Maritime Transport Research 3 (2022) 100053

Contents lists available at ScienceDirect

Maritime Transport Research

journal homepage: www.sciencedirect.com/journal/maritime-transport-research

Green shipping networks as drivers of decarbonization in offshore shipping companies

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ARTICLE INFO

Keywords:
Green shipping networks
Decarbonization
Offshore shipping
Clusters
Maritime sustainability transition

ABSTRACT

Within the next 30 years, shipping companies must find their zero-emissions route. However, there is no consensus on which technologies and fuels are the most appropriate to decarbonize shipping. Shipping companies are now navigating the flows of trends and new technologies and fuels. At the same time, the "cluster trend" raises expectations that "green networks," "green clusters" and "cleantech clusters" will aid sustainability transitions. This qualitative multiple case study of three Norwegian offshore shipping companies analyzes the drivers that shape the companies' strategies to reduce greenhouse gas emissions, with particular focus on how the strategies are impacted by membership in green shipping networks. Process tracing is used to track the case companies' approaches to emissions reduction from 2008 to 2020, the main drivers of emissions reduction, and whether changes in strategy are linked to network membership. This study finds that the main drivers have been initiatives by internal key persons, participation in voluntary programs, mandatory regulations, and customer demand. The analysis shows no major shifts in strategy after joining a green shipping network; however, it does show two ways that network membership may impact the way shipping companies work with emissions reduction. First, membership can lead to adjustments and smaller changes as shipping companies collect information about new trends and technologies. Second, one-on-one guidance and support for preparing funding applications from network administrations may lead to the adoption of zero-emissions technology or fuels.

Introduction

Greenhouse gas emissions from international shipping are to be reduced by at least 50% by 2050 (International Maritime Organization, 2018). This goal cannot be reached with today's fossil fuel technology alone, but requires new technologies and fuels (International Chamber of Shipping, 2020). However, there is no consensus on which technologies and fuels are the most appropriate to decarbonize shipping. The current situation for shipping companies is therefore one of great uncertainty. Shipping companies are now monitoring technology development in order to meet current and future demands for emissions reduction. One way of accessing information is by joining networks and clusters.

In the past decade, formal green shipping networks have emerged in several countries. This can be seen as a result of a "cluster trend" produced by innovation policy based on theories about innovation and clusters (Normann and Fosse, 2013). A key advantage of network organization is the ability to disseminate and interpret new information, and this is what makes networks well-suited to cope

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https://doi.org/10.1016/j.martra.2022.100053
Received 1 September 2021; Received in revised form 19 January 2022; Accepted 27 January 2022
Available online 14 February 2022

with change (Powell, 1990). Networks and clusters are increasingly used as policy tools to enhance regional economic development (Hatch et al., 2017; McCauley and Stephens, 2012), and there are high hopes that such initiatives can aid sustainability transitions. Also, vast public and corporate funding is awarded to the creation and advancement of environmental networks. For example, in the Norwegian national budget of 2021, the public–private partnership named "the Green Shipping Programme" was granted 2.6 million euros. Because of the strong belief in network organization and clusters, accompanied by public spending, it is necessary to understand how they function and query whether they are effective in sustainability transitions.

Although a system shift is required to decarbonize the maritime sector, it is the shipping companies that ultimately must make the decisions to adopt new technology and manage own emissions. This article investigates the drivers that impact the shipping companies' choices to change their emissions reduction strategy, with particular focus on membership in green shipping networks as drivers of decarbonization, by asking: *How does membership in green shipping networks impact individual shipping companies' strategies for the reduction of greenhouse gas emissions?* Strategy is here defined loosely and may materialize in, e.g., plans, processes, targets, reports, procedures (Sæther et al., 2021) and decisions. Actual emissions reduction is not measured, but Sæther, Eide, and Bjørgum (2021) find in a study of Norwegian shipping companies that there is a strong relationship between having a green strategy and emissions reduction.

By using the process tracing method in an in-depth case study of three Norwegian offshore shipping companies, the companies' strategies for emissions reduction in the years 2008-2020, and how the companies involve in green shipping networks were traced. First, the main drivers of strategy change were identified, and then the ways the companies were impacted by being involved in green shipping networks were studied in more detail. Although it is found that network membership has not led to major shifts in strategy, the analysis uncovers two ways in which it may indeed support decarbonization: First, gathering information in network events and then sharing them internally, followed by internal discussions about emissions-reducing methods, may lead to smaller changes or indirectly strengthen the strategy. Second, when a network offers one-on-one guidance and support in preparing a funding application, this may be decisive for the introduction of zero-emissions technology in a shipping company, and thus potentially have a large impact on the company's emissions reduction strategy.

The article offers insight into how shipping companies think about decarbonization and adds to the knowledge about how green networks contribute to the maritime sustainability transition. To better understand existing green shipping networks, the article draws on literature from network organization theory and research on green clusters. Network organization theory emphasizes knowledge transfer as a central trait of network function, but little attention has been given to how knowledge is transferred and used. This article contributes to the literature by demonstrating how knowledge is diffused from networks to members in three cases. It also draws on the growing literature on green clusters and cleantech clusters, as it aids understanding the thinking of green shipping networks and how sustainability networks can accelerate transitions. Little attention has been paid to micro-level processes and their effects in green cluster research (Andersson et al., 2019). This research contributes by showing what kind of business strategy changes successful knowledge transfer can lead to. It is suggested that information that is actionable and specific to the individual members is more likely to be beneficial. In fine, the proposed process of knowledge transfer and implementation (Fig. 5) benefits both network theory and cluster theory.

Contextual factors

This study focuses on the offshore shipping segment within the Norwegian context. Maritime industry as historically been of major importance to Norwegian economy. It is the second largest source of export income (only surpassed by oil and gas)(Helseth et al., 2020). The Norwegian maritime industry covers enterprises in the complete value chain (Norwegian Ministry of Trade, 2020), including specialized and technologically advanced equipment suppliers. The Norwegian fleet is thus characterized by advanced vessels (Bergek et al., 2021), and the maritime industry innovates and produces specialized equipment.

Norway is considered a leader in maritime decarbonization. The Norwegian government has set a goal to reduce emissions from domestic shipping and fishing by 50% by 2030 (Norwegian Ministry of Trade, 2020). It has introduced a broad set of policies for decarbonization of shipping, with quite generous funding schemes for research, innovation, and market uptake[1]. A result has been high research and development activity within battery electric technology and other types of zero-emissions technology (such as solutions for utilizing hydrogen and ammonia as fuels), which have been tested in collaborative projects involving research institutions, shipping companies and other industry actors (Bergek et al., 2021). The state supports collaboration in the industry, and among government and industry organizations. Research on the Norwegian maritime sector reports a culture of collaboration and willingness to share information and knowledge, also across shipping segments (Bergek et al., 2021; Sæther and Moe, 2021).

The maritime industry also works actively towards decarbonization. The Norwegian Shipowners' Association aims for a climate neutral fleet in 2050 (Norwegian Shipowners' Association, 2020). The combination of an active state and a forward leaning industry has produced a favorable environment for innovation. The general narrative among industry leaders is that the actors in the national value chain are strongly dependent on each other to be able to keep a leading international market position, and will profit from being an environmental technology leader.

The offshore shipping segment was chosen for this study because it has been attentive to emissions reduction for about 10 years, and there are available emissions reduction measures (batteries, liquid natural gas (LNG) fuel, operational measures, etc.). The

[1] Bjerkan et al (2019) provide a useful overview of the relevant funding schemes.

offshore segment is responsible for 23% of CO_2 emissions from Norwegian domestic shipping (Norwegian Ministry of Climate and Environment, 2019), and the government has recently committed to demand emissions reductions from the offshore fleet (Norwegian Government 2021).

