Decarbonising Short Sea Shipping Operations: Examining The Efforts And Outcomes Of A Finnish Shipping Line's Relevant Initiatives

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1. ABSTRACT: Decarbonisation of maritime transport operations has become a main priority for shipping companies around the world, especially after the adoption of the Initial International Maritime Organization's (IMO) Strategy on Reduction of Greenhouse Gas (GHG) Emissions from Ships in 2018 that sets the goal of reducing the global shipping emissions by 50% by 2050, as compared to 2008.

In a similar direction, the European Union's (EU) Green Deal initiative was adopted in December 2019 and proposed, among others, the inclusion of shipping in the EU Emissions Trading Scheme (EU ETS) as an additional tool for the achievement of climate neutrality in Europe by 2050.

The most recent UN Climate Change Conference (COP26) that was held in Glasgow also increased the momentum for global decarbonisation efforts highlighting the important role and contribution of maritime transport in these overall efforts. This paper discusses the efforts and initiatives undertaken by a Finnish shipping line (Viking Line) for the improvement of its fleet energy efficiency, along with the decarbonization of its operations; initiatives that encompass various technical and operational measures along with the employment of alternative fuels and/or energy sources (such as wind power).

According to the findings, significant energy consumption reductions can be achieved at the company level from the implementation of a number of energy efficiency initiatives that presuppose a company organization model focused on sustainable development. Global and regional regulations/ guidelines definitely initiate the introduction of energy efficiency measures, but their effective implementation depends largely on the organizational structure and priorities of individual shipping companies.

Key words: *decarbonisation; maritime transport; air pollution; GHG emissions; short sea shipping; Viking Line.*

2. INTRODUCTION

Decarbonisation of maritime transport operations has become a main priority for shipping companies around the world during the last decades, as the amount of GHG emissions from shipping has increased over the years and in 2018 it accounted for 2.89% of global GHG emissions following a constant increasing trend (Faber et

al., 2020; Giziakis and Christodoulou, 2009). It is clear that, besides the vital role of maritime transportation in global trade and its fundamental contribution to societal growth and progress, the negative impact of maritime GHG emissions needs to be tackled (Sirimanne et al., 2019). Although a number of technical and operational measures have already been introduced by the IMO for the abatement of GHG emissions - Energy Efficiency Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP), and Fuel Oil Consumption Data Collection System (DCS) - the progress has not been the desired one and in 2018 the Initial IMO's Strategy on Reduction of GHG Emissions from Ships was adopted (IMO, 2018; Ölçer et al. 2018). The Initial IMO Strategy sets the goal of reducing the global shipping emissions by 50% by 2050, as compared to their 2008 level, with a vision to phase them out by the end of the century.

In a similar direction, the European Union's (EU) Green Deal initiative was adopted in December 2019 and proposed, among others, the inclusion of shipping in the EU Emissions Trading Scheme (EU ETS) as an additional tool for the achievement of climate neutrality in Europe by 2050 (European Commission, 2019). Additionally, the Monitoring, Reporting and Verification (MRV) regulation also came into force since 2018 requiring all vessels above 5000GT operating within the European Economic Area, starting of finishing their voyage in a EU port to monitor and report their emissions on a yearly basis (EU Regulation 2015/757; Christodoulou et al., 2021). Finally, the most recent UN Climate Change Conference (COP26) that was held in Glasgow also increased the momentum for global decarbonisation efforts, highlighting the important role and contribution of maritime transport in these overall efforts.

