The role of a Human Host onboard of Urban Autonomous Passenger Ferries

Leander Pantelatos, Mina Saghafian, Ole A. Alsos
dept. of Design
Norwegian University of Science and Technology
Trondheim, Norway
e-mail: leander.s.pantelatos@ntnu.no
e-mail: mina.saghafian@ntnu.no
e-mail: oleanda@ntnu.no

Asun Lera St.Clair
Group Technology and Research
DNV
Oslo, Norway
e-mail: asun.lera.st.clair@dnv.com

Øyvind Smogeli
Zeabuz AS
Trondheim, Norway
e-mail: oyvind.smogeli@zeabuz.com

***Abstract*— Zero-emission Urban Autonomous passenger Ferries (UAFs) is a promising concept to serve as flexible, cost effective and sustainable public transport utilizing urban waterways. The perception of users and their attitudes plays a vital role in acceptance and use of autonomous technologies. For UAFs to be accepted, there are more factors to consider beyond having a robust and mature technology. The public should perceive it as safe, trustworthy, and convenient to use. In the future, from a technical perspective, abandoning a human host onboard is possible when reaching a higher level of autonomy. To understand the consequences or implications of human host removal in the future, we need to understand the current influence of the human host onboard. This research aims to shed light on the role of the human host onboard in acceptance and use of the UAF, and the implications it has for implementing remote supervision of such a ferry. We address this through the analysis of a set of citizen engagement activities performed as part of an ongoing R&I project exploring trust in zero emission UAFs. The citizen engagement consisted of table discussions, VR mixed reality simulations, and in-situ trips in the fully functional autonomous ferry prototype milliAmpere2. The findings outline six sub-themes to define the significance of a human host onboard an UAF. The qualitative results show that the perceived importance of the presence of a human host onboard is decreasing throughout the sessions. This is in a non-linear fashion, and especially after the immersive sessions. The context of where and how the ferry trials were conducted, meaning short distance within enclosed waters and the use of a small UAF, allows for alternatives to the full-time onboard presence of a safety host to be discussed.**

Keywords-urban autonomous ferries; citizen engagement; safety; trust; acceptance; convenience; level of autonomy; remote supervision.

I. INTRODUCTION

Autonomous technologies including unmanned ships in the maritime sector are gaining popularity due to their potential benefits, namely cost efficient, environmentally sustainable, and safe maritime transportation [1]. Currently, around 90% of the urban areas, including several of the largest cities in the world are coastal [2]. With urban sprawl across the globe, urban population is expected to increase, thus requiring better integrated, sustainable, and more efficient modes of transport ensure the quality of mobility and life in urban spaces [3]. Battery powered zero-emission Urban Autonomous passenger Ferries (hereafter UAFs) can be a solution for future public transport in cityscapes. This solution has been partly explored as in for example the modular system Roboat in Amsterdam [4], the passenger service Captn Vaiaro in Kiel [5], and the AutoFerry project in Trondheim resulting in the prototypes milliAmpere1 (mA1) and milliAmpere2 (mA2) [6]. Autonomous systems can be characterized by their Level Of Autonomy (LOA). [7] has defined five levels of autonomy for UAFs specifically, ranging from manual operation (level 0) to full autonomy with remote support (level 4). Level four would imply the UAF to monitor itself and the passengers, make decisions and determine actions by itself, and asking for assistance when needed. The operation of the ferry within a fleet of several, is monitored by operators at a remote support centre, similar to an air traffic control centre in its structure. Local emergency response would handle any emergency situations occurring [7]. The prototype mA2 is currently operated at level 2 (onboard supervised autonomy) but aiming towards operating at level 4 (Full autonomy with remote support).

Beside the technological development required to reach higher levels of autonomy, investigating user perceptions is important to understand various risks associated to UAFs. Reference [8] rightfully highlights the importance of understanding publics risks and safety perceptions and risk communication. In the work of reference [9], societal communication is emphasised to establish trust related to the operation of autonomous systems. However, there is a gap in perceived benefits, concerns, and safety perception of autonomous solutions and specifically urban autonomous ferries, which motivated [3] to fill the gap by investigating user perceptions towards UAFs amongst the senior urban population in Halifax, Canada.

