Acceptability & Usability of Location-Support Technologies for Cruise Ship Evacuations

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Abstract.
Emergency evacuation information provided to cruise ship passengers is static and hard to access and understand by some passengers. The SafePASS project is working to provide technology solutions which provide passengers with dynamic, real-time information which they can understand and follow to aid their evacuation from cruise ships in event of an emergency. This paper reports on acceptability and usability analyses of a Passenger Mobile Application, a Smart Lifejacket and a Smart Wristband. which were positively rated by passengers and crew in surveys and workshops. Passengers responded positively to the use of a Passenger Mobile Application for directions (suggesting a willingness to use smartphone technologies as support in emergencies), while they responded neutrally to wearable technologies (Smart Lifejacket, Smart Wristband). Crew responded positively to the use of smartphones and wearable technologies in emergency situations. This suggests high acceptability of smartphone-based technologies for use by crew in emergency situations. Workshops with industry experts and passengers highlighted the importance of data protection.

Keywords: Maritime Safety, Acceptability, Usability, Location Support, Human Factors

1 Introduction

At present, the emergency evacuation information available to passengers onboard modern cruise ships is only offered on safety leaflets in cabins or at corridors. Some cruise line operators supplement this by making safety videos covering the evacuation procedures available on the in-cabin television system. Despite these recent efforts to increase passengers' engagement with audio-visuals on cabin-based entertainment

systems or personalised applications,[1] the safety information is static and difficult to understand, especially under stressful conditions, and in conditions of low visibility [2,3] (e.g. fire, or evacuation at night). These limitations are compounded by limited user friendliness and the effects of language differences. Passengers receive a safety briefing and muster drill prior to departure. This is mandated by the International Convention for the Safety of Life at Sea (SOLAS) and is an emergency drill which consists of the sounding of the general emergency alarm, followed by safety announcements to passengers from the captain. Passengers head to their muster stations (assembly stations) and are instructed in the use of life vests, and what to do in an emergency.

In response to COVID-19-19, self-mustering of passengers has been introduced [1], in which passengers are provided their muster station upon boarding and must individually check in with staff at their muster station prior to departure. The use of technology to enhance self-mustering has also been noted, with Muster 2.0 as implemented by Royal Caribbean Group [2], allowing passengers to use their mobile device to complete the muster drill and navigate to their muster point. While these muster drills provide a valuable opportunity for passengers to increase their preparedness should an emergency scenario occur, as large passenger ships consist of complex infrastructures inclusive of several decks and public spaces, difficulties wayfinding in an emergency can emerge. Challenges are further compounded by the high volume of people on board, inclusive of both crew and passengers. Additionally, the ship's status during emergency evacuation situations is constantly changing with time and the present means do not account for such dynamic changes.

The SafePASS project is working to develop an integrated system to support the safe and timely mustering and abandonment of large passenger cruise ships during emergencies. This involves redefining the evacuation processes, and developing new technologies and equipment through real-time monitoring and location support for passengers (providing optimal evacuation routes) and enhanced life-saving appliances (life jackets and lifeboats). The SafePASS system for Dynamic Evacuation [3,4,5,6] can calculate where to send people. There are sensors on board, placed throughout the entire ship, and their status is constantly updated. This means that the system knows how many people are at each muster station, which muster stations are full or unavailable, and which is the nearest muster station for each passenger. The effect is that in the event of an emergency, all those people already at a muster station will be instructed to stay where they are (rather than making their way to a pre-assigned station which may be at the other end of the ship) and put on their lifejackets. Muster stations should never be overloaded because the system optimises where to send people and passengers are sent to their nearest available muster station.

The scope of the Location-Support Technologies developed during SafePASS was to design and develop components to address all these issues and offer passengers multiple powerful tools to assist them during ship evacuation. In particular, location-support technologies offer the capacity to locate passengers dynamically in the cruise

[1] https://www.royalcaribbean.com/blog/royal-caribbean-changes-the-game-with-muster-2-0/
[2] http://www.maritime-forum.jp/et/pdf/h29_Basic_Crowd_Management_Guidebook_en.pdf
[3] International Aeronautical and Maritime Search and Rescue Manual, IMO, 2016 Edition

ship wherever they might move to during the evacuation process. Building on this, the devices and applications implemented as part of the SafePASS system then provide personalised services and information to passengers for easy and safe evacuation based on their location at each moment. These SafePASS components, in addition to being fully personalised for passengers, are also easy to use and dynamic dependent on passengers' real-time status and position, and include:

1. Passenger Mobile Application: mobile app installed on mobile devices to provide dynamic and personalised navigation to the identified exits for each passenger based on his/her real-time location.
2. Smart Lifejacket enabled with audio and vibration-based navigation systems:
    a. Passenger Chatbot Application: dynamic audio instructions guiding passengers along the optimal evacuation route via an embedded earplug.
    b. Haptic Navigation Module: vibration sensors guiding passengers via haptic feedback through intense vibrations on their shoulders in order to guide them to the correct path and safe exit.
3. Smart Wristband: wearable wristband uniquely identifying each passenger and measuring and tracking the passengers' biometric information and vital signals in order to calculate their stress levels.