In order to comply with the evolving global and regional regulatory framework related to the abatement of GHG emissions from their operations, the vast majority of shipping companies around the world have proceeded with the adoption of a number of measures and initiatives in order to improve the energy efficiency of their fleet and reduce their carbon footprint (Brynolf et al., 2014; Wan et al., 2018). Apart from the implementation of the so-called "mandatory" measures, several proactive shipping companies have proceeded with the introduction of voluntary initiatives in order to reduce further their emissions and promote their sustainable development, but also gain a competitive advantage in the market where they operate (Lai et al., 2011; Lun et al., 2016; Christodoulou and Cullinane, 2021). The differentiation of the service and the sustainability concerns have been found to particularly impact liner shipping that operates in specific routes and trades. Even more intense is the competition and environmental concerns in the RoPax segment operating in Northern Europe, where the environmental regulatory framework is even stricter when compared with other regions of the world, with the environmental output being a crucial factor for the 'choice' of a company by its customers (Christodoulou and Kappelin, 2020).

This paper discusses the efforts and initiatives undertaken by a Finnish shipping line (Viking Line) for the improvement of its fleet energy efficiency, along with the decarbonization of its operations. These initiatives encompass various technical and operational measures,along with the employment of alternative fuels and/or energy sources (such as wind power). According to the findings, significant energy consumption reductions can be achieved at the company level from the implementation of a number of energy efficiency initiatives that presuppose a company organization model being focused on sustainable development. Global and regional regulations/guidelines definitely initiate the introduction of energy efficiency measures, but their effective implementation depends largely on the organizational structure and priorities of individual shipping companies.

1. METHODOLOGY

A case study methodology has been applied in this study for the exploration of the various initiatives implemented by the shipping line under consideration – Viking Line – for the reduction of its energy consumption and related GHG emissions. The reason why a case study method was chosen in this research, is primarily the fact that the main objective was to investigate a contemporary phenomenon in depth and within its real-life context, a phenomenon that could not have been examined outside of a specific context (Yin, 2009; Voss et al., 2002). In this case, the regulatory and the contextual framework within the company operates has played a fundamental role for the provision of incentives for the

implementation of these exact initiatives. The already existing global and regional regulations for the abatement of GHG emissions played an important role, on the one hand; the fact that Viking Line is a RoPax line operating in Northern Europe was another crucial parameter for the analysis. The various sustainability initiatives adopted by the company - encompassing different technical and operational measures along with the employment of alternative fuels and/or energy sources (such as wind power) – are analysed in this paper with the objective to provide some evidence of their potential to substantially reduce the carbon footprint of maritime transportation if effectively implemented.

In order to proceed with the data collection for the analysis of the case study, the authors first thoroughly went through Viking Line's sustainability reports and website and also gathered any information available on the news relevant to the company's sustainability initiatives. As expected, real- life and detailed practical data/information could not be obtained from these secondary data sources, so a semi-structured interview with the sustainability manager of the company was also conducted in October 2020. The sustainability manager was chosen as the most appropriate interviewee on the topic under investigation as he had a deep knowledge of the sustainability initiatives undertaken by Viking Line over the years, but he could also provide a comprehensive overview of the company's sustainability strategy. The interview lasted one hour and fifteen minutes; it was audio-recorded and took place via Zoom due to the pandemic of covid-19 travel restrictions. The interview guide was already sent out via email to the interviewee some days before to allow some time to prepare and gather the data relevant to the interview questions. Both primary and secondary data were analysed in conjunction in order to provide a chain of evidence and strengthen the data validation of this case. As proposed by Denzin (2012), one basic type of triangulation that was used in our analysis was data triangulation, including the use of multiple data sources in a single study to overcome subjectivity and establish a chain of evidence. The manuscript was also sent for review to the respondent to avoid misunderstandings and ensure that all the points were clearly and correctly presented. Figure 1 presents the data triangulation method applied in this study.

