Intersectional Analysis of the Challenges and Opportunities of Equitable Remote Operation in the UK Maritime Sector

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The maritime sector is increasingly implementing Maritime Autonomous Systems (MAS), such as remote operation of boats. This paper examines the potential for remote operations to address equity issues in the maritime sector, particularly for historically excluded and underrepresented groups. The study adopts an intersectional Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to explore the social inclusion benefits and challenges of remote operations. Increased safety and flexibility are identified as key strengths, offering opportunities for inclusion of individuals who may have faced barriers in traditional seafaring roles. However, scepticism and a lack of influence among decision-makers are identified as weaknesses, hindering the recognition of intersectional realities and the allocation of resources for accommodating diverse perspectives in design and deployment of MAS. This research contributes a holistic understanding of promoting social inclusion amidst technological transformation within the maritime sector. By centring the voices of underrepresented groups, it aims to inform the development of strategies and policies that address equity issues and enhance diversity in the sector. The findings emphasise the importance of considering intersectionality and adopting responsible research and innovation principles in the design and implementation of autonomous systems.

CCS CONCEPTS • Human-machine collaboration • Maritime autonomous systems • Participatory design

Additional Keywords and Phrases: Intersectionality, Intersectional SWOT Analysis, Responsible Research & Innovation

1 INTRODUCTION

The remote operation of ships, in which autonomous or remotely controlled ships are monitored or controlled from a control centre on shore is not something of the future. These Maritime Autonomous Systems (MAS) are being increasingly rolled out across the world right now. In the UK, the first autonomous ship was registered in 2017, and it is used for surveying and monitoring the environment [12]. In Norway and Japan, autonomous ships are being tested for container shipping and carrying cars or trucks [16,27]. Whilst most autonomous ships are remotely controlled or monitored by operators in remote control centres nearby, they may also be remotely controlled from a long distance such as controlling ships in Sweden from the UK to finish an environmental survey [10]. In the future, some ships may operate fully autonomously, such as The Mayflower autonomous ship trial, which garnered media attention for its mission to sail from the UK to the US autonomously without remote control. The trial had positive results but has not fully succeeded yet [2,11]. For now, remote operations will be a key area for growth within the sector, involving many tasks in which human operators in the loop will be necessary.

We ask, given this opportunity for growth within the sector, who stands to gain and who stands to lose out? Historically, the maritime sector has been referred to as a male-dominated environment rife with 'toxic-masculinity.' National statistics show that 82% of UK seafarers were male in 2021 [8]. Equity issues for women in the maritime sector are ongoing. These issues include cultural stereotyping, lacking essential safety equipment, discrimination, and harassment [1,25]. Women rarely make it to senior positions in the maritime sector, seeing limited opportunities for career progression [15]. Likewise, other underrepresented groups in the maritime sector also face equity issues. Yet, we know much less about the challenges facing diverse underrepresented groups, such as ethnic minoritized populations, LGBTQIA+, religious minorities, people living with disabilities or neurodiversity because disaggregated data is simply not available. Through the introduction of remote operations, we question whether and how the needs and aspirations of historically excluded and underrepresented groups may be met. What are the opportunities and challenges that remote operations present towards resolving some of these equity issues?

In this paper, we contribute knowledge of a comprehensive understanding of utilizing remote operation technologies to improve social inclusion in the maritime working environment in Strengths, Weaknesses, Opportunities, and Threats (SWOT) through an intersectional lens. This can benefit MAS by positively enhancing the public perception towards it, especially those who have been excluded from the maritime sector. In addition, we show that intersectional SWOT analysis can be a responsible research & innovation (RRI) tool. In the coming sections, first, we discuss the historical context of inequalities in the maritime sector; second, we look at the current situation of ship remote operations; third, we outline our research method and how we adopt the RRI principles; fourth, we present the SWOT analysis of four aspects respectively; finally, there are the discussion and conclusion of this research.