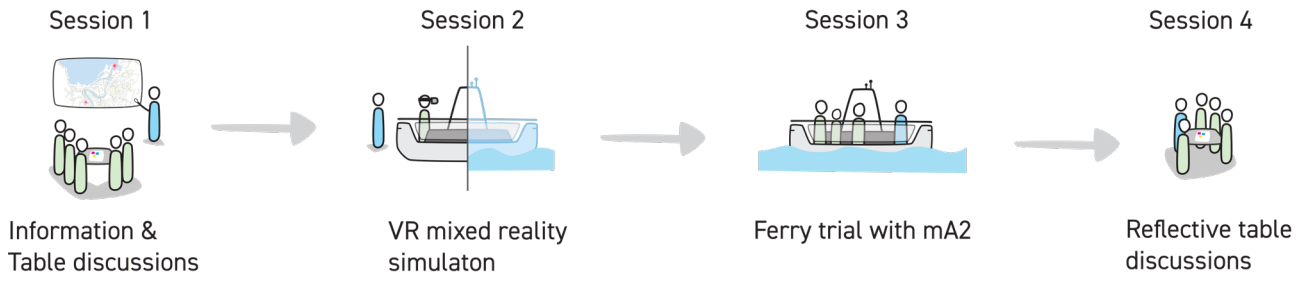

Figure 1: The four sessions of the citizen engagement.

A key finding there, was that increased levels of autonomy was supported, with the condition that an onboard operator would be present [3]. Both in the perspective of safety (personal and vessel related) and security (especially physical), an onboard operator would alleviate those concerns [3]. As such, the onboard operator is the doorkeeper to introduce fully unmanned UAFs towards the higher levels 3-4 defined in [7]. This paper seeks to explore the role of a human host onboard UAFs, and to discuss possible measures needed for a trustworthy operation of fully unmanned UAFs.

The study is conducted through citizen engagement, where the participants would experience the fully functioning UAF prototype mA2. The use of an immersive VR mixed reality simulation, as well as the functioning prototype to explore and evaluate the user perceptions is, to the knowledge of the authors, a novelty in the given context.

This paper is part of the TRUSST project – Assuring Trustworthy, Safe and Sustainable Transport for All. The primary objective of TRUSST is to innovate an integrated assurance framework, stemming from an interdisciplinary and socio-technical perspective. This project is a collaboration between DNV, as risk management assurance provider, Norwegian University of Science and Technology (NTNU) and Zeabuz, a spin-off company from NTNU seeking to introduce autonomous cost-cutting waterborne mobility solutions.

As part of the citizen engagement objective, we have used a multimodal data collection method which will be described in section II. Quantitative and qualitative results are presented in section III. A discussion and presentation of future research concludes in section IV.

II. Methodology

This research was conducted through an exploratory approach due to the context novelty. The overall aim was to gain a deeper understanding of the public perception of UAFs. In this paper we will focus on the data regarding the significance of the human host onboard and the implications of removing the human host when progressing towards level 4 (remote supervised autonomy), that was collected over the length of four sessions. The overview of the sessions design and the detail about the participants is presented next and can be seen in detail in appendix 1.

A. *The sessions*

Altogether 4 sessions (Figure 1) were conducted consisting of:

1. Information and table discussions
2. An immersive virtual mixed reality simulation of the ferry trial between Ravnkloa and Vestre Kanalkai (Figure 2, right)
3. Real ferry trials with the autonomous prototype milliAmpere2 within the real context (Figure 2, left and middle)
4. Reflective table discussions

The sessions focused on the topics of safety, sustainability, and societal impact. The study was designed this way to both capture initial perceptions, but also to see how this would change after more knowledge and immersion with the overall concept. The arrangement of several workshops with some time in between was done to capture both immediate feedback and reflected answers. The citizen engagement activities were designed under the guidance of Missions Publiques [10], a professional citizen engagement consultancy.