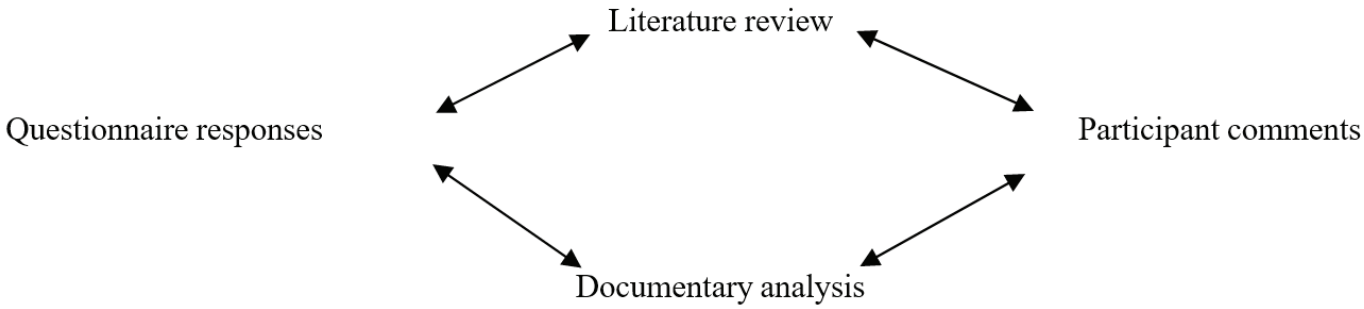

Figure 1. Data triangulation method applied in this study. Source: Authors' own elaboration

4. THE CASE OF VIKING LINE

Viking Line provides passenger and cargo carrier services using the vessels Amorella, Gabriella, Mariella, Rosella, Viking Cinderella, Viking Grace and Viking XPRS between Finland, Sweden and Estonia (Figure 2). The company owns the terminals in Turku and Stockholm and uses the various others in its short sea shipping network. All the company's vessels are certified in compliance with ISO 14001 environmental management standards and sustainability is a very important priority for the company that has already adopted various initiatives for the improvement of its fleet energy efficiency, along with the decarbonization of its operations; initiatives that encompass various technical and operational measures along with the employment of alternative fuels and/or energy sources (such as wind power). The company has also introduced a successful organization model that focuses on sustainable development and crew involvement in decision-making (Viking Line).

The efforts already undertaken, as well as the results from the implementation of the various initiatives will be presented and analysed in the coming subsections to shed light on the potential environmental benefits from their adoption, but also underline challenges related to their practical implementation.

Figure 2. Viking Line's route network. Source: Viking Line

4.1 Onshore Power Supply (OPS)

Viking Line has proceeded with the provision of OPS in 4 terminals located in Sweden, Estonia and Finland (Stockholm, Tallin, Helsinki and Mariehamn). By installing and using OPS at berthing time, the vessels do not need to use energy produced from their auxiliary engines, but they can instead use electricity from the port, significantly reducing in this way fuel consumption and emissions generated at the port area (Acciaro et al., 2014; Innes and Monios, 2018; Christodoulou and Woxenius, 2019). This installation has resulted in saving 1200 tonnes of fuel and reducing 3800 tonnes of CO2 emissions by connecting 4 of its vessels to OPS while in quay and verifies the findings from the existing literature that important reductions in vessels' emissions can be achieved from the implementation of this technology (Vaishnav et al., 2016; Winkel et al., 2016).

What is worthwhile to mention is the fact that, in the two Swedish terminals (Stockholm and Mariehamn) and Tallinn, vessels use 100% green electricity while at berth, in contrast to Helsinki, an issue creating significant differences in emissions reductions among the two cases. According to the interviewee, in the case electricity used for the provision of OPS is sustainably produced (green), there's basically no carbon footprint and the environmental benefits are not compared to the electricity coming from coal or other resources. Coming to the reasons why green electricity is not used in all terminals, the respondent highlighted that the company is engaged in talks with the terminal in Helsinki on this issue and the main reason is that in Helsinki Viking Line does not own the terminal and it is basically the port that decides where the electricity comes from.