2 INEQUALITIES IN THE MARITIME SECTOR

Data published by the Department for Transportation on Seafarers statistics shows a persistent gender inequality (Table 1), with women taking up between 3 and 7% of seafaring positions, and not more than 2% within engineering roles. Information about age and nationality are also available, showing the likely presence of other inequalities. Yet, research outlining inequalities in the maritime sector is scant, and typically focuses on the perspectives of women, using a single-axis framework. Bakhsh [1] and Kinthaert [15] presented concerns around mindset, culture and gender-related stereotypes and how they create a socially exclusive environment for women. Kim et al. [14] highlighted intimidation, bullying, and sexual harassment as key issues to confront, and that shipping companies often regard women as 'short-term' options because they assume that they will leave their job to have children. Other studies show that equipment and facilities on

ships are typically designed for men [1,25]. Working on ships can be hard, as it functions like a self-contained microcosm, it is isolated, and hierarchically controlled [14]. Seafarers can therefore face increased risks of marginalization or discrimination if they are underrepresented on board. Moreover, seafarers are not covered by the Equality Act 2010. They have some restricted protections against discrimination on ships flying UK or EEA flags, but no protection on ships with non-UK or non-EEA flags [26].

Table 1: Departmental profile of maritime officers by gender[a]

Type	Capacity	Total gender	% male	% female
Deck	Master	2,375	97%	3%
Deck	Chief Mate	970	94%	6%
Deck	OOW Deck	2,600	93%	7%
Deck	All deck Officers (CoC)	5,950	95%	5%
Engine	Chief Engineer	1,385	99%	1%
Engine	Second Engineer	975	99%	1%
Engine	OOW Engineering	2,380	98%	2%
Engine	Electro-technical Officer (ETO)	380	98%	2%
Engine	All engineers (CoC)	5,125	98%	2%
UK officers with Certificates of Competency (CoC)	All	11,075	97%	3%
Non UK officers with CEC	All	9,255	99%	1%

[a] Data taken from Department for Transport Seafarer Statistics, 2022 (https://www.gov.uk/government/statistical-data-sets/seafarer-statistics-sfr).

However, new initiatives are being created in the maritime sector to tackle some of these inequalities. The UK's Maritime 2050 People Route Map is a long-term strategy that establishes the goal to expand the UK maritime talent pool by addressing diversity [6]. However, clear targets are not set. Maritime UK, which is the trade association of the maritime sector in the UK, launched the Diversity in Maritime program in 2020. This program aims to create a fair, equal, and inclusive working environment, focusing on recruitment, progression, and support. It launched four networks targeting women, mental health, LGBTQIA+, and ethnic inequalities [21]. The program also created the Diversity in Maritime Charter, which has now been signed by 14 organizations pledging to improve diversity and inclusion [22].

This paper is part of an ongoing project that investigates intersectional theory/praxis to identify and address inequalities in MAS. Intersectionality is a theory/praxis that originates from Black feminism that uncovers intersectional inequalities that are caused by overlapping systems of oppression [4,5]. Inequalities may emerge for seafarers from underrepresented groups such as women, ethnic minorities, LGBTQIA+, religious minorities, foreign nationals, or people living with disability or neurodiversity. It is often the case that inequalities compound due to how multiple aspects of a person's identity come together in a time and place. For example, Table 1 shows that there are 2% (out of 3% total) fewer female non-UK officers, where non-UK officers are frequently from countries such as Poland, Philippines, Ukraine, Russia, Italy or India, such that gender and race relations combined may shape structural inequality and disadvantage significantly differently in those places. Our approach to intersectionality aligns with Collins' [4] view that intersectional analysis must go beyond this type of additive thinking alone, to examine root causes of systemic injustice, and to engage underrepresented groups in political processes aimed at addressing and overcoming social injustices.

3 REMOTE OPERATIONS IN THE UK

Remote operations in the UK may be an opportunity to resolve equity issues in the sector, but little has been done to consider how or why. Within the scope of the UK regulatory environment, a consultation for maritime autonomy regulation conducted by the UK's Department for Transport highlighted that a barrier to developing UK's regulations for autonomous ships and remote operations is the International Maritime Organization (IMO). As the maritime sector is a global industry, the IMO has significant influence over how regional regulations develop, and they do not intend to produce new regulations in this area before 2028 [7]. In contrast, the Maritime & Coastguard Agency (MCA), which is the UK's maritime authority, is expected to publish the Merchant Shipping (Small Workboats and Pilot Boats) Regulations this year, which will replace the current 1998 version and cover remotely operated uncrewed vessels [18]. Remote operations within the UK are expected to increase as a result.