1) Table discussions: Before the first session a briefing was provided to the participants with basic information and some pictures of the UAF concept by Zeabuz. As soon as the participants arrived at the first session the first questionnaire (WS1-A) was handed out to capture the initial perceptions of the participants. This was followed by informative presentations on future possibilities for urban spaces, the technology, and a visualized user journey. Afterwards, four groups were formed for a table discussion. The table discussion was guided by large worksheets which contained a set of questions which are listed in the appendix 1. For each question the participants were asked to reflect on their own and note their thoughts on post-its. Then the post-its were posted on the big sheet and presented to the group, whereby a discussion arose naturally. A plenary presentation of the discussion concluded each question. During these plenary presentations the participants also had the chance to ask questions to the different stakeholders present. Each group was accompanied by a facilitator taking notes and keeping time. At the end of the session a second

questionnaire (WS1-B) was handed out to capture changes in participant perceptions after the interactive session.

2) VR Mixed Reality Simulation: In the second session the participants were offered to try a VR mixed reality simulation of mA2 in the canal. This was conducted with the use of two full-size mock ups of mA2 and thereby making it a tangible VR lab as described in [6]. Three different scenarios were simulated as described in appendix 1. A facilitator was following the participant during the whole simulation and taking notes on behaviour, actions, and thoughts of the participant. After the simulations a questionnaire (VR) was handed out to capture the participants immediate thoughts. A focus group moderated by a facilitator concluded the session. An interview guide for the facilitator was prepared. The session was conducted in smaller groups (5-7 participants) spread over three different dates, where the participants could choose a preferred date.

3) Ferry Trial: Following the same structure, the third session offered a real ferry trial with the prototype mA2 (Figure 2), spread across three dates in smaller groups. The trials were divided in two parts, where the ferry crossed the canal without interventions in the first part, whereas in the second a leisure boat simulated traffic crossing the route and provoked mA2 to act. Two engineers onboard monitored the autonomous system during all the trails and answered questions the participants would have. Two facilitators noted behaviour, actions, and thoughts of the participants. It should be noted that the personnel on mA2 during the ferry trials would only partly play the role of a human host [3], or in the case of autonomous buses [12]. There was not a designated human host aboard. As in the VR session, a questionnaire (FERRY) was handed out and a focus group concluded the session.

4) Reflective Table Discussions: Lastly, a reflective session with a similar structure as in the first session was conducted (appendix 1). Divided into smaller groups, a set of open-ended question were asked in order for the participants to reflect on and build recommendations for the further development of the UAF concept. The table discussions, conducted in the same manner as in session 1, were followed by plenary presentation of the recommendations discussed in the groups. At the end a final questionnaire (WS2) was handed out.

B. Questionnaires

Through the sessions five different questionnaires were handed out. The questionnaires consisted of both a quantitative and qualitative part. Some of the questions were repeated through several and even all the questionnaires. This allowed investigating how the different sessions would influence the participants. As the context was new, the questions were developed through brainstorming within the research team and inspired from earlier studies within the field of autonomous transportation such as [3], and a local study with an autonomous bus service in Trondheim conducted by the public transport company AtB in 2020 [13]. The quantitative part consisted of 5-point Likert scale questions about safety, society and sustainability. The qualitative part consisted of open-ended questions where the participants were asked about thoughts, needs, expectations related to UAFs, in the light of the recent workshop. Appendix 1 gives an overview of the questionnaires and questions asked and analysed in this paper.