Offshore shipping companies are defined as "owners and operators of supply vessels, anchor handling vessels, construction support vessels, seismic and other offshore-related specialist vessels, and subsea contractors" (Norwegian Shipowners' Association, 2014). Norwegian offshore shipping companies experienced tremendous growth in the years 2004–2013 (Norwegian Shipowners' Association, 2014), but were then hit hard by the oil price plunge in 2014, seeing layoffs of staff and lay ups of ships. Several companies are today in the process of debt restructuring due to many years of poor revenues. As uncovered in this study, the poor financial situation in some companies hampers their ability to adopt new emissions reduction technology. Despite this, the industry has produced several important innovations for emissions reduction. In 2003, the platform supply vessel (PSV) Viking Energy, owned by the shipping company Eidesvik, became the first cargo vessel using LNG. PSV Viking Lady, also owned by Eidesvik, became in 2010 the world's first vessel to use fuel cells for on-board power (Norwegian Shipowners' Association, 2014). A consortium of industry actors is now working on an EU Horizon 2020-funded research project to retrofit Viking Energy to run on ammonia (E24, 2020).

While the technology for zero-emissions fuels is not yet mature and ready for use in offshore shipping, shore power and batteries onboard are becoming the mainstream on offshore vessels. Hybrid propulsion by using batteries on offshore support vessels can reduce greenhouse gas emissions (measured as CO2 equivalents) by 20% when operating in the North Sea (Lindstad, Eskeland, and Rialland, 2017). In this article battery installation for hybrid propulsion is therefore not regarded as a zero-emissions solution for offshore shipping. The use of the terms zero-emissions technology and fuels refers here to the utilization of energy carriers that do not lead to greenhouse gas emissions, such as ammonia and hydrogen (when produced without emissions).

Green shipping networks

Networks are here defined as "groups of three or more legally autonomous organizations that work together to achieve not only their own goals but also a collective goal" (Provan and Kenis, 2008). Green shipping networks are therefore here understood as intentional ways of organizing collective action over time with the aim of reducing greenhouse gas emissions from shipping. Such networks may be known as clusters, forums, public–private partnerships, or initiatives. In Norway, the context of this study, there are four formal green shipping networks with decarbonization of shipping as the goal. Table 1 presents key characteristics of three of them. The fourth is excluded because it was established as late as 2019, shortly before this study was started.

Sources: The information is gathered from the web pages of the networks in June 2021: https://maritimecleantech.no; https://greenshippingprogramme.com; https://www.maritimebatteryforum.com.

The networks are formal in the sense that they are purposefully established, and have defined goals and their own resources

Table 1
Key characteristics of the three green shipping networks.

	NCE Maritime CleanTech	Green Shipping Programme	Maritime Battery Forum
Members	122	80	54
Established	2011	2015	2014
Administration	Yes: 10 employees	Yes: 2 positions	Yes: 1 position
Purpose/ vision	Vision: "World-Leading Cluster for Clean Maritime Solutions" Main goal: "NCE Maritime CleanTech shall strengthen the cluster partners' competitiveness by developing and launching innovative solutions for energy-efficient and clean maritime activities"	Vision: "Establish the world's most efficient and environmentally friendly shipping." Main goal: "The Green Shipping Program's overall goal is to contribute to feasible solutions that ensure efficient and environmentally friendly shipping to achieve the national and international climate goals."	Purpose: "Promote battery-based value creation and make batteries a success within the global maritime market" • Keep members up to date • Exchange knowledge and experiences • "MBF promotes the members' interests and ambitions to become world leading in their respective fields activity towards a sustainable maritime industry with green growth."
Technological scope	Not technology specific	Not technology specific	Battery technology
Funding	Funded by Innovation Norway (public) and members	Funded by the Norwegian government and members	Funded by members
Network activities	Annual conference Member workshops Thematic seminars and events Subgroups Pilot projects Newsletter	Member meetings Thematic seminars and events Subgroups Pilot projects Newsletter	Annual conference Member meetings Thematic seminars Webinars Projects and initiatives Ship register Regional satellite hubs (Asia & America)
Network type	Cluster organization.	Public-private partnership.	Forum

(Musiolik and Markard, 2011). Further, all three networks have formal membership agreements, decision-making bodies, membership fees and member meetings. The members are from the private and public sector, and from academia and research institutions. Maritime CleanTech and the Green Shipping Programme are more extensive than the Maritime Battery Forum in size, technological scope, the size of network administration, and activities. The two also lobby policymakers (Hessevik, 2021), and are recognized as policy instruments in the government's action plan for green shipping (Norwegian Ministry of Climate and Environment, 2019).

Network organization for sustainability transitions

Research on networks is more relevant than ever, as actors are seeking together in networks to act against climate change. Two strands of literature will be presented, that are useful for understanding the effects of networks mentioned above. First, literature on network organization from organization theory, and then the more recent literature on green clusters. These literatures are developed within different disciplines, but it is proposed here that the older network literature from organization theory can fruitfully inform contemporary literature on green clusters, as it depicts how information flows in network structures.

Network research boomed in sociology and organization studies in the 1990s (Borgatti and Foster, 2003), and yielded conceptualization of network types, properties, and outcomes (for a thorough review of the network literature see Brass et al., 2004). This literature endorsed the concept of networks as a fruitful way of understanding basic mechanisms of economic activity, and networks became understood as fundamentally different from organization and market (Ahrne and Brunsson, 2011; Granovetter, 1985). In its essence, the concept of network directs the attention to the relationships that are linking actors in a formal or informal way.

Actors' motives for cooperating through networks are to "acquire resources, reduce uncertainty, enhance legitimacy, and attain collective goals" (Brass et al., 2004). Sharing of information and transfer of knowledge are recognized merits of networks, and it is particularly beneficial for technology-dependent organizations: As each individual organization has limited resources, other network membership may give access to crucial information and expertise in new technologies that the organization cannot mobilize internally (Ahuja, 2000; Powell, 1990). Moreover, Powell (1990, p. 304) notes that "networks are particularly apt for circumstances in which there is a need for efficient, reliable information," and when the environment is uncertain. He indicates that the flow of information in networks is of a different quality: Kaneko and Imai (1987, in Powell 1990) propose that information that flows in networks is "thicker" than in the market and "freer" than in hierarchies.

It is the relational structure of networks that provides transfer of knowledge and information. Inkpen and Tsang (2005) posit that "knowledge transfer manifests itself through changes in knowledge or performance of the recipient unit." Brass et al. (2004) review the effects of knowledge transfer, and show that such transfer results in imitation of other organizations and new innovations. They state that "networks speed up diffusion, even of practices that are widely known. Thus, networks do not cause adoption of practices solely through awareness. Network ties also provide information on costs and benefits of adoption at a greater level of detail and persuasiveness than other information sources do."

One type of network that has become important for sustainability transitions is cluster organizations. In this article it is argued that cluster organizations can be seen as types of networks, because network thinking is central to how they organize to obtain their goals. Cluster organizations are created intentionally and developed strategically and are therefore constructed networks (Rubach et al., 2014, 2017). A recent strand of literature, which builds on cluster theory, is up to date on analyzing the development of clusters working for sustainability transformations (Cooke, 2015; Davies, 2013; Hatch et al., 2017; McCauley and Stephens, 2012; Sjøtun and Njøs, 2019; Tvedt, 2019). This cluster literature puts less emphasis on the traditional cluster theory's premise of co-location (e.g. Porter, 1998), production and firm expansion, and more on collective knowledge production and diversity of organizations (McCauley and Stephens, 2012; Tvedt, 2019). Clusters are in this view understood as "transformative agents of change towards a green economy" (Hatch et al., 2017, p. 67). Such cluster organizations are strategically designed networks, and often funded by public cluster programs. The cluster literature is relevant in this study because the green shipping networks mentioned in the introduction use cluster thinking when they consciously build the networks to include a diverse set of actors and pool their resources to find new solutions and break barriers in order to decarbonize shipping.