All these components aim to provide personalised information to passengers and assist them to safely navigate along the ship along the designated evacuation routes and exits with the overall aim of reducing the time required for ship evacuation [7]. The involvement of user input is key to the meaningful deployment and successful implementation of the SafePASS solutions in the real word. To this end the research activities are supported by co-design activities involving both passengers and crew. Additional access requirements are key to these efforts and the SafePASS project runs a Community of Practice which is the mechanism to achieve a Social Licence to Operate (SLO) for the integrated SafePASS systems [8].

1.1 The SafePASS Project

The SafePASS project is an EU-funded Horizon 2020 research programme that aims to radically redefine the evacuation processes, evacuation systems/equipment and international regulations for passenger ships in all environments, hazards and weather conditions. The consortium consists of 15 partners including a shipyard, lifesaving appliance manufacturers, a cruise operator and academic institutions, and classification societies (http://www.safepass-project.eu/). The consortium contains all the stakeholders and expertise needed to develop an integrated system that can collectively monitor, process and inform both crew and passengers of the optimal evacuation routes during emergencies, coupled with advanced, intuitive and easy to use life-saving appliances, resulting in a significant reduction of the total time required for ship evacuation and increased safety. An important aspect of the SafePASS project is to design and develop personalized and location-based tools and applications, aiming to assist passengers during the evacuation process. Several location-support technologies

have been developed and integrated into mobile devices and wearables, the most important ones being the Passenger Mobile Application and the Smart Wristband.

1.2 SafePASS Location-Support Technologies

Passenger Mobile Application.

One of the main SafePASS applications, developed to provide location-based support during ship evacuation, is the Passenger Mobile Application. The main purpose of the application is to provide dynamic and personalized navigation to the identified safe exits, muster and abandonment stations for each passenger based on his/her real-time location. An indoor localization system, based on Bluetooth Low Energy (BLE) technology, has been implemented in order to track each passenger's location while onboard and it has been integrated with the mobile application. Moreover, the application facilitates the familiarization of passengers with the ship's areas and the safety instructions. The mobile app can also communicate with the SafePASS system and provide real-time passenger location information and biometric information when connected with the specially-designed Smart Wristband. Passengers can check their location onboard the ship at any time on the mobile app and use the map-based visual navigation in order to follow the appropriate evacuation route during an evacuation scenario. Additionally, a user-friendly interface is provided for text message chatting among groups of people (family members or companions travelling together) to enable instant communication even without 4G/5G cellular coverage. Furthermore, it offers passengers the opportunity to quickly, and easily, request assistance from the ship's crew via a "request for assistance" button- should someone become injured or distressed.

The Passenger Mobile Application can be installed on any mobile device carried by passengers, e.g. smartphone or tablet, who are requested to provide their active consent on location tracking, which is to be used only under emergency evacuation situations.

The following figures (Figure 1 to Figure 4), illustrate different screenshots of the Passenger Mobile Application, namely Home screen, Instructions screen, Personal Evacuation Navigation screen and Group Chatting interface, respectively.

