Participatory Approach to Sustainable Voyage Planning for Unmanned Vessels

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Abstract. Research in the design and development of sustainable operations in the maritime industry has received a great deal of attention in the recent past. Increased demand of sustainability, growth, skilled workforce, and competitiveness of maritime industry paved the way for unmanned vessels. This paper reports a participatory design process, where discussion emerged on sustainable voyage planning for unmanned vessels. The participatory approach in this study included a Futures Wheel workshop, semi-structured interviews, and a scenario workshop. These helped us to identify opportunities to improve voyage sustainability by optimizing the vessel size and efficient scheduling, and to include them in the use scenarios that guide the next steps of the solution design.

Keywords: Sustainability, Participatory Design, Unmanned Vessels, Voyage Planning, Futures Workshop, Scenarios.

1 Introduction

The maritime industry has recently paid a great deal of attention to the factors that enable the sustainable remote and autonomous shipping operations. The Maritime Autonomous Surface Ship (MASS) is currently focusing on vessels that utilize automated control system with advanced sensor technology to improve safety, increase efficiency and reduce fuel usage (Alsos et al., 2022). Rolls Royce (2017) predicted that MASS or fully autonomous marine fleets are expected to increase in 10 or 15 years time. Advancement in the port infrastructure, logistics, and energy-efficient vessels will increase the demand for marine trading (Hesse & McDonough, 2018). At the same time, the industry is progressively moving towards digitalization to find solution to modern challenges (Zhou et al., 2020).

The global marine trading is very essential part of the global logistical chain and is crucial to world economy (Boviatsis & Vlachos, 2022). Ships carry more than 90% of the world's cargo transports because of its cost-effectiveness. Shipping produces 2.2% of the world's total greenhouse gas emissions and it has a much lower carbon footprint per ton-mile than trucks and airplanes. Still, there is a need for a drastic reduction of the carbon footprint of shipping, and it is seen this can be achieved, e.g.,

by reducing the speed of ships to just about 10 knots. This would mean drastically slower transport times and would require many more and bigger ships with more personnel. At the same time, marine industry suffers from shortage of employees. Porathe (2016) estimates that unmanned ships will be necessary to reach the sustainability goals. Clean fuels in marine transport is estimated to bring remarkable changes in the maritime policy, focusing on reducing carbon emissions (Zhao et al., 2020).

Vessel electrification is also an important development towards more sustainable marine operations. In recent times, a good number of efforts being put into electrification as a key factor for sustainable and environmentally friendly marine operations (Lind et al., 2020). The fast growing marine electric technologies established a strong base for adapting new ships buildings to either hybrid or full electric propulsion (Bosich et al., 2017). A recent research study shows that nearly two-thirds of the electrified marine vessels function in hybrid mode and the rest are pure electric (Anwar et al., 2020). Additionally, the study indicates that Norway, Denmark and Scotland are the dominant countries that advocate green energy and design minimum one ferry per year in the last five years. The author Koumentakos (2019) in his study observed that variation in electric vessel sizes with different capabilities and needs may bring down emissions significantly and reduced the environmental impact on the maritime sector. Currently, electrification is considered as the most favorable environmentally friendly energy resource for the maritime sector (Prousalidis & D'Agostion, 2023).

This paper discusses about participatory study of how sustainable operation of unmanned vessels could occur in the future. The participatory design so far has included Futures Wheel workshop, semi-structured interviews, and scenarios of rough user interface ideas. These studies provided a user-centered approach for the early design phase.

2 Case study: future operation of unmanned vessels

The authors of this paper study remote operation of unmanned ships that deliver goods in the short sea shipping domain, utilizing waterways instead of the road network. In this case, shipping the goods over the waterways is more sustainable than transporting them by trucks via the road network. While our main research goal is to design human-centred remote operation rather than sustainable operations, sustainability issues are important to the client companies and they come up in our studies.

Our research has proceeded through participatory design studies. The first study, Futures Wheel workshop, helped us to understand the different aspects influencing the future of remote operation of the vessels. In this workshop, the company participants raised the need for sustainable operations, and the discussion included possible ways to reduce emissions via optimizing vessel size and more efficient voyage scheduling. Both of these were relevant to the voyage planning phase, which was chosen as our focus.

Scenario analysis workshop study was conducted with 6 professionals from two client companies to understand the context and specify user requirements. The scenarios were developed for the future sustainable human-automation based on the

findings from Futures Wheel workshop and semi-structured interviews. The scenario analysis was analyzed in three phases: 1) Starting a mission plan, 2) Assigning captains, and 3) Voyage plan. Each phrase was presented to the participants with storyboards. The workshop focused on navigation, waypoints, ship capabilities, external factors, anticipated contingencies, and advanced technologies. Each participant was instructed to go through each scenario and discuss with other participants in the workshop. The participants were asked to add notes about potential impacts, risks and opportunities, important plot points that align with their vision, liked areas or scenes from other fields and other ideas that emerges from the stories.

The participants pointed out that a more automated system could help the operator in choosing an optimized vessel size to reduce energy, emissions, waste of time and resources. Automation would also help scheduling the voyage based on the weather conditions, traffic and availability that require least power. In relation to the vessel electrification consequences, there was discussion about vessel charging activities at the port, and planning the time for charging the vessel batteries.

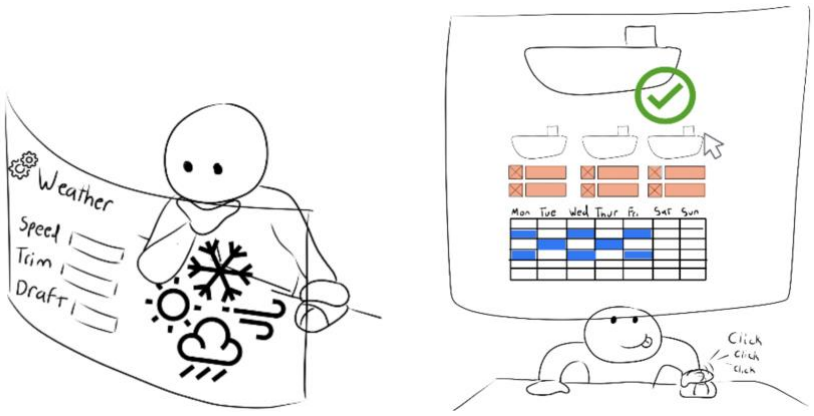

Fig. 1. Illustrations of weather and vessel size as examples of sustainable considerations in voyage planning scenarios.

3 Conclusion

Research in the maritime industry is growing rapidly and unmanned vessels have the ability to reduce the environmental impact in the maritime sector. Researchers with the background in user experience design can contribute to the sustainability goals by gaining a holistic view of the factors influencing the carbon footprint and designing a user interface that help the operator to address those aspects. In the reported case, it was the vessel size and scheduling optimization that were found important in reducing energy, emissions, and resources of operators, so the user scenarios were designed to prominently include these aspects. We hope these considerations through participatory UX design will contribute to a more sustainable maritime transportation.

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