TRANSNAV
http://www.transnav.eu
the International Journal on Marine Navigation and Safety of Sea Transportation
Volume 18
Number 3
September 2024

DOI: 10.12716/1001.18.03.17

Barriers for Inclusion of User Practices in Technology Development in Blue Denmark

R.G. Kristensen & T. Børsen
Aalborg University, Aalborg, Denmark

ABSTRACT: As the world collectively looks to technology to salvage what is left of our world to sustain a habitat that can accommodate our way of life, users are increasingly exposed to technological solutions, rarely developed with an offset in their practice. This also holds for the maritime sector in Denmark, where the way of developing technology is limited to the applicability of technological artifacts and can reduce the potential efficiency gains that technologies can introduce. This paper applies qualitative research to show that there is a disconnect between, on the one hand, funders, technology developers, and decision-makers and, on the other hand, technology users and practitioners in the Danish maritime sector. It argued that if technology is to replace or assist any human practice and solve for example the climate crises, then knowledge of users' practices must be key to developing the technological solutions.

1 INTRODUCTION

While climate change continuously manifests itself for the world's inhabitants, societies are increasingly focusing on solutions that will prevent Earth's hospitality level from deteriorating further. The ability to reduce fossil fuel consumption is investigated intensively. Shipping has, compared to other logistics and transportation industries, not been change-effective due to the complex challenges that international shipping actors point out themselves (Poulsen and Sampson 2020).

Shipping has become essential to today's standards of living as it connects the world. So much so that up to 80% of the world's goods are transported through shipping (OECD 2019). These living standards have a heavy price as shipping mainly relies on fossil fuels for propulsion (Martin Cames and Cook 2015). Shipping is heavily judged for contributing to human-generated Greenhouse gasses (GHG) and is held accountable for 2.7% of GHG emissions. Without averting actions, the number is projected to reach 17% by 2050 (Martin Cames and Cook 2015; Adland, Cariou, and Wolff 2019). The cases for radical change are overwhelming and something must change (Mazzucato 2021, 23). The International Maritime Organization (IMO) has vowed for GHG to reach net zero by or around 2050 (IMO 2023). Yet, it is unclear what that means or how to get there (Møhl, Krause-Jensen, and Skårup 2022, 5)!

Research shows simple low-cost energy efficiency (EE) measures in shipping can cut up to 75% of GHG, while also reducing the cost of operation (Johnson and Andersson 2016, 79–80; Viktorelius, Varvne, and von Knorring 2022, 2). However, this proves difficult to enact (Poulsen and Johnson 2016). A myriad of research has investigated the many barriers in shipping to implement energy-efficient measures. Barriers such as changing practices, governance, company and vessel policies, and adoption of technology (Adland, Cariou, and Wolff 2019; Poulsen and Sampson 2020; Poulsen and Sornn-Friese 2015; Johnson and Andersson 2016; Johnson, Johansson, and Andersson 2014; Trianni and Cagno 2012).

In 2022 Denmark ranked as the world's 6th largest commercial fleet (Steffensen and Torstensen 2021; DMA 2022). The Danish government released a report on ensuring Blue Denmark gains status as a global hub for maritime digital expertise. Blue Denmark refers to maritime businesses and industries, maritime researchers and educators, legislators, etc., nearly occupying a hundred thousand people.

A major point of the report is that a digitalization strategy can change our current trajectory. By claiming quality assurance from being made in Denmark, political backing, and quantum leaps in technological development, the future looks brighter (Braat 2022). Digitalization has long been a part of the agenda of Blue Denmark (Gyldensten 2017). Danish Shipping, an important voice in Blue Denmark, affirms the coming changes:

"Shipping companies face new challenges led by ambitious climate goals, environmental regulation, increased digitalization, and new business models, with large parts of possible solutions for the future being unknown. Innovation is, therefore, higher on the shipping companies' agenda than ever before. Development, new research, and innovation projects are, among other things, crucial for Danish shipping companies to achieve the climate goals and remain competitive in an increasingly digital world" (Vesterlykke 2019)

Developing newer technology, such as autonomous vessels, has arguably been established as a superpower in society as the only solution to the climate crisis; and steals focus from the low-hanging fruits of current technology, governance, policy-making, and changing human practice. It parallels the plot dramatized in the Hollywood movie "Don't Look Up", where known methods to avert certain destruction are waived to make way for untested futuristic technology that eventually fails, without ample time to revert to old methods (McKay 2021).

The belief that liberation through technology is succumbing to a total technocracy where solutions are based on technical expertise alone, is worrying. It appears forgotten to consider alternatives to new technology and its dependencies. Technological advancement must also deal with the social context of the user's practice (Johnson and Andersson 2016; Viktorelius, Varvne, and von Knorring 2022). While eyes are set on the development of technology, not much attention is devoted to the user and the changing technology landscape their practice is going through and technology is thought to effectivize (Man, Lundh, and MacKinnon 2019).

We need to broaden the perception of what constitutes technology to a nexus of the artifacts and the human practices, in which it is embedded. Critical authors in Technology Studies, e.g., Andrew Feenberg (Feenberg 2017) and Langdon Winner (Winner 2001), suggest that if we neglect the fact that technology is supposed to help and emancipate people it adds the opposite, inevitably generating animosity towards technology. A more inclusive definition of technology could offer us the chance to consider how technology is utilized in the real world and to discover how to design more democratic and adaptable technology that can be applied in practical contexts, ultimately increasing the chances of our future generations' survival.

2 RESEARCH QUESTIONS

This paper investigates the barriers to an equilibrium, in developing technology between technical artifacts and human practices and to understand its socio-technical configurations. In doing so we call for a democratic intervention in Blue Denmark's technology. In other words: What are the barriers to democratizing the system of technological development in Blue Denmark?