Traditional cluster theory gives little attention to micro-level processes on an organization level (Andersson et al., 2019). Rubach et al. (2014) study one case of a constructed cluster. Although it is a vital cluster with high activity, they find that cluster activities focus almost solely on the interorganizational dimension and that members to a very limited degree internalized new business opportunities. They conclude that there are "missing actions to enable organizational learning and innovation in companies" and that the companies in the cluster reported "only minor impact or changes in the way of doing business" (p.22). In a thesis on the same topic, Rubach, (2011) pointed out that "just bringing something new back to one's own organization doesn't mean it will be used, since this often remains decoupled from the value creating, daily activities in the company" and suggested studying the internal processes of network members to see whether and how transferred knowledge can be put to use.

Materials and methods

The study is a qualitative multiple case study of how network membership impacts company strategy. Process tracing method is used, which implies "analysis of evidence on processes, sequences and conjunctures of events within a case […]" to examine hypotheses about causal mechanisms (Bennett and Checkel,2015, p. 7). A case-based approach to process tracing is applied (Beach and Brun Pedersen, 2019). This approach does not seek to explain variance in variables between cases, as in a comparative case study, but to uncover causal mechanisms within each case.

Case selection

Shipping companies were chosen as cases of network members because it is the shipping companies that ultimately must make the changes needed to decarbonize shipping. Because the contexts (e.g. sailing patterns, markets, value chains, available emissions-reducing technology) for different shipping segments (e.g. long-distance carriers, cruise ships, offshore supply ships, fishing vessels, ferries) vary considerably, the cases are chosen from within one segment, the offshore shipping segment.

The population of cases was mapped in several steps. First, Norwegian offshore shipping companies were mapped by searching the membership list of the Norwegian Shipowners' Association. Second, to keep the context similar, only companies with the main office located in Norway were chosen. Because the purpose is to understand the impact of network membership, the selected cases are all members of green shipping networks. At the time of case selection, six offshore shipping companies were members of one or several of the three well-established green shipping networks in Norway. Of the six possible cases, three were eliminated because of size, or becoming a network member either very early or late. The remaining three are chosen as cases.

The selected cases are thus offshore shipping companies with varying affiliations with formal green shipping networks. Table 2 gives an overview of the selected cases.

Data material

The data material is composed of the following

- Semi-structured interviews conducted in February - March 2020 and March 2021 (58-98 minutes). Two informants from company A and C, and one informant from company B were interviewed.
- E-mails received in March/April 2021 with responses to follow-up questions to interviews and documents.
- Articles from Norwegian newspapers published from March 2010 to March 2020, which mention the companies and either of the search words "climate*", "environment*", "emissions", or "CO2" (Atekst database). Company A: N = 591; company B: N = 545; company C: N = 783[2].
- Web page content and official documents for each company (including company policy documents, yearly reports, etc.) Company A: N = 16; company B: N = 25; company C: 8.
- Non-official documents such as sustainability reports, company policies and strategies, steering documents, and PowerPoint presentations. Company A: N = 5; company B: N = 7; company C: N = 23.
- The data were collected and analyzed qualitatively in several stages, as illustrated in Fig. 1. First, in-depth interviews were conducted and available documents were collected. After completing the coding and analysis of this material, follow-up questions were asked by e-mail, one additional interview was conducted (with informant 2 from company A) and supplementary documents were collected. That way, missing information from the first round of data collection was added and some ambiguities clarified. Both documents and interviews provided facts about company strategy, major emission reduction choices and the drivers, and were used to build the case narratives and timelines. The interviews are the main data sources for information about network participation and the internal social processes, as the documents contained little information about this.

The informants are individuals who have represented their companies in network activities. They are in middle management positions with responsibility for sustainability, technology and/or energy efficiency. They have been chosen because they have the most knowledge about network involvement and the company's emissions reduction strategy. The informants may be indirectly identifiable, and have given their consent to this. They have also approved quotations and the case narratives.

Emissions reduction strategies of the case shipping companies

Shipping company A

Shipping company A was an early mover in operational emissions reduction measures. Fig. 2 shows the temporal advancement of the company's emissions reduction strategy. The focus on CO2 emissions originated in 2008, when the company developed a database for fuel consumption. The purpose was to report emissions of NOx. "At that time nobody talked about CO2". The environmental engineer decided to include CO2 in the database because "at some point someone will ask for it". He discovered that there was considerable waste of energy onboard the vessels, and identified energy-saving measures. The first CO_2-related project, the "Green operations" program, kicked off in 2009. It aimed to establish a culture for reducing fuel consumption. Fuel-saving actions, called "green operations" were registered, and the company launched a competition among vessels to perform the highest number of green operations. In 2009, the project was regarded as innovative, and the shipping company earned great attention from politicians and the mass media. Company A has as a result from the "Green operations" campaign reduced CO2 emissions from fuel by 17% in the years 2009-2019.

In 2010, the company ordered its first multifuel ship, which could run on LNG, biofuel, or diesel, and built its own shore power

[2] Many of the newspaper articles were either duplicates or irrelevant.

Table 2
Overview of selected cases.

Cases	A	B	C
Network membership*	Maritime Battery Forum 2014-2017 NCE Maritime CleanTech 2013 →	Maritime Battery Forum 2014 →	Maritime Battery Forum 2014 → NCE Maritime CleanTech 2012 → Green Shipping Programme 2017 →
Number of vessels	Ca. 137	67	32
Main office	Western Norway	Western Norway	Western Norway
Company type	Public limited company	Public limited company	Limited company

* Network memberships at the time of case selection in 2020. After the data collection was completed, shipping company B joined another network.

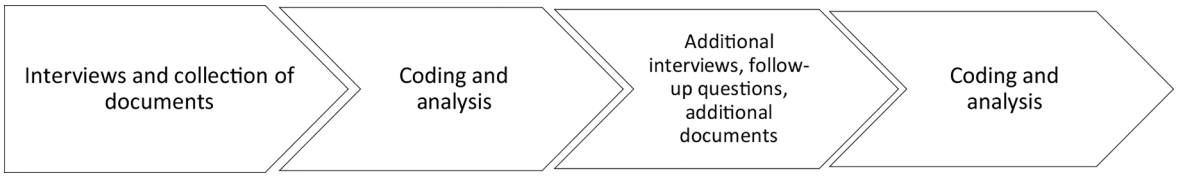

Fig. 1. Stages of data collection and analysis.

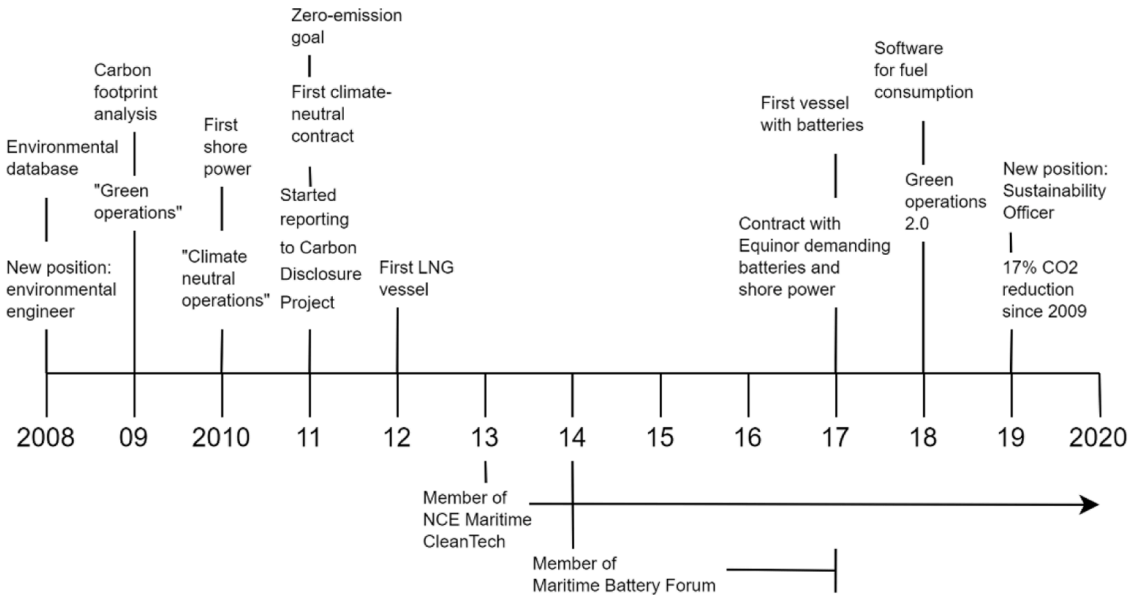

Fig. 2. Timeline of emissions reduction strategy elements in shipping company A.

solution at its base. The same year, the company started a new project called "climate-neutral operations" with the vision of becoming the first climate-neutral shipping company in the world. Climate-neutral operations were offered to clients, which entailed energy efficiency measures, protection of rainforest and emissions offsetting through the purchase of carbon credits. In 2011, the company landed its first climate-neutral contract. However, the company was unable to secure sufficient clients, and only three such contracts were signed over the next few years.

