contact with the shipowner's office occurs mostly during planning yard stays and when contract details need clarification. One of the technical advisors with the supplier stated: "We are much more involved with the operation and planning of larger maintenance work now than we normally do, and we are not really used to this." This was not viewed as unfavorable, and they also said they learned a lot from communicating with the ship and shipowner, which is helpful in other projects. During the first years of the contract, feedback from the customer to the supplier was very good, and the collaboration around solving technical issues was the focus for both organizations. However, the supplier said that several issues surfaced with the ships related to new technology and a quality problem in the yard where the ships were built.

After the PBC contract had been in service for some years, the shipowner filed some complaints concerning maintenance planning with PBC and synchronization of equipment maintenance outside of the PBC contract. One case entailed a major equipment failure that the PBC contract did not cover, which led to the ship being out of service for weeks. The supplier did not use this time well to perform maintenance due in the upcoming months. In response, the supplier set up a database mirror for the shipowner to use for planning equipment maintenance outside of the PBC contract.

Both vessels underwent a major maintenance program during the case study, including replacement of a troublesome main gear, which took a significant amount of planning between the shipowner and supplier. Although unexpected issues surfaced, they were resolved, and both parties viewed the program as a success. In the program's aftermath, the supplier arranged a workshop in which the shipowner, supplier and shipyard identified lessons learned and what could be improved for future yard stays. The technical superintendent stated, "I don't think this would have happened without the PBC agreement."

Discussion

This case study identified a turning point in the operation of these ships when the shipowner chose to introduce a new business model in response to reliability and cost issues, which entailed operating the ships with new technology. One choice available to the shipowner was to send the onboard personnel to training courses or hire more technical experts in the shipowner's office who could advise on operational issues. This would have been an example of single-loop learning to try and solve problems within their existing governing system (Argyris & Schön, 1978). The chosen solution included changing the business model, so that the supplier participates in the ship's operations and shares the operational risk for failure, an example of double-loop learning by changing the governing factors (Argyris & Schön, 1978). Not only were the imminent cost and reliability issues resolved, but the economic barriers between the organizations also were removed, setting a new stage for interorganizational learning. The shipowner's move also can be viewed as an example of choosing interactive learning over passive learning (Lane & Lubatkin, 1998). When the new business model let the supplier use its skills and knowledge to improve the ships' operations, a unique possibility for interactive learning arose, as they can work together to improve the ships' operations.

This case demonstrates that interorganizational collaboration is a driver of intraorganizational learning, as it provides incentives for increasing knowledge within organizations. Furthermore, the supplier's income is fixed per operational hour, thereby saving money by training ship engineers to perform more service work. The service engineers also can share their competence and knowledge freely without giving away knowledge to the detriment of their business activity.

Barley and Kunda (2001) advice, to focus on work practices and processes, proves essential to understanding the changes in action strategies and new knowledge from intra- and interorganizational learning. One of the changes in the work system occurred because the ship engineers had access to advanced training courses, which stimulated intraorganizational learning at the individual level, as well as intraorganizational learning at the group level, as the ship engineer could use newly acquired knowledge in discussions and through collaboration with the supplier's service engineers. The service engineers, in turn, had a new opportunity to discuss technology freely with the ship engineers without needing to charge for their services (which would have been a factor limiting their contact). From these interactions, the ship engineers could use the service engineers' specialized knowledge of the digital systems to assess what was necessary for their specific context. Simultaneously, these discussions with the ship engineers allowed the supplier's service engineers to learn more about how their systems functioned in specific contexts and better understand their application in practice. Such interactions among actors belonging to different formal organizations were signs of learning as a community (Brown & Duguid, 1991).

However, these communities spanned organizational, occupational and physical boundaries, creating complications for their role as learning catalysts. Following the theories of communities of practice, the three features of work practices that Orr (1990) highlights – narration, collaboration and social construction – are connected tightly to tacit knowledge that is challenging to share with organizations outside of the community (Ribeiro, 2013). When the community comprises members from different organizations, this becomes even more challenging. As a result, knowledge at the individual and group levels does not necessarily create learning at the organizational level. This seemed to be the case in this study, as the shipowner and supplier did not recognize the learning from ship engineers and service engineers that occurred at the organizational level. There are few indications that the combination of skills and knowledge was used to improve the organizations' formal systems and procedures. This study's examples of interorganizational learning are found primarily at the individual and group levels. The identified learning at the organizational level predominantly is practical and can be classified as single-loop learning (Argyris & Schön, 1978). For instance, the supplier mirroring the maintenance database of the shipowner to keep track of maintenance scheduled for equipment outside the contract can be viewed as single-loop learning.