C. Participants

Due to the resource intensive nature of the study, the citizen engagement was designed for a maximum of 20 participants. Altogether, 15 participants completed all four sessions who consisted of 47% women and 53% men. The age stretched from 19 to 64 years, with an average of 42 years. An age-limit was set to 18 years. Emphasis was put on recruiting an adequate representation of the inhabitants of Trondheim already using public transport in the city centre. The recruitment was done through the recruitment office Nordic Viewpoint, based on a recruitment profile that was

Figure 2: Prototype mA2 (left) (Photo: Ole Andreas Alsos), area of trials in Trondheim (middle) adapted from [11], VR mixed reality simulation (right) (Photo: Nicholas Lund).

produced by the research team to ensure an adequate representation of the inhabitants. The recruitment profile included postal codes, use of public transport, gender, age, disabilities, education, and ethnicity. Additionally, a slight overrepresentation of young adults was granted due to the large student population in the city. The selection and transference of contact details of the participants was GDPR compliant. All participants were informed about the purpose of the study, and how data will be collected, processed, and stored, that participation would be voluntary, and that confidentiality is ensured. The informed consent form, and data management has been approved by the Norwegian centre for research data (NSD) under project number 37623.

III. Results

This section presents the results from both the quantitative and qualitative data obtained regarding a human host onboard an UAF. The quantitative results reflect on the trends observed and the qualitative section explains the themes observed in the dataset.

A. Quantitative Results

1) Commuting routines, previous experience, and perceptions of the participants: Most of the participants used the bus as a daily mode of transport for commuting with an average commuting time of 15 min. Initially, the interest for using new means of transport was generally high with an average of 4,67 within a five-point liker scale. Some of the participants had previous experience with an autonomous vessel/vehicle before (21%) which could relate to the trial of an autonomous bus in the city centre a year before (Øya Project) [13]. The participants had great initial interest in the topic of "self-driving transport" where 80% answered to be "very interested". After the ferry trial almost all the participants answered "agree" to "very agree" to the question if they would like to travel with an autonomous ferry again. Only one participant did not answer the question.

2) Perceived importance of a human host onboard:

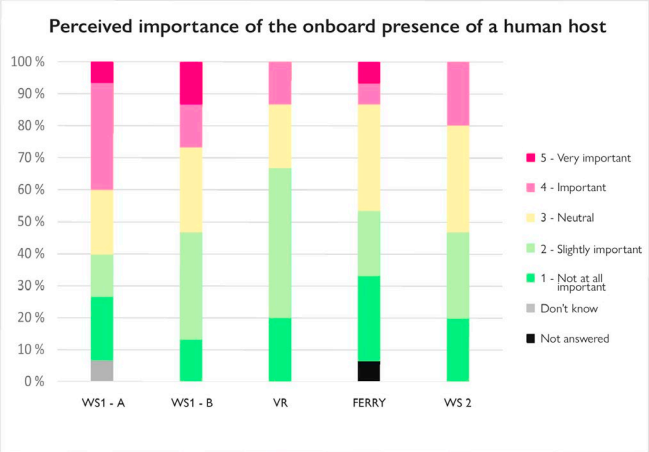

Figure 4: Percieved importance of a human host onboard

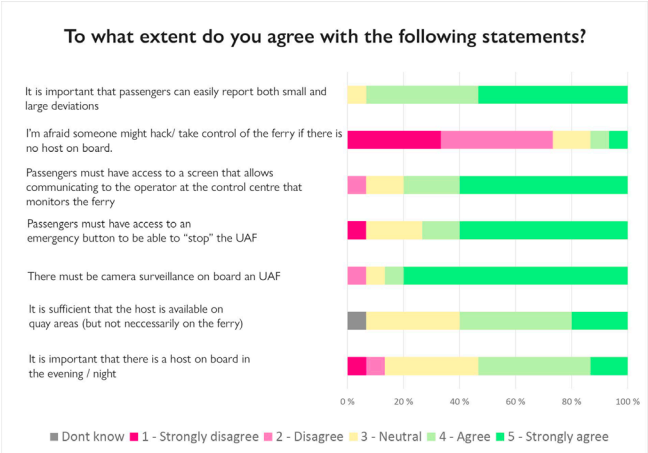

Figure 3: Percieved importance of other safety related questions.