One of the main regulatory bodies providing leadership in this space since 2017, is the Maritime UK Autonomous Systems Regulatory Working Group (MASRWG). MASRWG published the Maritime Autonomous Surface Ships (MASS) UK Industry Conduct Principles and Code of Practice, with updates annually. This is a set of guidance for stakeholders of autonomous ships in the UK, including definitions, recommendations for ship design, training, cyber security, safety, and etc. [19,20]. For MASRWG, wellbeing in remote control centers, building a just culture in the working environment, and raising awareness of the risks of this type of work are priorities [20]. Yet, more can be done to outline how such priorities can be achieved.

Within the context of UK-based remote operations, companies such as Ocean Infinity and Fugro, are expanding [9,23]. These companies may use autonomous underwater vehicles (AUV), remotely operated underwater vehicles (ROV), and autonomous ships for tasks such as subsea data collection, or to conduct inspections or surveys at sea [10,17]. Although it is necessary to understand the steps they have taken, or the challenges they face when recruiting, training and keeping remote operators, this is outside of the scope of this paper. Instead, we investigate these issues from the perspectives of underrepresented groups.

Our focus is on how best to resolve inequalities in the maritime sector by centering the voices of underrepresented groups in confirming opportunities and shaping responses to challenges. In the next section, we introduce intersectional SWOT analysis as a key way to do this.

4 METHODS

This study utilized an intersectional SWOT analysis, which is a variant of the commonly used SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis in strategic planning within business contexts [3]. Jeremiah et al. [13] combined intersectionality and SWOT analysis in their research on the health and wellbeing of minority groups, positioning health and wellbeing concerns raised as linked to, and formed by institutional contexts and power dynamics.

The intersectional SWOT analysis framework employed in this study aligns with the AREA (Anticipate, Reflect, Engage, Act) responsible research and innovation framework [24]. By exploring both positive and negative aspects, this intersectional SWOT analysis provides a balanced method to anticipate impacts. However, given the nascent status of the emerging remote operations industry, whilst we have reflected on the information derived across quadrants holistically, it would benefit to return to our conclusions periodically as the industry continues to grow. In contrast, the engagement methods we have used to underrepresented groups stand to contribute to RRI practice. In collaboration with the MCA, we developed a serious game in which participants explored remote operations scenarios, which aided discussion and the surfacing of views, opinions, and experiences in relation to the research theme. It also provided a means for participants to anticipate consequences and assist in the co-design of intersectional design and deployment guidelines. These guidelines

provide recommended actions for MCA and industry stakeholders to take. We have likewise been working collaboratively with the MCA as a means of maximizing the relevance and utility of the guidelines simultaneously.

Data for this study were gathered through interviews and a workshop conducted as part of the TAS Hub pump priming project, Intersectional Approaches to the Design and Deployment of Trustworthy Autonomous Systems. Data collection was ongoing at the time of writing this paper. Participants from diverse roles related to remote operation, policy, design, and support were included based on self-identification with at least one of the following personal characteristics: being a woman, belonging to an ethnic minority, identifying as LGBTQIA+, being a religious minority, being a foreign national, or living with a disability or neurodiversity, combined with experience working within the maritime sector (Table 2). Many of our participants had experience across multiple roles, holding multiple intersectional identities. To protect confidentiality, given the relatively small population of women seafarers and remote operators in the UK, and largely unknown population of other underrepresented groups, we have disaggregated their roles and characteristics to give the reader a sense of common characteristics. All participants held significant experience in the maritime sector, with careers spanning multiple roles, and often, significant leadership responsibilities.