According to Argyris and Schön's (1974) theories of action, changing ship engineers and service engineers' actions through this new knowledge would require changing governing factors. The governing factors for ship engineers often are found at the organizational level, in which procedures, responsibilities and strategies are created and implemented. Therefore, from such an interpretation, learning at the individual and group levels is valuable to the organization only if it is identified, absorbed into the organizational systems and able to direct future actions. However, the case indicates that much of the learning that took place at the individual and group levels was not implemented at the organizational level. Still, it was critical for successful operations and benefited both organizations. This can be connected to the case presented in Orr (1995), in which intraorganizational learning at the individual and group levels was critical for the organization's successful operation. However, the learning's nature made it most valuable at the collective level, and taking steps to implement it at the organizational level could counteract it. Thus, one can argue that learning that occurs at the individual and group levels among organizational members can affect the organization's operations permanently and is crucial for its success, even if it is not implemented in the organizational systems.

Interorganizational collaboration can be viewed as internalization, from Holmqvist's (2004) perspective, as it primarily stimulates learning within the involved organizations. The learning catalyst was the outside organization's contribution; thus, the interorganizational aspect can be viewed as a fourth level of learning (Crossan *et al.*, 1995). Going back to the question of how to understand this fourth level, the case suggests that it needs to be viewed as a level that stimulates the other three and is difficult to single out as a separate dimension.

This case presents few signs of learning at the organizational level that can support the increased performance expected when using a PBC contract (Selviaridis & Wynstra, 2015). One explanation could be that individual and group learning were not recognized at the organizational level. This can be explained by Mariotti's (2012) deutero learning process, in which the organizations did not succeed during the last deutero learning process. The partners have learned to collaborate, e.g. learned to share knowledge, but they have not learned how to create interorganizational learning. Mariotti (2012) describes interorganizational learning as something that exists outside of the organizations and a learning process that goes beyond knowledge transfer. The last deutero process, learning to create interorganizational learning, can be viewed as a learning process in which the organizations learn to take advantage of their common repertoire of experience and know-how. The final deutero process also can be viewed as learning that can happen only between organizations at the organizational level.

A different explanation for the lack of learning at the organizational level can be that interorganizational learning is a slow and complicated learning process (Holmqvist, 2009), i.e. the three years of operation were perhaps not enough to develop learning that involved the organizational level or learning that the organizations' management could recognize as strategic actions. This also can be linked to the contextual situation presented in this case study, in which the shipowner began a collaboration as a strategy to cut costs and reduce operational risk, i.e. its expectations of the collaboration's outcome limited its ability to learn, identify and use knowledge.

Conclusion

The literature on interorganizational learning often discusses the concept on its own, separate from intraorganizational learning. From such a perspective, the presented case would not be evaluated as successful necessarily. Few observable signs indicate bidirectional learning in the organizational systems, but when approaching this case with an emphasis on work practices and processes, it becomes evident that interorganizational collaboration stimulates intraorganizational learning at different levels, which is critical for operational success.

Furthermore, most intraorganizational learning presented in this case can be linked to interorganizational influences. As such, it can be understood and defined as interorganizational learning. Individual learning for the ship engineers primarily is viewed as the result of direct learning from courses that the suppliers provided. Also, members of both organizations gain skills and insights into the technology through increased contact and communication. Group learning is also a result of increased collaboration and collective activities that the new business model introduces. The case provides examples of learning at the organizational level, although these examples are less apparent.

These findings have implications for theoretical discussions on interorganizational learning. First, they imply a need to view the interdependent relationship between organizational levels. Second, other criteria for what comprises learning must be adopted. If work practice is viewed as mirroring manifested evidence of learning, this demonstrates the value of a practice-oriented approach to intra- and interorganizational learning. However, as mentioned in the theoretical section, choosing one perspective will elicit some questions and place others in the background.

Part of the explanations as to why bidirectional learning is less visible might be that the organizations entered into the collaboration with an emphasis on solving technical issues. This point also contributes to the current literature on interorganizational learning, as it suggests a wider reflection on the significance of the type of organizational collaboration. In the present case, interorganizational learning's potential was not an articulated motivational factor in choosing to enter into the collaboration. Nevertheless, the case indicates that this collaboration within both organizations stimulated intraorganizational learning. Suppose the organizations had entered the partnership with the intention of gaining a competitive advantage by collaborating. In that case, it is likely that capturing and implementing learning at the organizational level would be more prominent. It is also possible that learning at the organizational level will happen over time as the relationship matures.

Limitations and future research

A case study's strength is its ability to make in-depth investigations to study concrete processes regarding connections between work practices and learning. However, a significant limitation in a case study's design is the strong link to the particularity of the given time and place of the chosen setting. Because interorganizational learning has been demonstrated to be a complex and slow process, it also might be beneficial to adopt a longitudinal study to investigate the learning process. Another promising approach would be to use the lessons learned from intra- and interorganizational learning in other empirical contexts.

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Corresponding author
Bjarne Pareliussen can be contacted at: bjarne.pareliussen@ntnu.no

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