A crucial parameter for the implementation of OPS is the installation and operational cost for the vessels that is extremely high and requires large investments. According to the respondent, Viking Line's investments in all things that went into making the short side power possible accounted for around 500 to 700,000 euros per vessel, while the ports needed to pay to install the necessary equipment from their side. There was a 30% allocation from the EU through a project in Tallinn port for the installation of OPS that was divided between Viking Line and the ports. As already mentioned by the existing literature (Zis et al., 2014), the interviewee underlined the importance of providing national subsidies to incentivize and promote the installation of OPS given the high initial capital investment required and the potential operational cost from the increased price of electricity that is needed in high loads for the provision of OPS. According to the respondent, these subsidies are essential, but not provided at the moment, because shipping's emissions are not accounted for in the national gas inventories and it consists of an easy step that could bring about a significant change and emissions reduction.

Another major drawback related to the operation of OPS is that it's usually on high loads and, as a result, it is cheaper to use bunker fuel to power the vessel as in vessels' operations there are basically very few times that the loads are so low that it would be cheaper to run on OPS. In other words, the implementation of OPS is just something that shipping companies do as part of their sustainability work, but it implies increased running (operational) cost all the time as the electricity required for OPS is more expensive than using the fuel. Additionally, due to the lack of subsidies, when using OPS the shipping companies carry the entire risk if electricity prices rise unexpectedly while their price risks for bunker fuel is quite often mitigated by signing some kind of fixed price contracts with their suppliers.

Besides the subsidies that could be offered to provide some kind of compensation for the installation of OPS, there are also port environmental discounts that reward cleaner vessels and the use of OPS consists one of the criteria for the vessels' certification with maritime environmental performance indices (e.g. Environmental Ship Index (ESI), Clean Ship Index (CSI)) that form the basis for the provision of these discounts in a number

of ports (Christodoulou, 2019). According to the respondent, Viking Line's vessels are certified with the CSI and it is feasible to get environmental discounts from ports if you have to use OPS because this technology does reduce emissions in the port area. However, the certification with the CSI also depends on other parameters (e.g. waste, chemicals) and, although OPS helps in order to receive these discounts, the costs will never be returned unless bunker fuel prices go up a lot or the electricity price comes down or there are subsidies.

4.2 Wind power and LNG conversion

Viking Line equipped in 2018 Viking Grace – a RoPax vessel operating in the Turku-Stockholm route - with a rotor sail that turned her into the world's first hybrid ship of its size to run on both LNG and wind power. The employment of LNG as a marine fuel has been initiated by the Directive 2014/94/EU that requires all core ports in the EU to build LNG refuelling points by the end of 2025 along with the provision of OPS (European Union, 2014). In this sense, this initiative could be easily related to the upcoming European regulations. According to the interviewee, Viking Grace was a RoPax vessel running on LNG fuel from the start, so there were no conversion costs. The rotor sail was installed in 2018 in cooperation with the supplier Norsepower with the installation costs being low, as it was basically an investment from Norsepower to gain experience and build their reputation. Since its installation, the progress of using the rotor sail has been tracked in order to observe if there's any reduction in the total fuel consumption because of its use. The problem is that the data obtained is not really measurable, because there's software on the engine that propels the sail and it provides information on its effectivity, but this data can't really be connected to the data on fuel consumption and the amount of reductions. This is the reason why the company is still in testing for two years although they were initially going to be testing for one year. There were plans to also have the rotor sail on Viking Glory, but because of the test they made and the traffic on the route, the company decided that it's not optimal to proceed with the installation of the rotor sail on this vessel.

Coming to the emissions reductions from the use of LNG fuel from Viking Grace, the vessel already has some 20-25 % less CO2 emissions than conventional fuel. According to the academic literature, what's problematic about the LNG is the methane slip that occurs during the combustion process (Bengtsson et al., 2012). In the case of Viking Grace, the methane slip is estimated close to 1.5%, so it's inevitable that some of the fuel goes on burnt but it's still comparatively less emissions for using LNG than for using regular fossil fuels or bunkers. Additionally, from the use of LNG, SOx emissions are reduced by 85% while NOx emissions are close to zero in accordance with Bengtsson et al. (2012), which is truly beneficial for the population located near the ports (Winnes et al., 2015).