Table 2: Participants and their characteristics

Role	Underrepresented personal characteristics held by participants	Experience level of participants
Policy-maker (3)	Women (4)	More than 20 years (2)
Ex-seafarer (5)	Ethnic minority (2)	More than 10 years (6)
MAS designer/ industry representative (3)	Religious minority (2)	More than 5 years (1)
Remote operator (1)	Older in age (2)	
Seafarer training, education, or coaching (3)	Foreign national (3)	
Total participants: 9	Expertise in neurodiversity (1)	

Ethical clearance for this research was obtained from King's College London. To ensure participant confidentiality, all names were changed, and any personally identifiable details were removed. We use pseudonyms to make the participants' quotations more personable, and to signal the importance that embodied and lived experience has within our analysis. As the intent of our research was to engage our participants in a co-design process, and we did not intend to establish a representative sample for any specific underrepresented group. Nevertheless, participants were asked to reflect on personal experiences and discussed and debated a range of topics and issues across diverse perspectives. These debates and discussions serve to highlight the priorities and concerns of underrepresented communities that often become overshadowed. The researchers qualitatively coded these data thematically according to the SWOT analysis framework to highlight these concerns in a balanced and reflective way.

5 STRENGTHS: INCREASED SAFETY AND FLEXIBILITY

A main strength identified relates to the unique potential that remote operations offers to include those who have not been able to work as seafarers or chose not to. On the one hand, this view asserts that remote control centers could limit discrimination and create affirming spaces, becoming attuned to the needs and perspectives of underrepresented groups. On the other hand, participants often framed the strengths of remote operations in terms of what it is not – namely it is not working at sea. Safety risks and hazards at sea are significant, with potential collisions or extreme weather providing an

ominous background to daily activities. Moreover, working in a remote control center has a clearer jurisdiction than working at sea:

> Apart from some cruise ships, there's no way of acquiring forensic evidence in the case of a serious sexual assault, for example, there's even less chance of being prosecuted, in international waters, (different) flag state of the ship... Nobody goes through a DBS (Disclosure and Barring Service) check, even to go into any oil field and UK waters, nobody also needs to have a criminal record check to go work on a cruise ship where you can have children and vulnerable adults. You can just go from one flag state to another flag state. There's no mechanism for you to even lose your ticket (qualification) if you're convicted of a serious assault on board a ship (Claire, female, 30s).

She then added:

> I would feel safer in a control center than I would in a cabin on a ship where somebody can come into my cabin... (in the control center) If a serious assault was to happen... I know I'm able to call the police, get forensic kit done. There's a legal jurisdiction that covers me (Claire, female, 30s).

Increased safety is a huge strength given utmost importance by participants. Indeed, members of the LGBTQIA+ community may also see remote operation as a way to increase their safety as being gay, lesbian or transgender is illegal in many countries that ships sail to.

Increased flexibility in working patterns was seen as another strength. Although increased flexibility was often seen as 'not away for months at a time,' remote operations can take place over 24 hours, offering possibilities for shift work in the night or day. For Beverly (female, 40s), it opens the possibility to work in the sector again, saying, "I am a mom and I would never want to go to sea [again], leaving my child behind." Other seafarers who may have needed to return to shore to take care of children or family members could utilize their skills in this new profession. Likewise, seafaring is physically laborious, and one participant felt that an onshore working environment provides more possibilities for (ex-)seafarers to extend their professional lifetimes. It also eases some of the pressure from seafarers who may feel anxious about getting injured on the job with no alternatives to return to.

However, many participants felt that remote operations could create careers for people who have never worked as a seafarer before because they would not be able to qualify. People living with disabilities, such as hearing-impairments or wheelchair users could have reasonable accommodations made for them in a remote control center. Adjustable devices (chairs, screen mounts), or human-machine interaction can be modified, customized and tailored to individual needs. As Beverly (female, 40s) said:

> (Highly sensitive people may want to) have their own desk separated from others for them to concentrate better... Just ask them what they would like and what kind of environment they would like to thrive in and work in. And it might be as simple as working from home for two days a week, but that if you are at sea that you cannot do that.

These strengths outline why remote operations may be attractive to underrepresented groups, indicating that there is interest in engaging more diverse people to work as remote operators, but this is by no means a guarantee.

6 WEAKNESSES: SCEPTICISM AND LACK OF POWER TO INFLUENCE DECISION-MAKERS

Individuals from underrepresented groups are always aware of intersections of aspects of their identity such as their ethnicity, class, gender identity, sexuality and/or disability, but rarely do they feel comfortable to express intersectional disadvantage or discrimination in public, with crew-members aboard ships, or more generally in maritime operational environments. Because maritime operational environments currently lack diversity, there are limited opportunities to share

with people of similar background or experience. Consequently, underrepresented groups may continue to avoid the sector, as Claire suggests from her experience in remote operation:

> ... getting the benefit of both worlds [doesn't] exist. So we're not attracting individuals that are actually often minority individuals that didn't know about the sea or didn't know the opportunities or for reasons of socioeconomic background or all sorts of other factors could not go to sea.