Figure 1 is to illustrate the research question. On the left, we see the current technocratic view on technological development in Blue Denmark, focusing primarily on developing technical artifacts, while scrutinizing the practice. On the right, we see the desired situation where the development is balanced with an equal focus. The line in the middle illustrates the barriers to the requested transition that this paper will display.

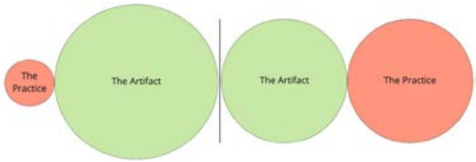

Figure 1 illustrates the research question structuring this study: What are the barriers to democratizing the system of technological development in Blue Denmark?

3 ETHNOGRAPHY

Ethnography strives to understand the meaning humans ascribe to their lives. Not by quantifying numerical global metadata, something the shipping industry has long suffered from (Viktorelius, Varvne, and von Knorring 2022), but by spending time with the people practicing that which technology aims to enhance. As stated by Sunderland and Denny; "if we accept the notion that technology refers to the use of artifacts in practice then it becomes clear that understanding human practice is an integral part to developing technology" (Sunderland and Denny 2007, 5).

Actors of Blue Denmark constitute a diverse group with multiple interests and expertise: fund and project managers, customers, shipping companies (who have the actual end-users as employees), etc.,. They vary in location, purpose, organization, as well as influence. Observing them, visually and audibly, in their socio-technical configuration is a valuable way to attain perceptions of contexts and constructions (T. H. Eriksen 2010). Thus, ethnographic work at their different sites is the method used to understand Blue Denmark as a system of developing technology.

Traditional ethnography is characterized by focusing on a single location or setting to immerse oneself into a socio-cultural installment intensively. To observe and make sense of a specific or unique group of people's lives. As the world became an interconnected system, multi-sited ethnography appeared, as a local, single-site, could no longer be understood as isolated from its place in the global system. (Marcus 1995, 96). Multi-sited ethnography moves away from focusing on internal scenarios, objects, and meanings. Instead, zooming out to understand a local setting's place in its larger network, such as a user's practice's place in developing a technology. By including a macro perspective, this method is suitable for understanding the system of the multi-situated processes of developing technology.

The mobility guides the researcher to follow initially unknown sources to their origin. Thus, investigating the original site in question through the different perceptions of the system (Marcus 1995, 96). When researching the context in a socio-technical setting (such as the system) it is possible to both follow the people and follow the thing, the thing referring to non-human actors, concepts, or in this case, a trend of grand technologification without the user (Marcus 1995, 106–7). The contents of the people or the thing may be completely or partially unknown as research begins. As people or a thing is mobile and found in various settings so must the researcher then move to understand the entirety of the system.

To understand the system and how technology is perceived and developed we conducted semi-structured interviews, and formal and informal talks, together with participation in various events, discussions, and projects. The empirical material was collected in the following sites: development of fund strategies, project facilitation and management, product testing, and project implementation. The named sites represent different stations of technology's development. The sites' embedded barriers to user involvement will be brought forth in the analysis. The list of interviewees from the sites can be found in Appendix 1. The list of workshops and other events where observations and informal talks were conducted is in Appendix 2.

Figure 2 is a model of the technology development processes in Blue Denmark. The model will scaffold our empirical investigation of actors in different stages of an artifact's development. To comprehend the processes that constitute development in Blue Denmark (and why it excludes the users' human practices) actors in Blue Denmark were followed to map them and place them in a development chain, labeled the system. Processes of the system were observed as follows: Directional change in society is fostered by the climate crisis. This change influences Blue Denmark to invest in greenifying shipping operations. It is thus decided that funds will be allocated to develop green technology. Funds are requested by and provided to those who claim green solutions. I.e., entrepreneurs, GTS, project- facilitators and managers, etc. Once funds are secured project execution can commence. The system ends in a potential implementation with the following nursing phase pursued.

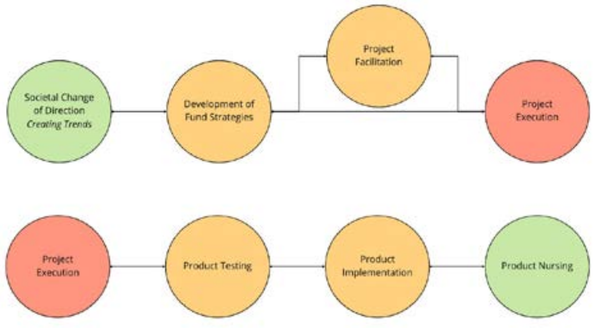

Figure 2. The figure illustrates the synthesis of the technological development system in Blue Denmark.

4 BARRIERS TO USER INVOLVEMENT IN THE SYSTEM

The analysis will identify barriers to involving users of technology in its development. Therefore, it was imperative to understand what constitutes the system, and its representatives' perception of what constitutes technology. Following technology and people in the system from the perspective of the user through the sites of the system showed that it fails to involve them enough and at the right time and place. This fact is acknowledged by a project facilitator; "[...] it is a hole in the process [of development] that is being dug with open eyes, which is paradoxical since one assumes that one has the interest [to implement technology] at heart" (I1). The terminology barrier might be perceived as physical and concrete, but a barrier can also be on a social-technical conceptual level.

Researching the system indicated that attention to user involvement appears late, after initial implementation attempts. As the complexity of the real world unfolds it becomes clear that human practices are not confined to a restricted set of scenarios. Thereby indicating that user-technology collaboration is dealt with reactively instead of proactively i.e. recognizing problems that could have been identified at much earlier stages. Indeed, value is not necessarily only created if the technology prospers. However, suppose failure purely occurs because of deficiency to appreciate the actual problem, failure with no gain seems accurate. I.e., if nothing was learned from failure it is arguably a complete waste of time, money, and resources.