Regarding the question if Viking Line would consider the investment in new technologies/fuels due to the introduction of the NECAs, the installation of humid air motors (HAM) is already in place in one of their vessels – Mariella – and has helped with the reduced production of NOx because the burning temperature is a bit lower, but other technologies available might also be considered to address this issue.

4.3 Construction of new vessels

Another initiative for the improvement of the energy efficiency of the company's fleet is the construction of a new vessel – Viking Glory – that is expected to use up to 10% less fuel than Viking Grace, which was previously awarded the honour of being the world's most environmentally-friendly passenger vessel in its size class. The construction of this ferry consists a huge investment as its construction costs around 200 million euros, it's been built in China and is designed to have around 10% less emissions than Viking Grace. Viking Glory will be replacing the vessel that's currently with Viking Grace on the Turku-Stockholm route – Amorella - so that we will have both these ferries complimenting each other. The Turku-Stockholm route is the most important market for Viking Line and it makes sense for the company to have two comparable vessels operating against each other and offering a product that is the most environmentally friendly way to travel from Finland to Sweden.

4.4 Energy management system

Viking Line has introduced since 2017, in partnership with the company Blueflow, an energy management system on all its vessels in order to ensure compliance

with the EU requirements for reporting CO2 emissions (MRV system); and this system has also served as a dual in the achievement of fuel savings on a daily basis. This reporting system enables the company to monitor the vessels' emissions, but has also been used as a trial by error tool to look at potential route planning changes and their effectiveness (of course it's not a proactive tool like other route planning systems that are installed on some of the vessels, basically take in account a few factors, like travel time, trim, weather conditions and then suggest routes planning). According to the interviewee, Viking Line believes strongly in these route planning systems and aims to develop them further. As these systems take into account the weather conditions, then technical conditions, the load, the trim and the wind, their application can result in significant fuel savings; when the vessel operates in the archipelago, there are obviously speed restrictions and it needs to be decided 'where do we push the brakes and where do we push the gas basically to do that optimally'. This process is very time-consuming and there might have to be some kind of artificial intelligence assisting. Stena Line for instance is applying artificial intelligence assisted pilots in one of their vessels that will be rolling out into their fleet and it remains to be seen if there will be significant reductions coming from that.

This energy management system was not costly and it basically included the installation of software into the company's automation systems, then getting screens up and running on the bridge and in the engine room. A crucial factor for the successful implementation of the system was the training of staff and crew. All the staff and crew had training that was not easy because they were working on shifts, so not everyone could be trained at once. Besides the training, the system has been designed to be really easy to understand that it would be intuitive to look at the screens with all the indicators and then to take out the reports. In other words, there's training available but the system is also so simple that a person who knows excel can operate it.

Concerning the certification of the company's vessels with ISO 50001 (energy management certification), the respondent replied that this would be something that he sees happening in the future but not right now, not in a couple of years a least, because doing these management systems and getting them really operational to the crew requires a lot of work that needs to be somehow compensated - there needs to be some kind of payoff, not necessarily purely economic. Moreover, certain aspects of ISO 50001 are more or less covered with ISO 14001 (environmental management) certification, so it would be more administrative workload in a period when administration load for the shipping companies is really heavy.

4.5 Energy efficiency improvement projects

Since 2016, Viking Line has proceeded with the investment of more than four million euros in different projects to improve the energy consumption of its vessels. The interviewee pointed out that by far the most effective investments have been in ventilation; the use of frequency converters resulted in the optimization of the engine's operation. For example, on Viking Gabriela these improvements in ventilation resulted in fuel savings of almost 600 tons per year. Similar improvements in ventilation were applied on Viking Grace, but not at full-scale, and the energy savings were equal to all the energy consumption of all the offices and warehouses of the company in Mariehamn where their headquarters is. It becomes obvious that even tiny energy improvements onboard the vessels – in this case this ventilation tweak on board the vessel - save that much energy compared to investments onshore. Concerning the amount of investments for the improved ventilation system on Viking Gabriela, it comes up to 800,000 euros with an expected return on investment in one and a half years. The most costly energy efficiency project Viking Line invested in is ventilation, but also the most effective. It was a big project that's why it costed so much and it was at the same time the hardest to implement as well.