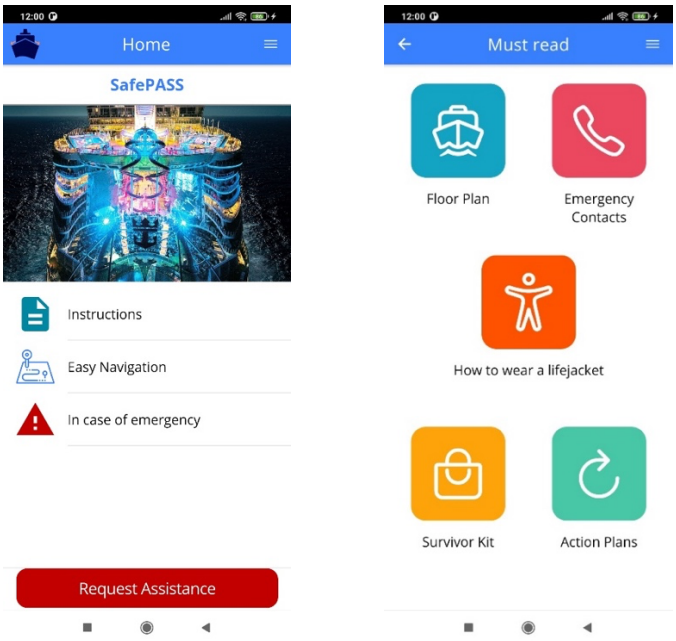

Figure 1: Home and instruction screen of mobile applications

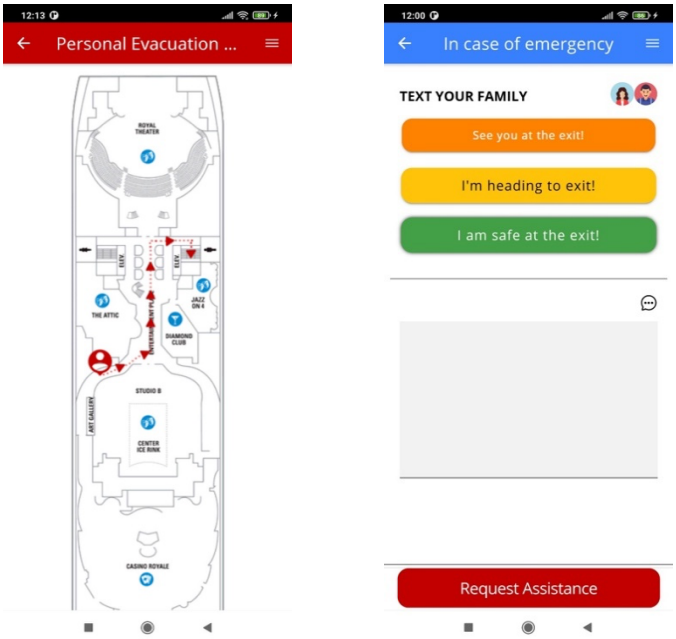

Figure 2: Navigation and group chatting screen of mobile application

Smart Wristband.

Figure 3: Smart Wristband

Another important SafePASS component is the Smart Wristband which is a wearable device that has been developed providing location support. The Smart Wristband integrates the Biometric Monitoring Module and its goal is threefold: (i) to uniquely identify each passenger or crew member, (ii) to enable physiological monitoring of passengers' vital signs, and (iii) to take it one step further, by providing a near-real time, reliable stress detection functionality upon ship evacuation, in case of an emergency. The Smart Wristband is intended to be handed out to each passenger at ship embarkation, containing a unique identifier associated with the specific passenger. Under emergency conditions, the Smart Wristband can be used for monitoring the passenger's biometric measurements (such as heartrate and R-R interval (the time between beats of the heart), and oxygen saturation (SpO2)), and for the association of the passenger ID with either the Smart Lifejacket or the Passenger Mobile Application.

Through the monitoring and analysis of the biometric measurements, a stress detection algorithm embedded on the Smart Wristband runs and assess the stress level of the passenger. If and when the passenger is considered "stressed", the Smart Wristband sends relevant information about passenger ID and stress status to the SafePASS system and this allows the SafePASS operator can assess the physiological conditions and potential stress of passengers during an evacuation process.

The physiological condition, and in particular the stress, of passengers and crowds can have a significant impact in the evacuation process. Therefore, the timely identification of passengers in need of assistance and under stress can enhance crew response and timely assistance during an emergency.

The Biometric Monitoring Module is disabled in normal conditions, and can be activated manually by the passenger in emergency situations so as to initiate the physiological sensing. **Error! Reference source not found.** illustrates the Smart Wristband prototype that has been designed and implemented.

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Smart Lifejacket.

Lifejackets, which are made up of buoyant or inflatable material are used to keep passengers safe in the water and are either handed out by the crew personnel at the muster stations or are located in the passenger cabins. In SafePASS, an inflatable lifejacket has been designed, to include novel technology and integrated into the

lifejacket transforming it to a Smart Lifejacket. The Smart Lifejacket provides situational awareness, as well as on-demand navigation for the passengers. It incorporates an indoor localization system and complementary passenger navigation systems via audio instructions and haptics. The indoor localization system is based on Ultra-Wide Band (UWB) technology and provides real-time location tracking of passengers, while the navigation system guides them across the evacuation route towards the evacuation exits in case of an emergency. The navigation systems that have been implemented are based on haptic feedback in the form of vibration actuations on the lifejacket, and a chatbot in the form of audio instructions using earplugs.

The haptic navigation is perceived as vibration signals on the passenger's body towards a specific direction (front, left, right, back, up and down). The haptic navigation is easily activated by the passenger by pressing a button on the lifejacket.

Another essential feature of the SafePASS system is the automatic language identification of preferred languages. The Chatbot navigation is in the form of audio navigation instructions in the passenger's predefined language. The Chatbot is easily activated by the passenger by pressing the earplug's button, while automatic voice detection identifies the preferred language of the passenger.