In 2013, company A became a member of the NCE Maritime CleanTech, and the year after they joined the Maritime Battery Forum. Their deepest involvement has been in NCE Maritime CleanTech: Informant 1 has been a board member since 2014. The company left the Maritime Battery Forum in 2017 due to financial reasons[3].

The electrification trend gained a foothold in the offshore shipping segment from 2014 onwards. In 2017, the Norwegian oil company Equinor (then named Statoil) issued tenders that required installing onboard batteries and the possibility for using shore power. Shipping company A won a contract, and installed a battery energy storage system on its first vessel the same year. In 2019, the

[3] Company A rejoined the Maritime Battery Forum in 2021. This is not included in the narrative because it happened after the data collection was completed.

company owned seven PSVs with battery energy storage systems and 10 vessels with shore power connection.

Shipping company A's emissions reduction strategy was for some time ahead of its competitors. Its zero-emissions target set in 2011 was radical. Protecting the rainforest and participating in Earth Hour was, and still is, unusual in the maritime sector. Although the company recognizes the need for zero-emissions technology and fuels, it was inhibited from starting new projects because of its poor financial status. The emissions reduction strategy therefore remains centered on energy efficiency and electrification. At the same time, the company expects that banks will start to ask for disclosure of emissions and that further emissions reduction may be crucial for future bank relations.

Shipping company B

Shipping company B's strategy for emissions reduction is focused on transparent reporting, energy efficiency and cultural change. The company started monitoring CO_2 emissions and reporting them to the Carbon Disclosure Project (CDP) in 2010. As a result, their first emissions reduction goal was set in 2011. The 2014 sustainability report states that reporting to the Carbon Disclosure Project has "directly influenced the development of our Business Management System and the programs established to manage our environmental performance."

The company has issued yearly sustainability reports since 2014, following the GRI (Global Reporting Initiative) standard, and lately aligned with the UN sustainability development goals. It has received high recognition for their reports, and were awarded A-rating from the CDP in 2020[4]. The first sustainability report recognized climate change and emissions to air as a strategic issue. Climate change and the 2-degree target were identified as possible drivers of new market demands, and the report stated that company B should invest in environmentally friendly energy for propulsion. Fig. 3 shows the timeline of the advancement of the company's emissions reduction strategy.

Early emissions reduction measures started with new ships built in 2008 and onwards. From 2011 on, new builds got an improved hull design for reduced fuel consumption. The same year, the company received its first LNG vessel. The year after, in 2012, the IMO (International Maritime Organization) energy efficiency regulation, "Ship Energy Efficiency Management Plan," (SEEMP), was implemented throughout the fleet.

Shipping company B chose the Maritime Battery Forum as one of its platforms for collaboration. It became a member in 2014, when the network was founded. In the following years, electrification became a part of the company strategy. Shore power was installed on the first vessel in 2015. The company representative states that "In 2016 and 2017 we saw that there was a growing focus on emissions reduction in the media and among our clients. And we saw that we could both win and lose tenders based on fuel consumption." In 2017, the company won a contract with Equinor, and as a result ordered batteries for two vessels, which were retrofitted and delivered in 2018.

The latest emissions reduction projects use digitalization to optimize energy use. In 2019 and 2020, the company installed software for monitoring energy consumption on all vessels. The company has also run its own research and development project since 2018, in collaboration with another major maritime company and two research institutions. The aim is to develop an advanced intelligent decision support system to support the operators and ship crew in planning for optimization of power use.

In 2020, company B held six ships with onboard shore power connection and two ships with onboard batteries. In the years 2013-2019, the company has reduced CO2 emissions per operational day by 15,6%. The focus remains on energy efficiency and electrification. The company is conscious that the future will demand the use of alternative fuels, but they do not have concrete ongoing projects.

Shipping company C

Shipping company C has a history of developing new technology, and innovation is central to its approach to emissions reduction. The timeline of the advancement of the company's emissions reduction strategy is shown in Fig. 4. In 2010, the company launched a campaign named "Mindset," described as the company's campaign to be at the cutting edge of technology development. The aim was "to set a new standard for the rest of the offshore industry to follow" (quote from video on website). In 2011, the company decided against using LNG technology on new vessels because of the inherent problem of methane slip. Instead, it launched a research and development project together with Siemens to create a propulsion system for optimal running of diesel engines. This project resulted in an improved diesel-electric propulsion system that has been implemented on several vessels.

Company C was several years ahead of its competitors in installing a battery package onboard an offshore supply vessel. One PSV delivered in 2013 with the new propulsion system and a battery package was presented at the time as the world's most environmentally friendly PSV. In 2020, all vessels had shore power facilities and two had battery packages[5].

Succeeding battery application, the company diversified in technology and services. In 2014, it decided after all to build three tugboats with LNG technology (delivered in 2017), after winning a contract with Equinor. In 2015, the company won a contract with Ørsted and thereby entered the renewable offshore wind sector. The renewable energy sector has since become a strategic market for the company.

[4] In 2021 company B was also announced one of "Europe's Climate Leaders 2021" by Financial Times. This is not included in the narrative because it happened after the data collection was completed.

[5] As of 2021, two more vessels have been retrofitted with batteries and the company has ordered six new vessels with batteries.

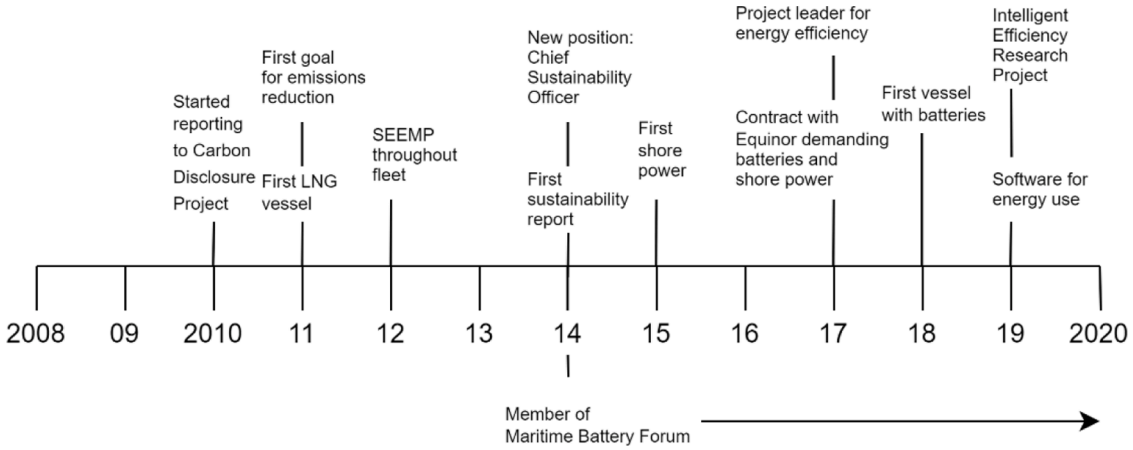

Fig. 3. Timeline of emissions reduction strategy elements in shipping company B.