Remote operations centers may have limited awareness of the needs or aspirations of underrepresented groups, unable to recognize the intersectional realities some of these communities face – especially in terms of a person's socioeconomic position as Claire mentioned.

Of greater concern was the skepticism that there would be any economic justification or political will to make reasonable accommodations. As Ron (male, 40s) said:

> If you divers[ify] further than [the situation we are currently in], the outlay of money to actually design the equipment is not going to make it financially possible. So, you have to stop at some point and say 'OK, we can include these, but we can't include everything.

Ron is referring to the costs associated with MAS customization, but the underlying assumption is that MAS designers do not ultimately consider or design for diverse perspectives. Across interviews and the workshop, the notion of 'men designing for men' was a common refrain. Women reflected on chairs and operating equipment that they could not use, or that screen readers only in English or multiple dashboards might be difficult to use for the many migrants that speak English as their second language. Without greater engagement or awareness of the perspectives of diverse users, skepticism that the needs of underrepresented groups creep in.

Additionally, it is not just MAS designers that need to have an awareness, but executives, policy-makers and managers as well. In particular, creating affirming work environments in which intersectional perspectives are valued and respected, and in which individuals do not expect to confront micro-aggressions or discrimination is a weakness. On the surface, some accommodations within working environments may easily be afforded, as Claire (female, 30s) said, "hir[ing] more women [requires] facilities to be able to breastfeed or other forms of childcare support." Similarly, a prayer room or opening control centers in localities closer to where members of underrepresented groups live could help. Yet, it is only when diverse operators enter the workforce and begin to reflect on intersectional experience that underlying issues may come to the surface. Furthermore, qualifications may need to be re-examined and revised to consider different pathways into this career, as Paula (female, 30s) noted, "I haven't had formal sea time. I can sail. I have been on boats, around boats my whole life, but because I don't have a ticket [qualification]" she would not be able to work as an operator at present.

7 OPPORTUNITIES: BLANK SLATES AND NEW QUALIFICATIONS

Most of the opportunities discussed focused on the fact that remote control centers are new, and thus offer the potential to recruit employees, and build inclusive organizational culture from the beginning. For Ron (male, 40s) this meant that remote control centers need not only hire more diverse workers, but ensure that all employees coming into the company shared the company's values to create an affirming work environment:

> If you're looking for a specific workforce, which includes women and people of color. You need to screen for those biases in people that are not that workforce… so that you don't employ people coming into your company that will actually affect your sort of core values of the company.

Similarly, Paula (female, 30s) commented that having enough people within the company that share the same values can help:

> You balance the training and bringing everybody on and along with that [preventing discrimination], because there are cultural elements to it, so there will be smoothing or evening out that to a kind of universal position on it and collecting the information as it goes. If ones slip through, it doesn't stop it, but it gives you more chance to kind of check that the whole ecosystem is working.

Paula, along with others felt both setting standards within the organization and ensuring that everyone is involved in creating an affirmative organizational requirement should also enable a more diverse workforce.

Additionally, as mentioned in the previous section, participants such as Paula and others, see opportunities to gain new skills and qualifications that were either previously out of reach or that may become available due to the affordances of new technologies and how autonomous systems are becoming operationalized. For example, we spoke of how getting promoted to Master is colloquially called 'dead man's shoes.' Ron shared how at his company, 95% of the employees have been there 10 years, since the vessel's contract had started. In his role, there is very little training or opportunity to progress up the ranks or make a horizontal change in his career. In some respects, there is a similar risk of this happening in remote operations as supervising operators from the perspective of mission control, or communications may require completely different skillsets than operators. Yet most participants felt there was less of a likelihood of 'dead man's shoes,' in addition to other new training and career progression opportunities. In Claire's (female, 30) view, her remote control center has:

> lots of young people coming through, a lot of them do all their seats are only on cruise ships for example, whereas they can come in to ask for a week or two and get exposure and experience for offshore survey operations to broaden the horizons cause this country, we are terrible at giving people broad opportunities.