This successful project and significant energy consumption improvement on Viking Gabriela also shows that even on old vessels there's a lot of ways that energy consumption can be optimized with the retrofitting and there's a lot of work that's been done in vague all the time on the company's old vessels. What the respondent has observed is that – on the one hand- energy consumption climbs basically because the company puts in stuff for the passengers and comfort and – on the other hand - at the same time it keep optimizing the energy consumption so a marked reduction in the total has been achieved but not of the required magnitude to have the desired effect on the

climate. According to the interviewee, the company needs to fight on both fronts: of the technical reduction of having the engines and everything operating as well as they can and then it needs to combat the climbing consumption.

4.6 New organisational model

Since 2018, Viking Line has launched a new organisation model, beginning from the vessels and continuing during 2019 with the land-based organisation. The first results from the implementation of this results-driven model are positive, according to the company's sustainability report. The interviewee commented that this new organisation model was basically a way to reorganize the company that allowed the decisions to be made closer to the operations. According to the interviewee, the main motivation behind this organizational restructure was the fact that it would be more effective if the vessels themselves that were every day close with the customers were given more responsibility and more options to decide how to improve the customer experience. He added that at the same time the new organization model allowed them to streamline the organization, but unfortunately due to the covid the company is now back in the same place again as they needed to make big cuts.

Besides the impact of covid-19 pandemic, the new organization model is quite effective, according to the respondent, with positive economic results because there's always a benefit when the people who are operating the vessels are given more responsibility to take decisions on their work. Similar positive results from the environmental auditing for the ISO 14001 certification were also seen for the years when the vessels themselves were given the responsibility of the work and they had some person on board in charge of this. Along with the economic and developmental benefits, the organizational restructure also brought environmental and energy efficiency improvements of the company's fleet. An overview of Viking Line's sustainability initiatives related to the improved energy efficiency and decarbonization of its fleet is presented in Figure 3.