Before the first session the human host was perceived to be "important" to "very important" by 40% of the participants, and 20% being "neutral" to the question (Figure 3). This changed in a non-linear fashion through the sessions and at the end only 20% found the host to be at least "important" to have onboard (WS2). A larger share of the participants was uncertain (33%). Notably, the lowest importance for a human host was perceived after the VR session where only 13% answered "important" contrasting 67% finding the matter to be "not so important" to "not important at all".

3) Perceived importance of other safety related measures: Further questions related to the human host and other safety related measures, obtained from the questionnaire after the last session (WS2), are presented in Figure 4. Regarding certain time frames, 53% did at least "agree" that it is important that a human host is onboard in the evening and at night. The possibility to report deviations and problems, communication to the monitoring shore control centre, and camera surveillance onboard found great resonance by the participants. Interestingly, 60% did at least agree that it would be sufficient that a human host would be available on quay areas. Furthermore, most participants did not believe that the onboard presence of a human host would hinder any cyber threats towards the UAF. Here 73,3% answered "do not agree" to "do not agree at all".

B. Qualitative Analysis

All the notes collected during the workshops and all the responses were converted into text in one document. We applied thematic analysis [14] to the text to find the most important themes and subthemes regarding the human host onboard the autonomous ferry. The role of a human onboard a UAF was not explicitly defined to the participants through the sessions. A notable amount of the data collected, contains information regarding a human host aboard.

The overarching theme in the data was the importance of the general perceptions of safety. The general perception of safety is an important antecedent to acceptance and use of the autonomous ferry in the long term. The decision to use

the ferry depends on feeling safe as can be seen from this quote by one of the passengers: “my perceived safety must be taken care of!” This theme in turn consisted of several subthemes. These subthemes are various dimensions that together form the perception of safety, and they include the following:

1) Contextual and the environmental factors onboard and around the ferry and the need for resilience: The perceived safety of the autonomous ferry depends on safety onboard and around the ferry. One of the key notions was mentioned to be “safety for all” when using the ferry. The importance of a human host onboard is to ensure that the ferry trip goes smoothly and that the people on and around the ferry are safe. The context of a ferry is one of a floating platform on water, a closed space where one cannot run away if something happens, despite being in the open space of sea or canal. It was mentioned that the external environment of the ferry can also pose a threat if somebody decides to challenge the ferry and expose the ferry to danger. As such it was mentioned that we need a resilient system that will function despite any attempt to challenge it. Since the context of a ferry is one that is open to external threats while being an enclosed space – it is a context where people cannot escape – it is important that surveillance is in place. However, it was also mentioned that one might feel safer on board a ferry that has video surveillance rather than walking alone at night in the streets. The perceived safety of the passengers was mentioned to need further work. Interestingly the perception of the context changed throughout the workshops as one participant mentioned after the ferry trial that it was “safe because of the short distance, and it is possible to see both the start and the end”. This subtheme focused on external factors, but the most salient subtheme was about an internal challenge: the need to create social order and prevent unsafe behaviour of the passengers as presented next.

2) The importance of human host onboard to create social order in certain time windows: This subtheme is the most prevalent one across the dataset and the focal point when it came to the importance of having a human host onboard. There were several references made to the need for a host to ensure social order and safety as an authority figure onboard. The participants believed that a human host is needed in the case of robbery, abuse, violence, for keeping peace onboard and ensure safety for everyone by preventing unsafe behaviour. Participants were mainly concerned that people will not respect order if there is no authority onboard. The threat posed by drunk people to themselves and to other passengers was a salient concern. They believed that drunk people and children need to be supervised onboard by a human host. The participants referred to a time-window where the human host would be even more important. Repeated references were made to not wanting to be alone at night, or after big festivals or football matches. For example, it was mentioned that “social safety is important to prevent unsafe behaviour and it is situation-based, for example after a football match” and that “a human host is needed to control who will get onboard and who should not board the ferry. If that is not the case, then the ferry should provide an overview of the other passengers”. However, it was also mentioned that abusive conduct also happens in manned vehicles such as taxi and in a subway where the driver is also present but not able to respond fast. The data showed that people need video surveillance and quick spotting of potential criminal activity by land-based operators. One of the participants mentioned that “so long that there is video surveillance from a land-based station, it is not needed to have a human host onboard”, while another participant believed that “one should be able to get help immediately and even with the possibility of pushing a button to get help, it is not clear how fast and how well you will be helped”. Another participant added that “it maybe even safer to travel with a ferry that has video surveillance than to walk alone at night”. After the ferry trial, having immersed with the concept, a participant stated that “regarding strangers, it is possible to choose not to board the ferry if there are passengers acting out. The distance is also short”. An interesting question that was raised was “whether the presence of human host could actually create a false feeling of safety” since what the human host could do in the face of danger and with respect to vigilance over everything, is limited.