4.1 *Barrier One - Users*

When developing technology it is difficult for the creator to understand the various ways in which it can be used. The focus of technology's development needs to be readjusted from the artifact to the practice. Allegedly technology cannot succeed without both; "If you think all you need to develop technology is technical insight, or to just get it to work according to some criteria of functionality, then you have not understood what technology is" (I4). Research underlines the importance of user involvement. Research such as human-computer interaction, different methods of user involvement, participatory design, and user ethnography (Hyysalo, Jensen, and Oudshoorn 2016; Oudshoorn and Pinch 2003;

Woolgar 1990; Sunderland and Denny 2007; Børsen and Botin 2013; Büscher et al. 2009).

Informants have acknowledged the uneven distribution of focus on artifact and practice; "there has been an exaggerated focus on the technology [artifact]" (I9). We see this in the maritime sphere with investments in autonomous vessels and navigational aids. Such systems, among others, are not understood nor functioning optimally because the user was excluded from the development of the system (Grech and Lemon 2015, 2).

All sites recognize the importance of user input for a successful implementation. An informant concedes; "if it [technology] is not adopted, the other half of the calculus is missing, and that is the end-user" (I9). The system appears to want to involve users but is often obstructed by the shipping structures (Møhl, Krause-Jensen, and Skårup 2022, 25). Overall, there is consensus that user involvement is important but it is debatable as to what extent it is practiced; "I am not sure, but I think it has always been the intention to incorporate end-users" (I9).

4.2 *Who Constitutes Users*

User involvement is not just involving people. There seems to be ambiguity as to what and who the user is, like what a user is and when/what they should be involved in. Looking at technology deployability, this is exactly the knowledge that developers need that users can help with. By listening to inputs seafarers feel included and they can illuminate problems that developers alone could never foresee. Seafarers are often exposed to complex technology in a top-down implementation (Man, Lundh, and MacKinnon 2019, 4).

An important defining parameter is that while preferable to the exploitative and applicable technology, user involvement might be less relevant on a conceptual level; "regarding exploitative technology, I think it is extremely important to incorporate them, otherwise it will not work. With explorative technology, I do not think it is that important at the first stage that is about understanding the potential but to apply the technology to solve a problem, involvement is vital" (I9).

While exploring the system different conceptions appeared of who the users are elaborated in 5 misconceptions;

The first misconception is that the customer is the user. Reaching out to a private maritime fund they were assured that their project facilitator has user contact through applied sciences. When interviewing said project facilitator they replied; "[...] that [applied science] is together with the companies [...]" (I3). I.e., not the user but the company. When discussing user involvement it sometimes appears misunderstood and instead referred to as customer involvement; "you could say that our end-users are the manufacturers and the shipping companies" (I1). Customers do not understand the practice as a user. As agreed by an informant; "I would say it should be the end-users, as the customers are constructed by a financial relation" (I9).

The second misconception is, that when users are involved, it is often only specific ones; "[...] there were the darling captains who always were brought in on the projects [...]" (I5). This leaves few candidates and limits the available practitioner knowledge to one or a few positions. Various positions and individuals can have greatly different tasks on a vessel.

The third misconception is that users could also refer to former users. This introduces the risk of patenting knowledge from when leaving life at sea; "I have observed, there are many [ex-seafarers] know-it-alls with the solution for all the world's problems" (I2). This is problematic because there is a risk that extracted knowledge is not grounded in contemporary seafaring practices; "[...] the end-users are often represented by former seafarers [...]" (I9). This has caused; "[...] many half-hearted solutions from a former navigator or marine engineer with old knowledge" (I2). The industry keeps on evolving, so it can be a big problem if former seafarers are used to reflect current life at sea.

The fourth misconception. The maritime academies have also been pointed to as a source of contemporary knowledge; "we depend on the maritime academies, SIMAC e.g., and their facilities [...]" (I1). While training facilities, teachers, etc., can provide valuable knowledge, they cannot replace real-life scenarios, experience, and expertise.

The fifth misconception. The industry and the agenda of the funds were identified as an outcome-altering factor; "we are driven by the industry's interest as they are our core stakeholders [...]" (I1). If project facilitators cannot secure their interest and funds, there will be no project.

It must be understood who the users are. It is the active seafarers. The above illustrates the first barrier to real end-user involvement as important actors can be under the illusion that end-user involvement takes place. A user's input is needed in Blue Denmark, as an informant states "Some of the projects we have are very technical and very engineer savvy, but there are no marine engineers connected [...]" (I1). It is indisputable that domain-specific knowledge can help verify potential in development. But it must stay diverse and current; "it is important to be observant of the diversity of knowledge [...] also within maritime knowledge, that you are aware that there is a seafarer from China and India who also are end-users of the product" (I2).

4.3 *Barrier Two - Technology*

The second barrier is the false idea of what technology should be developed for and why. Arguably there is more than one truth, but for the sake of the green transition we can look to a dictionary definition of the word technology, "the use of tools and machines to help people conduct tasks more efficiently and with less effort" (Cambridge University Press 2021). I.e., technology can reduce emissions from shipping, as a project facilitator mentions; "moving people and goods creates a lot of value for the world. However, there is also a dark side, in this case, a negative impact on the environment, we work to bring that down" (I9). We have to remember that technology should be developed, invested in, and committed to, so we can ensure our future on this planet. The disconnect between land and sea along with the construction of the world of shipping often results in sub-optimal conditions for change when deploying new technology. Therefore it is important to see how the perceived purpose of developing new technology changes throughout the system. The system has shown two main categories of false beliefs: removing humans and technological glorification.