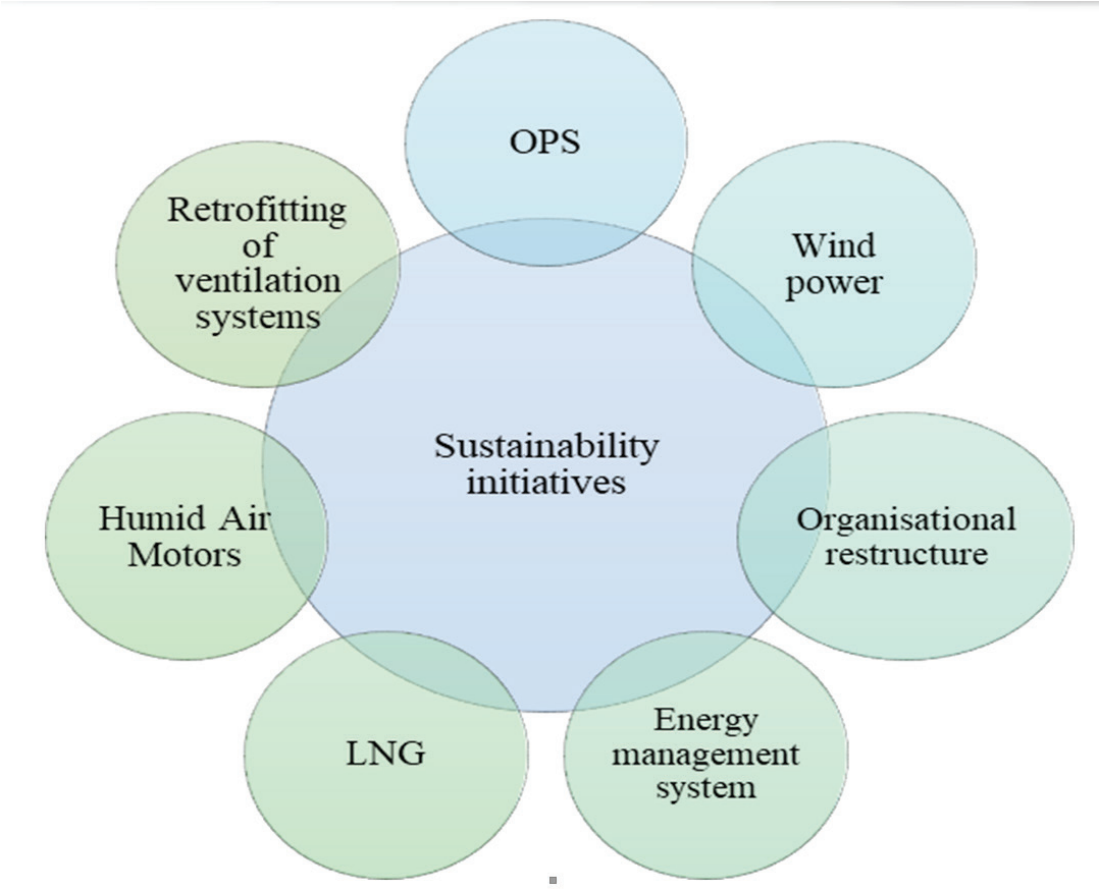

Figure 3. Viking Line's sustainability initiatives

5. DISCUSSION AND CONCLUDING REMARKS

Viking Line has implemented a variety of sustainability initiatives for the improvement of the energy efficiency of its fleet and the reduction of GHG emissions from its operations. Initiatives that range from technical measures, like retrofitting of the ventilation systems of certain vessels and the use of wind power, to the introduction of energy management system for the monitoring of the emissions and the use of LNG as a marine fuel. The company has been closely following the existing and upcoming regulations; the use of OPS, as well as LNG fuel could be considered as an answer to the relevant upcoming EU regulation (European Union, 2014). The same applies in relation to the introduction of the energy management system for the monitoring of the vessels' GHG emissions that is the company's way for complying with the MRV regulation.

Besides the initiatives driven by the relevant regulatory framework, the company has also moved forward with a huge investment that costed around 200 million euros – the construction of a new vessel, Viking Glory, that is expected to use up to 10% less fuel than Viking Grace, which was previously awarded the honour of being the world's most environmentally-friendly passenger vessel in its size class. Viking Glory is designed to have around 10% less emissions than Viking Grace that is the world's first hybrid ship of its size to run on both LNG and wind power with the emissions reductions from the use of LNG fuel being some 50% lower CO2 emissions compared to the conventional fuel.

The organizational restructure of the company has played an important role for the effective implementation of all these initiatives and brought environmental and energy efficiency improvements of the company's fleet along with the economic benefits. The fact that the staff and crew are now more involved in decision-making has promoted/enhanced the integration of energy management into the company's procedures and processes with beneficial outcomes in many domains.

Another issue that needs to be mentioned here is the importance of efficient collaboration with cargo customers and port authorities that has a direct effect on the energy efficiency of maritime operations. Good collaboration with ports means that no longer times are needed at the port area for accommodating the vessels and, at the same time, the vessels can operate at lower speed, consume less fuel and have less emissions.

In this paper, the efforts and initiatives undertaken by a Finnish shipping line (Viking Line) for the improvement of its fleet energy efficiency, along with the decarbonization of its operations were discussed in order to shed light on the potential of private companies' initiatives for the reduction of their GHG emissions. According to the findings, significant energy consumption reductions can be achieved at the company level from the implementation of a number of energy efficiency initiatives that presuppose a company organization model focused on sustainable development. Global and regional regulations/guidelines definitely initiate the introduction of energy efficiency measures, but their effective implementation depends largely on the organizational structure and priorities of individual shipping companies.

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