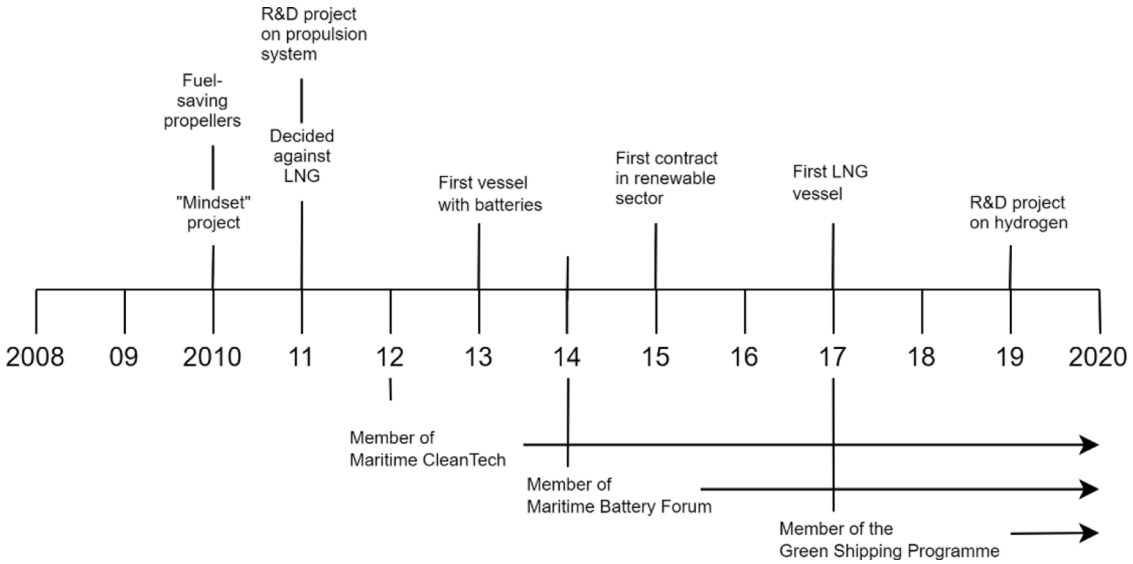

Fig. 4. Timeline of emissions reduction strategy elements in Shipping company C.

In 2019, the company announced a zero-emissions project with the aim to develop technology to utilize hydrogenated oil (LOHC, liquid organic hydrogen carriers) as fuel. The company used open access research articles to develop the project, and its representatives traveled to Erlangen, Germany, to discuss the solution with scientists. The company concluded that the technology was suitable for offshore supply vessels and service operation vessels (for offshore wind), but that a consortium was needed to take the technology further and to create the necessary infrastructure. This technology is still a good way from being ready for adoption. Nevertheless, all new builds are prepared for installing zero-emissions technology when it is ready.

Shipping company C is today a member of all the three green shipping networks. It joined NCE Maritime CleanTech and the Maritime Battery Forum in 2014 and the Green Shipping Programme in 2017. Upon joining the Green Shipping Programme, the company initiated a pilot project within the program.

Shipping company C started out by tackling emissions reduction with energy efficiency measures, but soon moved on to drive innovation of low- and zero-emissions technology. According to its website, the company is "always striving to be two steps ahead." The interview with two company representatives confirms this attitude: "This is based on an analysis of what we think is the next thing. It is clear that we are going to zero [emissions]. We can do a lot with batteries and LNG, but it doesn't take us there. […] We have to do something more than that." The informants point to the owner's high ambitions for innovation as the driving force. Together with the ability to engage with research, this gives the company good conditions to adopt new technology.

The impact of networks on company green strategies

Why and how the shipping companies engage in green shipping networks

In the interviews, the informants reported that their main motivations for joining green shipping networks were to keep abreast of the newest technologies, observe trends, monitor what their competitors do and thereby manage the risk of falling behind technologically. Other motivations for membership were to develop relations with other members, manage their reputation and access expertise on funding schemes.

Company B admits that scarce inhouse knowledge about battery technology was the motive for joining the Maritime Battery Forum: "Our motivation was very much that we were curious. We knew nothing about batteries then. We reasoned that it would be an arena where we could learn [about battery technology]."

Company C points to the same motivation in a somewhat sharper language:

> *In a way, we felt like we were forced into [the Maritime Battery Forum]. Not being a member could lead to loss of access to important information, or at least access at a later stage, after everyone else. As a member you are granted access to information before it is official and have the opportunity to contribute to important discussions."*

About joining NCE Maritime CleanTech, the representative says: "We joined Maritime CleanTech to be aligned with upcoming trends and to learn what other members were doing within such a powerful organization."

The green shipping networks have similar ways for members to be involved. First, all three networks organize conferences, regular seminars, and workshops. All the informants interviewed reported that they participate in such activities. This is linked to accessing information as a main motive. Informant 2 from shipping company A explains how such network activities usually play out:

> *Typically, you are in a hotel or other venue. It starts with mingling and talking to the other participants: 'What's new with you? This is new in our company.' And then there usually are presentations about the latest developments. The quality of the content in the activities of Maritime CleanTech has been very high.*

Second, network members may be involved in network management. One of the informants from Company A has been a board member of NCE Maritime CleanTech since 2014. The informant from company B has been a board member of the Maritime Battery Forum since 2018 and was elected chairman of the board in 2019.

Third, NCE Maritime CleanTech and the Green Shipping Programme organize subgroups and pilot projects that members can engage in. Company C has been part of the working group for green cruise ships in NCE Maritime Cleantech. They have also led a pilot project in the Green Shipping Programme.

Lastly, NCE Maritime CleanTech and the Green Shipping Programme have strong network administrations and increasingly offer one-on-one guidance and support in preparing funding applications. This function may be very important for the adoption of zero-emissions technologies, and will be elaborated on in Section 5.3.

How information and knowledge travels from networks to shipping companies

The informants were asked what they do when they get back to their offices after taking part in network activities. Informant 1 in shipping company A explains as follows:

> *[At the last network conference] there were a number of presentations. Here is an example: I pull out my camera and take a few pictures of the presentation. I believe Maersk had a presentation about sustainability that was interesting. We [are there to] see what we can learn from other companies that are ahead of us on some issues. Can we do something like that? […] [There was another presentation that was] interesting. So I took a few photos and data and shared them in the leader group. 'These are some new things that are coming up.' Discussed it with the finance section: 'These are things that we need to look out for in the time to come.'*

Informant 1. in company C does it in the same way:

> *What I typically do is that I take notes from presentations and then distribute them in-house. That way everyone gets to know a little bit about what was presented. […] Some are particularly interested, and others are more moderately interested. […] There are a few of us who are especially interested in environmental technology. I mostly talk with [colleague]. We share information and discuss issues between the two of us.*

Informant 2. in company A explains how ideas are brought back:

> *Then I usually take home [to the company] a number of ideas and talk about them to everyone who will listen. Some of us then get strengthened in the ideas we already had from before. Fuel is added to the fire. We carry on with our projects with new enthusiasm. Or maybe we consider doing something completely new that we have learned about. Usually the content is quite varied […]. Different ways challenges are solved. It can be installing batteries, or shore power or other types of fuels, or other types of motors, other ways of operating a vessel.*

The informant from company B explains how information is shared:

Usually [I share information] in weekly meetings. Or rather, the best is actually [to share information] over a cup of coffee. […] That morning chat. Five to ten minutes over a cup of coffee with colleagues. That's how we spread information. […] Often, more interesting conversations come out of these informal talks than in the weekly meetings.

So far, the evidence demonstrates that network membership does function as a relational structure that transfers information. The quotes show that the company representatives use networks to gather information about new trends and technologies and document it by taking notes and photos. When the representatives get back to their offices, they have discussions with colleagues, and the newfound knowledge is diffused within the companies, formally or informally, to leadership and particularly interested colleagues.