In continuing her train of thought, she reflected on a time when they had finished their work:

> and we said right, anybody in the office that wants to come see a remotely operated little yellow boat come have a look… and the enthusiasm on our receptionist's face and a few other people's faces when they got [it] and all they were doing was [moving] a joystick… But that is how you inspire people to… imagine if you have school kids doing that for a day and that is then how we tackle some of the recruitment challenges of getting underrepresented groups.

In addition to the excitement around learning a new skill, Claire also suggested that in the future, remote operators could also foreseeably gain qualifications in remote operation of drones. If operators were able to gain qualifications across sectors, they would be able to access opportunities to progress in their career horizontally as well as up in the ranks.

8 THREATS: WHO IS QUALIFIED TO REMOTELY OPERATE A BOAT?

A main threat relates to a debate that is happening within the maritime sector regarding who is, or may be, qualified to work as a remote operator. This debate poses a threat to equitable remote operation, because it may limit the strengths and opportunities available to underrepresented groups. On one side of the debate participants argues that it is necessary for remote operators to have offshore experience:

> If you don't have that actual experience in the past of being on a ship, seeing this wind gradually increase and start, you know, feel the ship thrusting more. It's the ship that is the one that's losing… losing position. You tend to feel those thrusters before you see the red-lining on the screen. I don't think you can necessarily replace that experience quickly (Claire, female, 30s).

In Claire's view, she felt that prior experience at sea was required to anticipate emergency situations. Whereas, on the other side of the debate others felt strongly that this experience could be gained through other means. In response to Claire, Paula

(female, 30s) said, “but you’ve learned that… If you never learn that behavior, you don't rely on that behavior.” Others chimed in to support Paula’s view:

> I think the sea experience is vital in the development of the equipment... But operators themselves, I think should come from a new face. The younger generation who has special awareness from a 2D screen that I can only dream (Carl, male, 50s).
>
> I don't agree with that... [just like] you would never understand in your stomach what it is like to be at war, but we can study it rationally... My daughter, she knows more about how to operate my iPhone than I do. It's natural. So you create from our next generation, not us that we're lost cause, but the next generation you create a new type of seafarer (Beverly, female, 40s).

Whilst it appears that provisions are being made for training pathways that would include people that do not hold seafaring qualifications, the answer to this debate is not yet fully resolved.

Moreover, the international scope of remote operations likewise poses intersectional threats to the opportunities for underrepresented groups in remote operation. For instance, the P&O Ferries ordeal that happened last year highlighted how precarious UK maritime employees can be within international maritime operations. In one fell swoop, 800 employees were replaced with (cheaper) foreign workers, spurring further xenophobia and mistrust in the UK. For remote operations in international waters, there may be no reason to have remote operation centres located within the UK. Whilst this scenario poses a threat to UK residents and nationals, it may certainly be regarded as an opportunity by others in less advantaged places.

9 DISCUSSION

In this paper, we use an intersectional SWOT analysis to investigate the potential to resolve inequalities in the maritime sector through the introduction of remotely operated ships and control centers. Remote operations are a type of Maritime Autonomous System that are increasingly taking root across the UK for environmental monitoring, surveying, and other activities. Our intersectional SWOT analysis revealed important insights into the lived realities of underrepresented groups, with participants who reflected on their experiences of working in the maritime sector and being a woman, ethnic minority, older in age, and/or foreign national. We listened to how some of our participants keep embodied seafaring experiences within them at all times, negotiating their identities, and fighting for their safety and security. Our results support previous research findings and suggestions that underrepresented groups face considerable discrimination and disadvantage within a sector that favors particularly middle-class cisgender, Caucasian males. With the advent of remote operation, an opportunity presents itself to shift the dynamics seafarers, sometimes reluctantly, face. However, little is known about whether and how remote operations will support a more diverse workforce or more equitable employment. This study engages in intersectional practice, by centering voices of members of underrepresented groups to investigate this topic and propose appropriate ways forward.