Although the most salient subtheme was the importance of a human host for intervening in the socially induced danger, and at specific times in the day/night, another important role of the human host was to intervene with other unexpected incidents and accidents.

3) The role of human host in emergency situations, rescue, and evacuation: In cases of emergency, such as a passenger suddenly getting a heart attack, a human host can immediately intervene. The human host is the annotated responsible person when the unexpected happens. The participants expressed the need for a human host onboard if somebody falls overboard, if a life-threatening situation happened that would demand a short response time, and if an evacuation order should be placed and performed. However, it was also mentioned that “accidents also happen onboard of manned ships” and that the important thing here is that “people should get help very fast when in need”. According to the participants “a very good system would be needed onboard of the autonomous ferries to put out fire”. In addition to intervention in unexpected situations, the human host was important in offering ad-hoc services for an improved passenger experience.

4) The importance of technical and ad-hoc services offered by human host: Human hosts can offer services that improve the passenger experience onboard the ferry. For

example, they can make sure that onboarding and offboarding go well and control the number of passengers. Another point that was mentioned, was that the human host could offer services to the elderly passengers if needed. In addition to that, a human host could resolve technical issues should the ferry's technical system fail. This can also improve the ferry trip experience for the passengers. This was mentioned to be "especially important for long term trips" and especially for the first trips, but not necessary after a few trips. A safety host is important to keep an overview of what is happening and intervene if needed, which was aligned with the notion of general perception of safety and dealing with the unexpected. It was mentioned that "the human aspect must be in balance with the technical aspect" meaning that the perceived safety is still key despite having technical safety. It is expected that one should be able to trust that all the prerequisites for the trip are taken care of, and if so, then there is no need for human host as long as the ferry is remotely watched and operated. Furthermore, it was mentioned that it is difficult for a human host to always keep focus. Nevertheless, in times of higher traffic or higher risk, such as during the high season for tourism, it is better to have a human host onboard to ensure a better ferry trip experience.

5) The need for gradual transition towards unmanned ferries: The participants emphasized the importance of a gradual transition from having a human host onboard towards an unmanned ferry. They mentioned that "the ferry should have the possibility to be steered manually by a human host" since a slow shift "will be more reassuring". The data showed that at the start phase, the presence of a human host can help passengers to trust the ferry, and this was a necessity at the start up phases of having an operational autonomous, unmanned ferry. Also, when there is high traffic, it can be helpful to have a human host onboard. Passengers need to trust that the ferry have had time to build resilience towards various scenarios as can be seen from this quote: "the learning process for autonomous ferry is a long process for dangerous situations, and in the meantime, one wants to feel safe with a host onboard".

6) The importance of information and transparency in transition towards unmanned ferries: The participants expressed the need to understand and to see that the technology is safe. Since there will be no person steering the ferry, it will be essential to have good and clear information. Passengers need to be made aware of what the ferry is doing and why, as can be seen from this quote: "having sufficient information from people who have designed and made the system is very reassuring to know what is going on. This was specifically mentioned in retrospect to a ferry trial when the ferry's sensors captured waves by its own thrusters as obstacles and stopped in its track. The participants mentioned that the engineers aboard informing about what was happening felt reassuring. In addition to that, people need to have information about onboarding and offboarding. Generally, the participants also mentioned in retrospect that the information obtained through the workshops increased their level of trust towards urban autonomous passenger ferries. Here trust may be simply better understanding rather than reliability.