4.4 *Removing Humans*

The first false belief is that technology should replace humans. Aside from the expense, that crew needs to be paid and therefore will result in fewer expenses, it will allegedly also result in fewer errors, i.e., it equals fewer disasters, higher efficiency, and more revenue (Man, Lundh, and MacKinnon 2019, 3). However, removing human operators from ships is implausible for three reasons.

First, technology is not capable e.g., the unmanned autonomous vessel is not able to deal with the dynamics of the seas or to possess the level of adaptability of humans while being built on the COLREG that is dependent on human intervention. And, if technology was able it would have happened already as the business case would be too lucrative for any shipping company to pass, as an informant argues; "if the technology were a product you could just go and buy off the shelf, then it would already be implemented" (I14).

Secondly, the false belief that seafarers solely exist on the vessel to steer the vessel. The auto-pilot technology has existed for years, the ship is steering itself. Most of the work that happens on a ship is maintenance (S. Eriksen, Utne, and Lützen 2021, 9). Along with other workloads, maintenance is not something an autonomous vessel is exempt from, even though Danish Shipping anticipates robots will be able to overtake this task (RINA 2018). The workload from digital systems is still increasing (Ljung and Lützhöft 2014, 3). An informant said; "companies, at the moment, have more crew than legislation requires, because there is too much maintenance work" (I10).

Thirdly, the argument that computers are safer, and the concept of human error. The main argument is that roughly 85% of accidents can be attributed to human error (AGCS 2017). The problem is that human error does not classify as an error isolated to a human making a mistake, but rather because of multiple factors failing. As noted by Rothblum; "human errors are generally caused by technologies, environments, and organizations which are incompatible in some way with optimal human performance" (Rothblum 2011, 5). It is also explained as a human error if the operator is incapable of comprehending the complexity of a system (Grech and Lemon 2015, 3). As no apparent data exists on how many times a human prevented a system from making a critical error, it is a very one-sided argument. When asked, an informant answered; "[...] show the other perspective, if that statement is to have any validity, I want to know how many accidents did not happen because a human told a computer it was wrong" (I14). A study on the near-miss system showed that 87% of such occurrences had been discovered by humans (S. Eriksen 2020, 99).

Furthermore, an informant says; "it is important to say that safety cannot be understood by some numerical value as it is bound by the context in which it emerges" (I11). Ultimately, an informant assesses that we should; "let humans do what humans do best and let machines do what they do best, then assist each other" (I14). The crew is present to act on sudden, unforeseen, dangerous situations and handle such situations all the time without drawing on external parties (S. Eriksen 2020, 89).

4.5 *Technological Glorification*

The second false belief is that of potential gains from doing technology simply because it is technologically possible and cool (I14). There appears to be a discrepancy between the land-based actors' idea of a modern vessel and what is currently possible with the infrastructure of the sea. Such misalignments and unreal expectations lead users to abandon technology as critical issues and constant problems inhibit adoption (Krause-Jensen, Hansen, and Skårup 2020, 7, 20). The reliability of systems at sea carries important significance. The technician is not just around the corner and consequences can be devastating at unfathomable levels. Where an entrepreneur might be willing to take risks of losing their investment, the risk measures greater for a Captain and their crew. Risks include human lives, man-made natural disasters, and innumerable amounts of monetary loss. Toying with new and fancy technology just because one can, should not be an argument for the pursuit. Such a discrepancy can be harmful to the much more useful technological development that we so desperately need (Hancock et al. 2013, 10; Krause-Jensen, Hansen, and Skårup 2020, 41; Kristensen 2022, 25). As an informant describes the technical characteristics of a ship are spot on and need to be understood by all; "We need to remember when characterizing a ship, it is extremely low-tech [...] nothing like a plane or a train [...] a ship is multiple different systems connected from multiple different brands and manufacturers using different methods and having different rules, so nothing is standardized. A ship works, yes, but at the same time, it never really works [...] so you place 20 crew members on board, running around 12 hours a day to try to keep the vessel afloat and get from A to B. This is the context we should think about when thinking about automating ships" (I11). Noting that this quote only deals with the complexity of one ship and does not recognize that similar ships in a fleet further differentiate in equipment and systems. It is sort of a microcosmos composed of elements from all over the world. It is quite normal for systems to be supplied by more than 15 different manufacturers (Krause-Jensen, Hansen, and Skårup 2020, 8).

The need for streamlining systems is problematic for progress. Manufacturers often worry about production costs, not integration capacities resulting in a low ability for the system to work together with the operator. This causes technology, even though introduced to reduce error, to in some cases directly contribute to accidents (Grech and Lemon 2015, 2–4).

As technology increasingly becomes a vital support function for humans, the role of the navigator is changing from being a controller to a supervisor of systems. Technology is becoming increasingly complex and systems' full capabilities can be overwhelming, while the human operator has remained stationary and does not follow the exponential path (Grech and Lemon 2015, 2; Lundh and Rydstedt 2016, 2–3; Man, Lundh, and MacKinnon 2019, 2). It is a known challenge within shipping companies to provide attention to crew competency development (Froholdt 2010). It is a major democratic problem as responsibilities are not subjected to change. As the final decision maker, the seafarers should be included to ensure the operator has the required skill and knowledge to sufficiently operate and supervise the system (Man, Lundh, and MacKinnon 2019, 2–3). Seafarers still have the final call, they will decide what action to take and be held responsible. The importance of the system's ability to facilitate the navigator in the unique settings where the pot is boiling and an overview of the situation is vital e.g., in the unavoidable case of system or machinery breakdown. Those are the situations where the systems are needed most (Grech and Lemon 2015, 11). These are the situations that can only be prepared for by involving those who have the experience. And the deliberate absence of the same means that the scope of technological glorification is undemocratic.