In an ideal scenario, remote operation can remove many barriers and challenges that stood in the way for women, people living with disabilities, LGBTQIA+ communities, amongst others, and that they encountered whilst working in the maritime sector. Above all else, a key strength of remote operations relates to the increased safety that many participants immediately acknowledged. Sexual assault, harassment, and bullying can be regular occurrences aboard ships, yet when ships sail in international waters, it is incredibly difficult for seafarers to access justice. We listened to horrifying details of violence and abuse that created vivid pictures of just how important the safety of the work environment aboard ships can be. Our intersectional analysis highlighted how the magnitude and type of risk can be experienced and felt significantly differently by various underrepresented groups such as women or ethnic minority seafarers. It was largely assumed that

remote operations would provide safer physical work environments. Yet, new safety risks may be introduced if MAS are not designed appropriately. Women, in particular, reflected upon experiences of inappropriate human-machine interaction design, and the lack of knowledge or testing of their specific requirements. Alternatively, it was noted that some remote operation companies have been making their work environments wheelchair accessible, along with other ergonomic design features to accommodate diverse needs. Although the Maritime 2050 People Chapter [6] framed diversity as an awareness and training issue, we showed how intersectional analysis of participants' experiences and concerns relate also to the design of MAS technology as much as to qualifications and aspects of the work environment. Many participants were skeptical that MAS designers and remote control centers would willingly accommodate the needs and aspirations of underrepresented groups if it was too expensive to invest in human-machine collaboration research and design.

Additionally, although the participants all felt strongly that remote operations offered safer new opportunities. There are different reasons for this when examining intersectional perspectives. Intersectional disadvantage faced by men or ethnic minorities may at times be more subtle. Male participants spoke of risks associated with disclosing mental health problems, and the culture surrounding seafarers that makes them feel disposable. This is in addition to the apparent sexism, heteronormativity, and systemic racism that may ultimately seep (back) into newly formed remote operations. Despite the potential for underrepresented groups to work now as remote operators, a main weakness is that MAS systems and organizational structures within remote operation centers may lack awareness, policy and practice to recognize and affirm the intersectional realities of underrepresented groups.

Indeed there were tensions and differing opinions whether the legacies of maritime seafaring culture, reported by participants as problematic, could be eliminated as with a blank slate. Some participants believed that there are many opportunities to change organizational culture for the better. Many mentioned focusing on recruitment and management strategies, as well as a host of changes to the operational environment are needed to create affirming work environments in which underrepresented groups feel valued. But they also wanted stronger policies and enforcement to ensure that respectful and inclusive values were shared by other organizational members. Moreover, when participants compared their prospects for career progression and growth, many remarked that the opportunity to learn new skills and take alternative routes into and alongside remote operation was highly desirable. A key tension and threat to ensuring equitable participation in remote operation is whether or not people who have not trained or gained qualifications or experience in seafaring should be able to work as remote operators. Although we listened to differing opinions on this matter, what is clear is that more research into the benefits and drawbacks of other learning methods (than experience on water), such as simulation, for the safe and trustworthy operation of boats.

Our intersectional SWOT analysis further confirmed the value of using intersectional analysis within responsible research and innovation practice. It allowed us to understand the views and perspectives of members of underrepresented groups on remote operation in a way that emphasized reflection on the matter from their unique standpoints. In sharing experiences from their own standpoints, and frequently not in categorical terms (i.e. as a woman or a person of color), enables a holistic evaluation of remote operation via its strengths, weaknesses, opportunities and threats. Certainly, many strengths and opportunities will be shared by participants and others. Yet, prioritizing the value of the strengths and opportunities in the context of the weaknesses and threats would likely be different.

10 CONCLUSION

In conclusion, our participants have made it clear that they want to work with organizations that are sensitive to their needs and realities. A holistic strategy that takes into account not only the opportunities for growth, but also flexible working patterns, organizational culture and support, as well as training and career progression are necessary in light of

intersectional realities. Moreover, within the context of autonomous systems, addressing diversity also requires research and investment into human factors and human-machine interaction from diverse standpoints. One of the most important takeaways from this research is the need to affirm and address the realities of underrepresented groups in remote operation. This may need careful operationalization, incorporating multiple avenues of MAS design, user experience testing, or simulation as well as making organizational commitments, changing or establishing inclusive organizational culture, and action-planning. In addition to reducing inequality in the maritime sector, these strategies have the potential to make remote operations a pillar of success for the TAS industry.

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