Impact of network membership on company strategy

The informants were asked directly (at the end of the interview or after in order not to bias the informants' reasoning during the interview) whether network membership has influenced the companies' emissions reduction strategy. The answers were ambiguous: On the one hand, none of the companies directly linked network participation to the development of their emissions reduction strategy. Company C replied that it is unlikely that the company had done anything differently if it had not been a member of networks. On the other hand, company A and B answered that network membership likely has influenced them, but indirectly. Moreover, all three companies gave examples of being indirectly influenced by network participation. The data reveal some ways that participation in a network has impacted the case companies. Based on the analysis of the data, a model is proposed that shows the processes of how network membership can have either a minor and/or indirect, or a substantial impact on the emissions reduction strategies (Fig. 5). The process model shows two separate mechanisms that link network participation to changes in strategy. In the following paragraphs the "information and inspiration mechanism" (the upper part of the model) is presented first, and the "individual member support mechanism" (bottom part) second.

Part 1 of the process lists elements mentioned by the informants as main benefits of participating in network activities. First (for the "information and inspiration mechanism"), network members get access to information about new technological innovations, trends, and regulations that are in the pipeline. Second, another main reason to join a network is to monitor what the competitors are doing, so that a company can make sure that it can compete also on emissions reduction.

The data show that the case companies joined networks primarily to stay informed about technology development. Company A acknowledges the importance of the Maritime Battery Forum: "Things we learned there probably contributed positively to the process that led to us to today having eight vessels with batteries onboard." One concrete example of how new information led to changes in the company comes from company B. Company B learned how to use battery technology more efficiently, so that utilization in certain DP (dynamic positioning) modes can affect the sizing of batteries. The representative picked this issue up at the Maritime Battery Forum and suggested taking advantage of such utilization on the company's own vessels.

Access to information and monitoring trends and competitors does not by itself lead to strategy change. Part 2 in the model describes the discovered mechanism that link part 1 to the outcome. Informant 2 in Company A stresses that becoming inspired at network gatherings is important for the determination to push the company strategy forward: "I believe there is one thing that is the most important and is very important to stress: You get inspired in such events. You get inspired to improve yourself. Read up on things. Get things to happen in your firm." Thus, the ability of network activities to inspire is an important function.

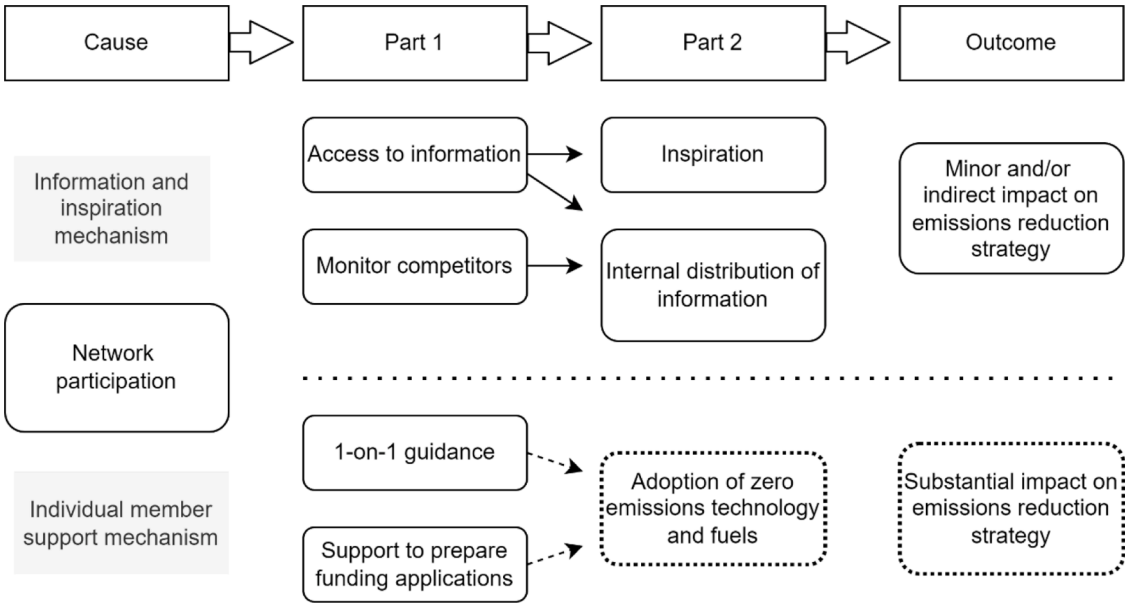

Fig. 5. Process tracing of the impact of network participation on companies' emissions reduction strategies.

After taking part in network activities, the company representatives typically discuss informally with colleagues and sometimes distribute notes and slides. In this way, information, and potentially inspiration, is diffused in the organization, at least to those who are interested or targeted by the network representatives. The network representatives in the companies all had formal and/or informal access to top management. Thus, they were all able to set forth new strategy ideas to the relevant decision-makers.

The analysis of network impact so far has only displayed minor and indirect effects on the emissions reduction strategies of the case companies; as a contributing factor to adoption of batteries, better utilization of batteries, preparing for future regulations and new technologies, and inspiration to push the work further. However, the informants reported another network function that has the potential to impact the case companies' decarbonization strategies in a more forceful way, and potentially lead to the adoption of zero-emissions technologies, for which the companies need external expertise and funding. This is presented as "the individual support mechanism" in the model (Fig. 5). It is presented as potential because the case companies in this study have not yet adopted zero-emissions technology, and the theorized process is therefore not completed. As mentioned in Section 5.2., one-on-one guidance for members is increasingly offered by NCE Maritime CleanTech and the Green Shipping Programme. The network administration sits down with individual members and evaluates the specific challenges and possibilities for emissions reduction. For example, Maritime CleanTech has acquired expertise in applying for funding for developing and implementing new technology. In 2021, the cluster hosted a meeting with several managers in Shipping Company A, where they together evaluated what kind of solutions and funding schemes were relevant for the company. At the moment, company A is not building any ships, because of financial limitations, but they envisage building new vessels in a few years. Network membership is for them a way to keep up to date on the development of new technology and alternative fuels, make future plans, and get help to implement them.

Company C has independently developed a zero-emissions project where network membership was unimportant for the initiative, but they see that they need the support of NCE Maritime CleanTech to move forward. In this case, the idea was born within the company, and it has the relevant technical knowledge, but need Maritime CleanTech for help with preparing applications for funding. This is particularly with regard to EU funding programs: "These are heavy processes, and we see that they [Maritime CleanTech] have the experience needed. To get our project started, we see that we can use them."

Such support from green shipping networks has the potential to accelerate the emissions reduction strategy work in shipping companies. First, the kind of one-on-one guidance that was offered to company A from NCE Maritime CleanTech can help members evaluate which zero-emissions technologies or projects suit the particular member, and which funding schemes are available. With individual support, the members get information that is tailored to their needs. Second, as preparing comprehensive funding applications is a complex task that individual companies are hesitant to embark on themselves, support in preparing such applications may lead to funding for company-level projects that otherwise may not have been realized.

Discussion

In the time period 2008-2020, all three companies have strengthened their strategy on emissions reduction, and in 2020, they were all aware that the future will require decarbonization, although only company C had started working on a zero-emissions solution. The case narratives reveal the main drivers of new elements in the emissions reduction strategies. What has driven strategy change in all the cases is a mix of external drivers and internal initiatives. Early initiatives have come from within the companies and focused on energy efficiency, for example the "Mindset project" of company C and company A's "Green operations" campaign. Key persons within the shipping companies have initiated new measures and innovations. Typically, these are the environmental engineers, and in the case of Company C, it is the owner that leads the vision for innovation.

With time, the internal initiatives were mixed with participation in voluntary programs and mandatory regulations. Voluntary participation in the Carbon Disclosure Project has for company B directly influenced its emissions reduction strategy. Also, implementation of the IMO's SEEMP regulation is central to its strategy, and SEEMP is implemented on all ships.