4.6 *Barrier Three - Funding*

The last selected barrier requires a short prelude.

As an example of the technology criticized in the previous chapter, autonomy in navigational systems has been described as a pinnacle for bringing down emissions from the shipping industry (by Danish Shipping). Looking at ShippingLab, half of the budget for ShippingLab is earmarked for autonomy research and development (ShippingLab 2022). When opening the discussion on the topic of technologification, whether or not one believes in total digitalization and autonomy, it does seem peculiar to address self-sailing crewless vessels as a solution when global connectivity infrastructure is unable to sustain usable connections for daily operation. Sunbae Hong from the Korean Ministry of Oceans and Fisheries, in a presentation at Digtal@Sea 2021, calls for addressing the challenges in global maritime digitalization. He calls for collaboration between stakeholders to reach a state within shipping that can support the very basic level of digitalization on a global scale (Hong 2021). Going back to Blue Denmark, it leaves one wondering about the actions taken when autonomous shipping becomes a top priority when, simultaneously, the world's maritime stage is trying to figure out how to ensure basic connectivity to the world's oceans.

The third barrier is funding strategies. Is the technology to be developed chosen in accord with trending hot and sexy topics while leaving more boring yet necessary-for-us-as-all projects for others? It poses a problem if funding focuses on individual success and not the progress of the world, as declared by Hong; "focus on progress, not perfection, one step made together is more powerful than 10 steps made by one country" (Hong 2021).

An informant mentions that; "we see the same logic in many other places in society" (I4). This can mean that research and projects can be influenced by trending topics. There are similarities to global social trends, something that an informant concurs with; "if we take society as a whole I think we can establish that there is an overexcitement towards technology [...] that technology will come and fix all the problems of the world" (I9). Arguably this trend has gotten a foothold within Blue Denmark, as the informant continues; "like the rest of society, there is overweight of focus on the technology, but I do not think it is with bad intentions, it is just following society where fancy exponential technologies are mentioned everywhere, so naturally, that is what attracts funding" (I9).

Hard science and quantitative data have mainly been in focus in shipping when presenting the state of business (Viktorelius, Varvne, and von Knorring 2022). Similarly, it appears that trends decide what research gets prioritized and that appears to be reflected by funding structures. Funding strategies rarely specify expectations for user involvement but focus on hard science statements, as an informant shares; "it is my opinion that it is easier to get funding for technical research in place of social sciences, I do not carry in statistics, but it is my opinion, the technical stuff is the big trend right now" (I7). Which is peculiar as it is common to; "assume that having a more humanistic instead of purely technical approach would enable a higher applicability" (I7).

The funding system appears to influence how Blue Denmark seemingly chooses to focus on technical experts and their artifacts more than the users and their practices. When discussing what impacts the operation of project facilitators it seems plausible that they are influenced by more powerful actors, an informant states; "it is about creating jobs, and promoting the Danish maritime industry, if you cannot do that, then it is not a Fund's project [depending on the Fund]" (I9).

Furthermore, technical experts try and keep their current societal validation, as an informant talks about the power of technical experts; "[...] they hold on to the idea that pure technology is fantastic, so when they tell the story they make it seem like it was technology in itself that did it" (I4). AI, e.g., is extremely resource-demanding and dependent on human work such as setting the framework, sorting the data, and maintaining it. Granted, quantification is next to impossible for a human to do but as an informant explains; "[...] at the end of all that work, indeed, you can say, AI did it. It is like saying it was the nuclear physicists that won World War 2" (I4). After which they address; "[...] the same as every other sector, not because the tech industry is worse than others, they are simply extremely privileged at the moment. A sort of unjustified power that lets them dominate the narrative" (I4).

Unfortunately, this upholds the assumption that technological greatness is a technical expert thing. As the board member argues, campaigning and lobbying are not free services; "researching technology is big business so there is an ongoing quest of justifying continued research" (I4). Arguably, when such systems are driven by what is trending, it adds a layer of ineffectiveness to positive change.

The structures of funding sometimes remove the true context from innovation as it becomes a goal to secure funds. A project facilitator mentions; "[...] sometimes it is very easy to see in the application that they are trying to appease us with what they think we want" (I1). It can be traced to trends like the use of certain terminologies that are used simply because of their power in society, as the project facilitator continues; "sometimes it is more the fact that there is an argument, than the quality of that argument, that means something [...] like it does not matter what you answer as long as you answer" (I1). Such projects are doomed at once, as he states; "in those cases, for sure it will not get implemented, because it does not matter to them" (I1). Possibly we as a society do not have unlimited time therefore it is a harmful way of looking at progress, as an informant observes; "there are seemingly no consequences from exaggerating what a project is capable of achieving, they just get another try" (I4).

If the mentioned barriers to not involving seafarers in the development of technology, replacing humans, and technologification, are combined, we can look at a defining trait of the system funding strategies and trace barriers back to here. Involving the user and assuring application must be considered already at the funding stages.

5 DISCUSSION & CONCLUSION

User involvement usually first emerges when technology is implemented and operational malfunctions manifest themselves. There are no formal standardized methods for ensuring user involvement. Often, solutions are top-down implemented and alien to their users, thus assessing the system as rather undemocratic. There is a risk that solutions will oppress seafarers, reducing the chance of adoption. Which means the needed technologification is postponed. The system is very complex which makes it difficult to determine who should be responsible for keeping in touch with the seafarers.