IV. Discussion and Conclusion

The aim of this paper was to understand the consequences or implications of a human host on an UAF, and in what way a human host would shape the passengers' perceived safety, trust, and convenience of UAFs. Furthermore, the aim was to understand the implications of a possible removal of a human host from an UAF. To achieve this objective, we examined the role of a human host onboard UAFs with data collected as part of a citizen engagement consisting of four sessions of both theoretical and immersive parts. The data collection was targeted towards the participants' perceptions of UAF in this context and followed them through the sessions. The data was subject to quantitative and qualitative analyses. The findings are discussed in the following.

A. Quantitative

Over time and throughout the session, the participants' emphasis on the presence of a human host decreases in a nonlinear manner. The decrease could be associated with the repeated exposure and immersion with the technology that creates familiarity and trust to a certain degree. Although trust may be simply better understanding rather a proven reliability and predictability of the technology in operation. Particularly after the tangible VR simulation (VR), the importance of a human host was rated as "not so important" to "not important at all" by the majority of the participants. A possible explanation for this could be the increased trust in the system as the simulation was partly hardcoded and, in that sense, "fail proof". Additionally, the VR simulation did not include other humans, and thereby social security aspects might not have been so evident. Furthermore, VR can be a novelty itself that can engage people in the mere experience rather than the operational implications of the concept.

This nonlinearity could be due to the group dynamics or the speculations and reflections as they are engaged in a novel situation and making sense of the technology itself and its implications for them and the society. Also, several participants claimed that they did not remember what they answered on earlier questionnaires, as several days where in between them. This in turn would make the participants answer on their current perceptions and experiences. The slight increase in the perceived importance of the human host during the ferry session (FERRY) can be explained by minor technical issues still present on the prototype. The presence of the personnel onboard, and the need for their interventions together with the information they provided to the participants, could have underlined the need of a human host in the transition towards fully unmanned UAFs.

Furthermore, the emphasis on the importance of a human host was highlighted during later pm hours, and it became limited to the quay areas. Therefore, it is becoming temporally and geographically more limited. This can be seen in relation to the context where the trial was conducted within closed waters, and where both ends of the crossing were always in sight. The short distance to land where a human host is overseeing from the quay areas could be seen as sufficient to feel safe.

The need for surveillance cameras onboard was highlighted, and even claiming that the ferry would be safer than the street at night. The accessibility to emergency response and the possibility to report any deviation to the responsible authority was highlighted at the end phase. Communication in real time to an onshore control centre, knowing about, and being able to manually stop the boat with an emergency button, were also mentioned as essential. This could reflect on people already trying to find alternatives for a human host and shows a belief in digital technology to substitute a human host. Given that the study was conducted in Norway, this seems to be a plausible explanation as the general society has adopted many digital solutions in the everyday life. Furthermore, people started to see the shortcoming of a human host in the modern times with respect to new threats, such as cybersecurity breach.

However, this observed trend of how the participants think a human host could be restricted in its presence and replaced by features such as information screens, communication tools, remote monitoring, and surveillance, could be influenced by the workshop's discourse itself; the framing of the research may have directed the participants thinking and reflections.

B. Qualitative

The context played an important role which sets this paper apart from that of [3]. His operational context was concerning longer distances (across the Bedford basin in Halifax, Nova Scotia) framing the case around the current human operated ferries of 24 m in length and a maximum capacity of 390 passengers aboard. This is very much in contrast with the context of the current case where the crossing was short and the terminals were visible from both ends with the use of a small UAF, making it less risky in the minds of participants. Nevertheless, the unexpected contextual, technological and social incidents still asked for the intervention of a human host onboard that could explain the *what* and *why* of the situation. Thus, the human host still played a role as a resilience anchor and the agent to provide transparency and situational awareness. Given the operational context of the study, the results indicate that a level 3 [7] would be perceived as trustworthy by the participants. In the related field of autonomous vehicles, the willingness to use public autonomous vehicles is increasing with the level of supervision [15]. In the context of autonomous buses in Trondheim, a study described by [12], several participants emphasized the need of a human host aboard mainly for security reasons. Interestingly the participants were found to demand a bus host even more after the physical trial, which is discussed to be because of operational situations where the bus host had to intervene, described in [12]. Arguably there are differences in the context and between water-based and land-based transport. As this specific study was conducted during no traffic in the canal, the land-based real-life studies would be more prone to a higher traffic complexity. The vulnerability of other road users, higher differences in speed between different between the autonomous bus and other vehicles, and complexity in the interaction between road users would arguably have a role to play in the perceived importance of an onboard human safety host.