The customer demand for low emissions shipping services has had an increasing impact on the companies over the last decade. While company A failed to sell carbon neutral services in the early 2010s, company B reports a recent increase in focus on emissions among clients. The oil company Equinor has been particularly important for implementation of batteries in offshore shipping. Since 2017, the company has issued tenders that demand the use of batteries and shore power. The installation of batteries on ships owned by company A and B was a direct result of Equinor's requirements in their tenders.

Although this study has not focused on barriers, one major barrier has shown to hold back further decarbonization initiatives: The aftermath of the oil price plunge has led several Norwegian offshore shipping companies into financial crisis. Because of this, company A reported not being able to start new zero-emissions projects at the moment.

While the empirical data showed that these were the main drivers for emissions reduction strategy changes, the driver of particular interest in this study is the impact of membership in green shipping networks. The case companies' accounts are in line with the network literature's postulations that organizations' motivations for joining networks are to reduce uncertainty and acquire information and expertise that they themselves do not have, and that networks are particularly useful tools for sharing information in technology dependent industries (Ahuja, 2000; Brass et al., 2004; Powell, 1990). Further, the analysis shows that the information transfer function of the networks works well. New knowledge acquired by the companies' representatives at network events is being transferred to the companies, and reaches key persons within the networks. An added contribution of this study is therefore that is unveils how the transfer happens, which is neglected in the network literature.

But does the new information acquired through network participation lead to changes in emissions reduction strategy? At first glance, it appears that network membership has had no effect on the strengthening of strategies. The timelines and case narratives do not reveal major changes in strategy after joining a network, but rather show that new measures are connected to the other drivers

mentioned above. It is thus clear that network membership has not had an immediate and profound effect on company strategy. This means that green shipping networks do not function as tools for convincing shipping companies to radically change their strategies.

Nevertheless, the data material and analysis show that network membership can lead to a strengthened emissions reduction strategy in two ways (i.e. the "information and inspiration mechanism" and "the individual member support mechanism" in Fig. 5). First, receiving information about trends and new technologies led to smaller changes or indirectly impacted the case companies. The changes were centered on energy efficiency and electrification, which reduce emissions, but also establish an approach to decarbonization entailing incremental changes rather than a rapid shift to zero-emissions shipping. This finding resonates with Rubach et al. (2014), who found only minor impacts on the practice of individual cluster members. It is suggested here that although networks do transfer knowledge and information, the impact on members remains minor when the information that is transferred is general, and not adapted to individual members. In the cases studied here, this information was not enough to support them to make large steps towards decarbonization.

However, the analysis also reveals another way green shipping networks may impact individual members in a more profound way. The case companies report a need for individual support by the network administrations when planning for zero-emissions shipping, and some of the networks have started to provide this guidance. One-on-one guidance and support in preparing funding application may therefore in the future contribute to adoption of zero-emissions technology and fuels. Green shipping networks can therefore be decisive for individual members when they are ready to adopt zero-emissions technology.

The case companies value general information that helps them keep abreast of the trends and technological development, but the action required to go to zero emissions is still missing. The companies need advice that is actionable and specific to their operations. This analysis suggests that one-on-one guidance and support in application writing may speed up diffusion of new innovations, increase learning and create the needed action that Rubach et al. (2014) found to be missing. In this kind of interaction between network and member, the information is tailored and usable for the individual member. It is a dialogue about the shipping company's possible strategy for decarbonization, that engages the participants in a more active way than seminars and workshops. The analysis suggests that these network functions serve to couple the knowledge and goals of the networks with the strategy work in the shipping companies. Such guidance requires a resourceful and dedicated network administration with expert knowledge and that knows the needs of the individual members. It is resource intensive, but potentially very rewarding.

The collection and analysis of qualitative data has yielded a comprehensive understanding of how shipping companies involve in social processes in the quest for decarbonization. Although network participation is not a strong driver for strategy change, it plays a part in the larger context for decision-making within the shipping companies. Network participation also interacts with other drivers in certain ways: Onboard battery installation is mainly attributed to tender demands by Equinor, but membership in the Maritime Battery Forum gives the members information about technology development, which in the case of company B led to better performance. Also, the networks are fora for discussing how to be one step ahead of upcoming regulations and how to influence policymaking. Further, the optimism within the networks resonates with and also strengthens the existing engagement of the engineers to act. In the words used by informant 2 in company A, inspiration and new enthusiasm raise the efforts for improvement. This means that the company representatives are not neutral actors whose function only is to transfer new knowledge from networks to the companies. They join network activities and return to their offices with a new assurance of being on the right path, having observed what other actors in the maritime sector do and believe. Network participation impacts the individual members by diffusing information and knowledge, and this information is "thicker" (Kaneko and Imai 1987, in Powell 1990), in that it also carries social aspects, such as what other actors think and are up to, and the awakened enthusiasm in the company representatives.

Validity and limitations

There are several limitations to this study. First, it is constrained by the limitations of the data sources. Documents and interview data can only give a certain degree of detail in tracing the process of what influences company strategy. Regarding the interviews, the informants were quite open about internal processes. However, in some instances the informants did not remember the details or talked very generally about network membership. To get close enough to be able to trace the unabridged transfer, diffusion, and manifestation of knowledge from networks to company strategy, ideally a researcher should personally observe the process as it plays out, for example through shadowing (McDonald, 2005).

Second, the study is attentive to general traits of networks and does not attempt to analyze whether different types of networks impact members in different ways. NCE Maritime CleanTech, the Green Shipping Programme and the Maritime Battery Forum have different origins and characteristics that are not extensively examined in this article. The way knowledge is transferred may vary according to network type (Inkpen and Tsang, 2005). This possibility is only addressed to a very limited extent.

Third, the scope for generalization is restricted. The case shipping companies are specific types of organizations embedded in the Norwegian context. The findings cannot automatically be generalized to other types of network members or other contexts. The selection of cases is not a representative sample of all network members, and different types of members may engage in networks in different ways (Andersson et al., 2019). The sample represents shipping companies that are of medium to large size and moderately involved in green shipping networks. It is likely that the way the case companies relate to and are impacted by networks is similar in other comparable companies in similar contexts. Strengthening the confidence in the proposed process model can be done in future research by studying more cases, starting with similar cases and then "snowballing out" (Beach and Brun Pedersen, 2019).

Conclusion

As shipping owners search for information about future solutions to decarbonize shipping, they are turning towards established green shipping networks. This study has investigated whether joining a green shipping network has an impact on the decarbonization strategy of individual shipping companies, and the relative importance of network participation as a driver versus other drivers of decarbonization. The analysis reveals that the main drivers of changes in company strategy are initiatives by internal key persons, participation in voluntary programs, mandatory regulations, and customer demands. Membership in green shipping networks is not a main driver for decarbonization in shipping companies, but nonetheless may contribute to strengthening and extending decarbonization strategies. By collecting information, monitoring new trends and what their competitors are doing, and thereby sharing this new knowledge internally, the shipping companies adjust their emissions reduction strategies. The information transfer function of networks works well, as information flows from network arenas to individual network members. However, when the information shared in network arenas is general and not accommodated to the individual member, the impact on the companies' emissions reduction strategies remains minor. There is greater potential for networks to impact the decarbonization strategy of individual members if they offer one-on-one guidance and help members with preparing funding applications to implement zero-emissions technology. This is resource intensive for network administrations but can lead to adoption of zero-emissions technologies and fuels.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

I am grateful for the feedback and support received from colleagues at the Department of administration and organization theory, as well as from a considerable number of colleagues from around the world, who have read and given comments to drafts of the article. I kindly thank the editors and anonymous reviewers for thorough feedback that helped improved the article considerably. I also thank the informants for generously giving interviews, providing data, and answering many questions.