The green transition is a topic everyone knows, and this is a subject to agree and collaborate on. However, a disconnect to real-life practices enters. It is the impression that the system is mainly concerned with the artifact of technology, influenced by trends and funding practices. User involvement is not alien to any of the actors, but it is not a normal, standardized practice either.

It is a challenge as Blue Denmark is too massive an entity for anyone one individual to be held responsible. The system is a mesh of so many different actors with varying agendas. It is genuinely a microcosmos. An informant mentions that project facilitators are connected and collaborate only competing on funding and stakeholders' time (I9). They ensure that other companies have a collaborative space, this is something that is constantly under development; "we have creators who focus on action-based research and bring more disciplines in [...] and through that evolve some methodologies that can help in future development" (I1). This appears to have a positive effect on the system. However, it is only a place for ideas to grow and nothing will change without the businesses' support.

If a project facilitator does not interact with the end-user but leaves it up to the shipping company to take care of that part, it leaves the shipping company in charge of something they perhaps will not keep to, as told by an informant at a shipping company; "no, we do not have that much focus on the end-users on the ship, but we ensure to collect as many perspectives as possible when discussing these technologies" (I9). Shipping companies can appear to act as gatekeepers and designated user facilitators by other actors. Actors seem aware of the value user involvement has, as they continue; "gaining mutual understanding can help avoid many of the traps of inducing change with unwanted consequences that affect others negatively, because you just did not see it from that perspective" (I9).

Shipping companies might increasingly face this responsibility if user involvement activities were funded from the beginning when the technologies were conceptualized and also later on when they are developed and implemented. This will force and award the different actors in Blue Denmark to reflect and act on user involvement.

However, understanding users' practices has been revealed to be more problematic as ex-seafarers and academies often represent actual users. In some cases, actual seafarers are consulted but typically only Captains. The system must ensure that the people who get to represent the seafarers' practices represent actual practices, not the academy's, not the captain's, and not former seafarers', but the real deal. The actual end-users must be involved.

While there is consensus on the importance of user involvement in the system, there are uncertainties as to how it can be achieved, a challenge noticed by an informant; "the end-user cannot be a technology expert, of course, it is not their job, they have a ship to navigate. So naturally, there is a difficult task incorporating them in a workshop, etc." (I9). Furthermore, it can be a practical challenge to test the technology on a vessel, as an informant assesses; "I think it will be difficult to establish procedures for testing the technology on vessels due to their trade and the complexity of ship operations [...]" (I7).

While this might be speculative, something that is not is that shelved technology caused by seafarers and land-based actors not understanding each other, resulting in technology holding no ground in reality, does not solve anything. It does not make the operator or their ship any safer, more environmentally friendly, or better in any way. It is a waste of time, money, and resources. Therefore, what can be done in the early stages of developing technology, should be done. The true purpose of technology should be known and appreciated by all actors. It is damaging to technological advancement and the green transition if seafarers understand technology as an enemy and not as a digital colleague.

Based on multi-sited fieldwork at different sites of technology development in Blue Denmark (what we call the system) we have in this contribution selected three central barriers for the involvement of end-users. The first barrier is an ambivalent understanding of who constitutes the user to be involved. The second barrier regards the purpose of developing new technologies in Blue Denmark that are centered on efficiency, automation of human work tasks, and technological glorification rather than on addressing socio-ecological challenges. The two mentioned barriers are both underpinned by the third one that is existing funding structures. Thus, if funding structures would increasingly award user involvement, it could generate clarification of who the users are and reorient the goals of technological innovation.

Ultimately user involvement in the system fails because it generally focuses on the artifact and the claims of technical experts while the constellation is hostile to changing structures. It appears that there is a need for a democratic intervention in Blue Denmark to support further technological advancement in the service of green transition. This democratic reorientation we suggest is initiated in the funding structures of technological innovation in the maritime sector. Actors of the system mean well and strive for a better world. However, becoming lost in the complexity of the shipping world. The funding of transdisciplinary work could be a positive way to structure and facilitate further technologification of Blue Denmark. By bridging the many different sites of the system, a holistic view of how technology should be developed can be acquired. The system's understanding of technology must become more inclusive referring not only to the technical artifact but also to the practices of people.

APPENDIX 1: SITES & INFORMANTS

Main Affiliated Site	Organization	Description	ID
Development of Fund Strategies	A fund in Blue Denmark	A private fund with a focus on wild ideas	I5
Product Testing, Implementation & Nursing	Accident Investigation	An organ conducting research and investigating the root causes of accidents in Blue Denmark	I11
Product Testing, Implementation & Nursing	A Captain and active practitioner	An active captain who engages a lot with his shipping company to address issues with technology	I13
Product Testing, Implementation & Nursing	Maritime Academy	A Maritime Academy in Blue Denmark testing many modern technologies such as autonomy	I14
Product Testing, Implementation & Nursing	Maritime Academy	A Maritime Academy in Blue Denmark who also conducts research	I10
Project Execution	Maritime Startup	A newly formed company developing a platform for mutual learning at sea	I2
Project Execution	University and Project Facilitator	An organ that organizes research and functions	I3
Project Execution	Shipping Company	A shipping company implementing new solutions	I8
Project Execution	Maritime Startup	A start-up that has developed an innovative location beacon for maritime personnel	I15
Project Execution	Maritime Startup	A start-up that developed an intelligent searchlight for vessels	I6
Project Facilitation	Project Facilitator	An independent collaborative platform for other companies in Blue Denmark	I9
Project Facilitation	Maritime Knowledge and Project Facilitator	An initiative to facilitate and broadcast research across Blue Denmark	I7
Project Facilitation	Project Facilitator	ShippingLab is a public-funded initiative to address the climate crisis through technical innovation directly	I1
Societal Change of Direction Creating Trends	University	An anthropologist, Senior Researcher, and Author	I12
Societal Change of Direction Creating Trends	University	A Professor in Techno-Anthropology and Science and Technology Studies	I4