Technology acceptance extends to automation technology acceptance, and this requires that people trust the technology and suppliers. This process should happen over time and through a transitory period that allows people to evaluate if the technology is safe, reliable, and trustworthy. This is in line with [15] for instance, in the context of public autonomous buses, where transition from lower LOAs to higher LOAs must take place over time.

Although people started to speculate about less human host presence, they still mentioned the need to know what is going on (transparency) and to be able to intervene (emergency button and real-time communication with onshore) which emphasizes that the principle of designing for human-in-the-loop even for higher LOAs, whether that 'human' is the human host or the passenger, is still present. In the field of non-rail autonomous vehicles, [16] and [17] highlights that participants in their studies were interested in information and means to intervene. This reflects on a partial transition of responsibility from a human host to the passenger in the face of adversity. It is interesting to consider the legal and ethical implications thereof.

This paper highlights that although the trend of automation in maritime and urban transportation is moving towards higher levels of autonomy, this transition, and the end result, which is a service that will be continually used by real end-users, can benefit from such participatory workshops and a co-creative design perspective. This can balance the technology-centred and human-centred schools of thoughts into creating a product and a process that considers both aspects, people and technology.

C. Limitations and future research

As an early study within the context of UAFs the paper seeks to investigate the role of a human host onboard. It is acknowledged that the study has several limitations.

A first limitation is that the sample size of the population is very small (N=15). This was partly due to the resource intensive nature of four sessions with immersive components such as the VR experience and ferry ride only allowing for smaller groups. The sample is far too small to draw any significant conclusions, and the patterns observed should only be seen as preliminary insights which inspire more extensive future studies. A larger sample size would also allow for a closer investigation of how - age, gender and socio economical background would influence safety related perceptions. The second limitation is that the participants were only recruited from Trondheim, meaning that the findings might not be transferable to other locations

However, given that this is a case study in a specific context some familiarity with the context is required. A further limitation is the recruitment, where the participants themselves signed up for the sessions in compliance with ethical standards. As seen in the results section, all the participants were "interested" to "very interested", which might induce that the population has generally more positive perceptions towards autonomous transportation.

Some limitations are also seen in the research design. To have a set of four different sessions with both informative and immersive parts are seen as an opportunity to investigate how the perceptions develop through immersion beyond the initial ones. It also allows for investigating how different events and topics would influence the perception of the population. On the other hand, social group dynamics did occur potentially biasing the population towards positive perceptions. Another factor was the aforementioned technological framing with comprehensive explanations and insights into technological possibilities for such a ferry system. The nature of having several events did make the topics in the later discussions somewhat repetitive and some of the participants felt they had nothing more to add. A reduction in the number of sessions, and a more streamlined undertaking would be preferable.

Beside mitigating the limitations above, future research should be expanded in both sample size and geographical context to confirm or challenge the findings of the current study. Furthermore, it would be of great interest to further explore the concerns of participants regarding safety and security onboard and specially safety at night, during festivals, and in emergency situations. This could be done through role play on the real ferry or VR simulations. An investigation of how age, gender and socio-economic status affects the demand for a human host aboard, would add further granularity to the research and this requires larger sample size to have valid and reliable findings. Within the context of enclosed water and small scale UAFs, a trial with no personnel aboard would be of interest. It is also recommended to angle further research into designing systems for the "passenger in the loop" in combination with a remotely located safety supervisor.

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