References

Ahrne, G., Brunsson, N., 2011. Organization outside organizations: THE significance of partial organization. Organization 18 (1), 83–104.
Ahuja, G., 2000. Collaboration networks, structural holes, and innovation: a longitudinal study. Adm. Sci. Q. 45 (3), 425–455. https://doi.org/10.2307/2667105.
Andersson, G., Johansen, F.R., Rubach, S., 2019. Clustering ambiguities: how companies and public bodies develop a cluster. Int. J. Adv. Corp. Learn. 12 (1), 17–28.
Beach, D., Brun Pedersen, R., 2019. Process-Tracing Methods: Foundations and Guidelines, 2nd ed. The University of Michigan Press, Ann Arbor, Michigan.
Bergek, A., Bjørgum, Ø, Hansen, T, Hanson, J, Steen, M., 2021. Sustainability transitions in coastal shipping: the role of regime segmentation. Transport. Res. Interdiscip. Perspect. 12, 100497.
Bjerkan, K.Y., Karlsson, H., Sondell, R.S., Damman, S., Meland, S., 2019. Governance in maritime passenger transport: green public procurement of ferry services. World Electric Veh. J. 10 (4), 74.
Borgatti, S.P., Foster, P.C., 2003. The network paradigm in organizational research: a review and typology. J. Manag. 29 (6), 991–1013.
Brass, D.J., Galaskiewicz, J., Greve, H.R., Tsai, W., 2004. Taking stock of networks and organizations: a multilevel perspective. Acad. Manag. J. 47 (6), 795–817.
Cooke, P., 2015. Green governance and green clusters: regional and national policies for the climate change challenge of Central and Eastern Europe. Technol. Mark. Compl. 1 (1), 1–17. https://doi.org/10.1186/s40852-015-0002-z.
Davies, A.R., 2013. Cleantech clusters: Transformational assemblages for a just, green economy or just business as usual? Glob. Environ. Chang. 23 (5), 1285–1295. https://doi.org/10.1016/j.gloenvcha.2013.07.010.
E24, 2020. Eidesvik får verdens første utslippsfrie offshorefartøy. E24. Retrieved from. https://e24.no/hav-og-sjoemat/i/6jA0Bz/eidesvik-faar-verdens-foerste-utslippsfrie-offshorefartoey.
Granovetter, M., 1985. Economic action and social structure: the problem of embeddedness. Am. J. Sociol. 91 (3), 481–510.
Hatch, C.J., Tremblay, D.-G., Cazabon-Sansfaçon, L., 2017. The role of social actors in advancing a green transition: the case of Québec's Cleantech cluster. J. Innov. Econ. Manag. 24 (3), 63–87. https://doi.org/10.3917/jie.024.0063.
Helseth, A.M., Jakobsen, E.W., Aamo, A.W., Riiser, J.E., 2020. Maritim Verdiskapingsrapport 2020. Maritimt forum/Menon Economics, Oslo. Retrieved from. http://s3-eu-west-1.amazonaws.com/maritimt-forum.no/documents/Maritim-Verdiskapingrapport2020.pdf.
Hessevik, A., 2021. Network-led advocacy for a green shipping transformation: A case study of governance networks in the Norwegian maritime sector. Regul. Govern. https://doi.org/10.1111/rego.12386 n/an/a.
Inkpen, A.C., Tsang, E.W., 2005. Social capital, networks, and knowledge transfer. Acad. Manage. Rev. 30 (1), 146–165.
International Chamber of Shipping, 2020. The Urgent Need to Accelerate R&D to Deliver Zero-Carbon Shipping by 2050. Retrieved from London. https://www.ics-shipping.org/wp-content/uploads/2020/11/Catalysing-the-fourth-propulsion-revolution.pdf.
International Maritime Organization. (2018). *Annex 11, Resolution to MEPC.*304*(72) (*adopted on 13 April 2018*),* Initial IMO strategy in reduction of GHG emissions from ships.
Lindstad, H.E., Eskeland, G.S., Rialland, A., 2017. Batteries in offshore support vessels – Pollution, climate impact and economics. Transport. Res. Part D 50, 409–417.
McCauley, S., Stephens, J., 2012. Green energy clusters and socio-technical transitions: analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA. Sustainabil. Sci. 7 (2), 213–225. https://doi.org/10.1007/s11625-012-0164-6.
McDonald, S., 2005. Studying actions in context: a qualitative shadowing method for organizational research. Qual. Res. 5 (4), 455–473. https://doi.org/10.1177/1468794105056923.
Musiolik, J., Markard, J., 2011. Creating and shaping innovation systems: Formal networks in the innovation system for stationary fuel cells in Germany. Energy Policy 39 (4), 1909–1922.
Normann, R.H., Fosse, J.K., 2013. Nettverksstyring av klyngeprosjekter. In: Abelsen, B, Isaksen, A., Jakobsen, S.-E (Eds.), Innovasjon. Cappelen Damm, Organisasjon, Region, Politikk. Oslo.
Norwegian Government, 2021. *Hurdalsplattformen*. Norwegian Government. Retrieved from. https://www.regjeringen.no/no/dokumenter/hurdalsplattformen/id2877252/.

Norwegian Ministry of Climate and Environment, 2019. The Government's Action Plan for Green Shipping. Retrieved from. https://www.regjeringen.no/contentassets/2ccd2f4e14d44bc88c93ac4effe78b2f/the-governments-action-plan-for-green-shipping.pdf.
Norwegian Ministry of Trade, Industry and Fisheries, 2020. *Meld. St. 10 (2020 - 2021)* Melding til Stortinget. Grønnere og *Smartere – Morgend*agens *Maritime Næ*ring.
Norwegian Shipowners' Association, 2014. Norwegian Offshore Shipping Companies - Local Value Creation, Global Success. Retrieved from. https://rederi.no/rapporter/.
Norwegian Shipowners' Association, 2020. Zero Emissions in 2050. Oslo. Retrieved from https://rederi.no/globalassets/dokumenter/alle/rapporter/2020–klimarapport-engelsk.pdf.
Porter, M, 1998. Clusters and competition: new agendas for companies, governments and institutions. In: Porter, M. (Ed.), On Competition. Harvard Business Review, Cambridge, MA, pp. 212–304.
Powell, W.W., 1990. Neither market nor hierarchy: network forms of organization. Res. Organ. Behav. 12 (2), 295–336.
Provan, K.G., Kenis, P., 2008. Modes of network governance: structure, management, and effectiveness. J. Public Admin. Res. Theory 18 (2), 229–252. https://doi.org/10.1093/jopart/mum015.
Rubach, S., 2011. Company Learning in a Network: A Dual Organization-Development (OD) Process: Bridging the Learning Processes in a Network and the Local Learning Processes in the Participating Company. Norwegian University of Science and Technology, Faculty of Social Sciences and Technology Management, Department of Industrial Economics and Technology Management, Trondheim, 2011:131).
Rubach, S., Hoholm, T., Håkansson, H., 2017. Innovation networks or innovation within networks. IMP J.
Rubach, S., Johansen, F.R., Andersson, G, 2014. Missing actions in cluster innovation. Int. J. Adv. Corp. Learn. 7 (1), 17–23. https://doi.org/10.3991/ijac.v7i1.3524.
Sjøtun, S.G., Njøs, R., 2019. Green reorientation of clusters and the role of policy: 'the normative' and 'the neutral' route. Eur. Plann. Stud. 27 (12), 2411–2430. https://doi.org/10.1080/09654313.2019.1630370.
Sæther, E.A., Eide, A.E., Bjørgum, Ø., 2021. Sustainability among Norwegian maritime firms: green strategy and innovation as mediators of long-term orientation and emission reduction. Bus. Strategy Environ. 30 (5), 2382–2395.
Sæther, S.R., Moe, E, 2021. A green maritime shift: lessons from the electrification of ferries in Norway. Energy Res. Soc. Sci. 81, 102282.
Tvedt, H.L., 2019. The formation and structure of cleantech clusters: insights from San Diego, Dublin, and Graz. Norsk Geografisk Tidsskrift-Norwegian J. Geogr. 73 (1), 53–64.