APPENDIX 2: OVERVIEW OF WORKSHOPS AND OTHER EVENTS

Events	An Update on Maritime Autonomous Navigation (07-03-22) Autonomous Ships from the Perspective of Operation and Maintenance (06-10-21) Autonomy ships and new paradigm (25-10-21) DanaDynamics Presentation 2021 (31-08-21) Digital Harbor (01-03-22) Digital Tech Summit 2021 (30-11, 01-12-21) Human + Tech = Problems? (28-10-21) InnoFounder and InnoBooster (04-03-22) Marine Sustainability by Digitalization (2021-2022) ShippingLab Conference (24-11-21) Summer Business Networking 2021 (25-08-21) TechBBQ 2021 (16,17-09-21) The New AI Regulation (09-03-22) Values and Norms of the Green Transition in Blue Denmark (28-01-22) World Maritime Technology Conference 2022 (26-04-22)
Workshops	Maritime Competencies of the Future (01-10-21) Predicting future trends based on past predictions (26-04-22) User Involvement (16-11-21)
Projects	The Connected Ship (2021) VHF Data Exchange System (VDES) (2021)

REFERENCES

Adland, Roar, Pierre Cariou, and Francois-Charles Wolff. 2019. "When Energy Efficiency Is Secondary: The Case of Offshore Support Vessels." Transportation Research Part D: Transport and Environment 72 (July): 114–26. https://doi.org/10.1016/j.trd.2019.04.006.

AGCS. 2017. "Allianz Global Corporate & Speciality Safety and Shipping Review 2017." An Insurer's Perspective. Cardiff University.

Børsen, Tom, and Lars Botin, eds. 2013. What Is Techno-Anthropology? 1st ed. Series in Transformational Studies, v. 3. Aalborg, Denmark: Aalborg University Press.

Braat, Jenny. 2022. "Made in Denmark - En maritim industri i verdensklasse." Newspaper. Business Review. April 23, 2022. https://businessreview.dk/transport-logistik/made-in-denmark-en-maritim-industri-i-verdensklasse/.

Büscher, Monika, Roger Slack, Mark Rouncefield, Rob Procter, Mark Hartswood, and Alex Voss, eds. 2009. Configuring User-Designer Relations. Computer Supported Cooperative Work. London: Springer London. https://doi.org/10.1007/978-1-84628-925-5.

DMA. 2022. "Det Blå Danmark." Organization. Danish Maritime Authority. June 3, 2022. https://www.soefartsstyrelsen.dk/vaekst-and-rammevilkaar/maritim-erhvervspolitik/det-blaa-danmark.

Eriksen, Stig. 2020. "On-Board Human Operators: Liabilities or Assets?" 13.

Eriksen, Stig, Ingrid Bouwer Utne, and Marie Lützen. 2021. "An RCM Approach for Assessing Reliability Challenges and Maintenance Needs of Unmanned Cargo Ships." Reliability Engineering & System Safety 210 (June): 107550. https://doi.org/10.1016/j.ress.2021.107550.

Eriksen, Thomas Hylland. 2010. "Fieldwork and Ethnography." In Small Places, Large Issues: An Introduction to Social and Cultural Anthropology, 3rd ed., 27–43. London: Pluto. http://www.dawsonera.com/depp/reader/protected/external/AbstractView/S9781849645676.

Feenberg, Andrew. 2017. Technosystem: The Social Life of Reason. Cambridge (Mass.): Harvard University Press.

Froholdt, Lisa Loloma. 2010. "Getting Closer to Context: A Case Study of Communication between Ship and Shore in an Emergency Situation." Text & Talk - An Interdisciplinary Journal of Language, Discourse & Communication Studies 30 (4): 385–402. https://doi.org/10.1515/text.2010.019.

Grech, Michelle R, and Nick Lemon. 2015. "Human Centred Design for Enhanced Navigation Systems: Shifting the Focus on User Needs," 13.

Gyldensten, René. 2017. "New Political Agreement Will Strengthen Danish Businesses." Organization. Ministry of Industry, Business, and Financial Affairs. November 13, 2017. https://eng.em.dk/news/2017/november/new-political-agreement-will-strengthen-danish-businesses/.

Hancock, Peter A., Richard J. Jagacinski, Raja Parasuraman, Christopher D. Wickens, Glenn F. Wilson, and David B. Kaber. 2013. "Human-Automation Interaction Research: Past, Present, and Future." Ergonomics in Design: The Quarterly of Human Factors Applications 21 (2): 9–14. https://doi.org/10.1177/1064804613477099.

Hong, Sunbae. 2021. "[Sunbae Hong, MOF] Global Maritime Digital Clusters & GMDRT (Global Maritime Digital Route)." Conference Presentation presented at the Digital@Sea Asia Pacific, Sejong Convention Center, September 9. http://digitalsea-ap.org/p4/c4/.

Hyysalo, Sampsa, Torben Elgaard Jensen, and Nelly Oudshoorn, eds. 2016. The New Production of Users: Changing Innovation Collectives and Involvement Strategies. Routledge Studies in Innovation, Organization, and Technology 42. London New York: Routledge.

IMO. 2023. "2023 IMO STRATEGY ON REDUCTION OF GHG EMISSIONS FROM SHIPS RESOLUTION MEPC.377(80) (Adopted on 7 July 2023)." London. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/annex/MEPC%2080/Annex%2015.pdf.

Johnson, Hannes, and Karin Andersson. 2016. "Barriers to Energy Efficiency in Shipping." WMU Journal of Maritime Affairs 15 (1): 79–96. https://doi.org/10.1007/s13437-014-0071-z.

Johnson, Hannes, Mikael Johansson, and Karin Andersson. 2014. "Barriers to Improving Energy Efficiency in Short Sea Shipping: An Action Research Case Study." Journal of Cleaner Production 66 (March): 317–27. https://doi.org/10.1016/j.jclepro.2013.10.046.

Krause-Jensen, Jakob, Stephan Hansen, and Bettina Skårup. 2020. "Robotten/teknologien som 'kollega.'" 1. Copenhagen: Aarhus Universitet.

Kristensen, Rasmus Gammelby. 2022. "Socio-Technical Configurations in Blue Denmark." Copenhagen: Aalborg Universitet.

Ljung, Margareta, and Margareta Lützhöft. 2014. "Functions, Performances, and Perceptions of Work on Ships." WMU Journal of Maritime Affairs 13 (2): 231–50. https://doi.org/10.1007/s13437-014-0057-x.

Lundh, Monica, and Leif W. Rydstedt. 2016. "A Static Organization in a Dynamic Context – A Qualitative Study of Changes in Working Conditions for Swedish Engine Officers." Applied Ergonomics 55 (July): 1–7. https://doi.org/10.1016/j.apergo.2016.01.006.

Man, Yemao, Monica Lundh, and Scott N. MacKinnon. 2019. "Facing the New Technology Landscape in the Maritime Domain: Knowledge Mobilisation, Networks and Management in Human-Machine Collaboration." Edited by Neville Stanton. Advances in Human Aspects of Transportation, Advances in Intelligent Systems and Computing, 786: 231–42. https://doi.org/10.1007/978-3-319-93885-1_21.

Marcus, George E. 1995. "Ethnography in/of the World System: The Emergence of Multi-Sited Ethnography." Annual Review of Anthropology 24: 24.

Martin Cames, Jakob, and Vanessa Cook. 2015. "Emission Reduction Targets for International Aviation and Shipping." EPRS: European Parliamentary Research Service, November. https://policycommons.net/artifacts/1334721/emission-reduction-targets-for-international-aviation-and-shipping/1940504/.

Mazzucato, Mariana. 2021. Mission Economy: A Moonshot Guide to Changing Capitalism. London: Allen Lane, an imprint of Penguin Books.

McKay, Adam, dir. 2021. Don't Look Up. Drama. Netflix. https://www.imdb.com/title/tt11286314/.

Møhl, Perle, Jakob Krause-Jensen, and Bettina Skårup. 2022. "Grøn Omstilling i det Blå Danmark." 3. Copenhagen: Aarhus Universitet.

OECD. 2019. "Ocean Shipping and Shipbuilding." Https://Www.Oecd.Org/. 2019. https://www.oecd.org/ocean/topics/ocean-shipping/.

Oudshoorn, Nelly, and Trevor Pinch, eds. 2003. "Introduction - How Users and Non-Users Matter." In How Users Matter: The Co-Construction of Users and Technologies. Inside Technology. Cambridge, Mass: MIT Press.

Poulsen, René Taudal, and Helen Sampson. 2020. "A Swift Turnaround? Abating Shipping Greenhouse Gas Emissions via Port Call Optimization." Transportation Research Part D: Transport and Environment 86 (September): 102460. https://doi.org/10.1016/j.trd.2020.102460.

Poulsen, René Taudal, and Henrik Sornn-Friese. 2015. "Achieving Energy Efficient Ship Operations under Third Party Management: How Do Ship Management Models Influence Energy Efficiency?" Research in

Transportation Business & Management 17 (December): 41–52. https://doi.org/10.1016/j.rtbm.2015.10.001.
RINA. 2018. "'More than Just Maersk': Denmark Stakes Its." Organization. Royal Institution of Naval Architects. April 2018. https://www.rina.org.uk/More_than_just_Maersk.html.
Rothblum, Anita M. 2011. "Human Error and Marine Safety." U.S. Coast Guard Research & Development Center, 9.
ShippingLab. 2022. "ShippingLab." Organization. ShippingLab. 2022. https://shippinglab.dk/about/.
Steffensen, Anne, and Peter Torstensen. 2021. "Dansk skibsfart rykker plads ned." Organization. Danish Shipping. January 7, 2021. https://www.danishshipping.dk/presse/nyheder/dansk-skibsfart-rykker-plads-ned.
Sunderland, P. L., and Rita Mary Taylor Denny. 2007. "Anthropologists and Anthropology in Consumer Research." In Doing Anthropology in Consumer Research. Walnut Creek, CA: Left Coast Press.
Trianni, A., and E. Cagno. 2012. "Dealing with Barriers to Energy Efficiency and SMEs: Some Empirical Evidence." Energy 37 (1): 494–504. https://doi.org/10.1016/j.energy.2011.11.005.
Vesterlykke, Sif. 2019. "Ny maritim forsknings- og innovationsstrategi." www.danishshipping.dk. December 16, 2019. https://www.danishshipping.dk/presse/nyheder/ny-maritim-forsknings-og-innovationsstrategi/.
Viktorelius, Martin, Hanna Varvne, and Hannes von Knorring. 2022. "An Overview of Sociotechnical Research on Maritime Energy Efficiency." WMU Journal of Maritime Affairs, February. https://doi.org/10.1007/s13437-022-00263-5.
Winner, Langdon. 2001. The Whale and the Reactor: A Search for Limits in an Age of High Technology. Nachdr. Chicago: Univ. of Chicago Press.
Woolgar, Steve. 1990. "Configuring the User: The Case of Usability Trials." The Sociological Review 38 (1): 58–99. https://doi.org/10.1111/j.1467-954X.1990.tb03349.x.