The Smart Lifejacket is able to connect to both the Smart Wristband and the SafePASS backend system (which runs and supports the integrated SafePASS technologies) for receiving personalized evacuation routes and for sending the passenger location in real-time and in sub-meter level accuracy. Its main aim is to provide an alternative and complementary mean of personalized evacuation support to passengers, especially in low visibility scenarios and extreme emergency situations, as well as in cases where passengers are lost and no crew members are present for assistance.

Figure 4: Smart Lifejacket

1.3 Research Question

This manuscript seeks to explore the perspectives of passengers, crew and community of practice members on proposed Location Support Technologies within the SafePASS project. This is achieved through crew and passenger surveys and community of practice passenger workshops to examine the perceived usefulness of the proposed Location Support Technologies. From this, enhanced design of technologies will be achieved to support usability and acceptability for end-users.

2 Methods

To address the research question listed above, the present analysis consisted of 1) a passenger survey, 2) a crew survey, 3) a workshop with industry experts, and 4) a community of practice workshop.

2.1 Participant Recruitment

Survey: A sample of cruise passengers and ship crew were recruited to take part in the study between January and May of 2021. Eligibility criteria consisted of either 1) having been a passenger on a cruise previously or 2) having worked on board a cruise ship. Recruitment was conducted using a purposive snowballing strategy, with invitations to participate shared on social media and circulated by industry associations and representative bodies relevant to cruising. For crew, emails to current crew members were circulated by a cruise ship company to support recruitment.

Community of Practice Workshop: For the community of practice passenger workshop, participants were recruited directly from the SafePASS community of practice, which consists of representatives across stakeholder groups related to cruise ships, including those who work or stay on board. Any individual with interest in cruise ships can join the community of practice, with invitations to join shared frequently with stakeholder groups, at events and through social media. In addition, members of the public were also invited to attend through sharing of invitations to participate across SafePASS social media and with email contact lists.

Full ethical approval was obtained from the School of Psychology Ethics Committee (SPREC) at Trinity College Dublin (Ref: SPREC032021-09). Full informed consent was obtained from all survey participants through an online form and information sheet at the start of the survey. For those participating in workshops, information on the project objectives was provided during the workshop and informed consent was obtained earlier when the participants signed up to the SafePASS community of practice.

2.2 Survey

In order to determine crew and passenger perspectives on the usefulness of the proposed SafePASS technologies, two short surveys were developed. These surveys were developed in collaboration with technical partners and human factors specialists and sought to gather participant perspectives on the usefulness of location support technology in emergency situations on board cruise ships. Surveys were conducted online using Qualtrics.

Passenger Survey: The passenger survey consisted of 30 questions, and included sections exploring demographic variables, past cruise experience, experience with muster and abandonment and perspectives on the novel technologies. With regards to location support technologies, two questions were posed namely; 1) “How happy would

you be to wear a wristband/other wearable tech that would allow crew to locate you in an emergency?" and 2) "How happy would you be to have your mobile device/tablet help crew in locating you in the event of an emergency?". Both of these were responded to using a five-point Likert-type scale from 1 (*completely unhappy*) to 5 (*completely happy*).

Crew Survey: The crew survey consisted of 26 questions exploring past experience onboard cruise ships, training for mustering and abandonment, perspectives on current Life Saving Appliances and Personal Survival Equipment, and perspectives on the novel technologies. Specifically crew were asked how strongly they agree or disagree with the following statements 1) I would like to have a smart phone application that would help me evacuate passengers and crew, 2) I would like to have additional information about the location of the passengers in case of an emergency; 3) I would use a smart phone application that would help me with the safety training, 4) It would be useful for me to have information about the vital signs of the passengers in case of an emergency, 5) It would be useful for me to have information about the vital signs of the crew in case of an emergency. Each of these statements were responded to using a 5-point Likert-type scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

2.3 Workshop with Industry experts

In June and July of 2021, workshops were carried out with members of the External Advisory Board of the SafePASS project. These members consisted of industry experts in data protection, maritime surveyance, the human element, maritime policy, coastguard and maritime safety assessment. The purpose of these workshops was to validate the socio-technical research approach and to ensure that it was comprehensive in nature, thus addressing concerns (from their respective expert fields) regarding data collection and the operational realities of implementing SafePASS technologies for human users. Feedback from the Advisory Board was invaluable and full detail of this is contained in the SafePASS project outputs [9]. In particular, feedback on data protection for both location and biometric data was useful. This features heavily in the human factors recommendations for implementation of SafePASS technologies and for future research to be carried out. These recommendations will inform SafePASS submissions to the International Maritime Organization (IMO).

2.4 Community of Practice Passenger Workshop

To add additional depth to the analysis, and to gather user input into the design of the SafePASS technologies, a community of practice workshop was hosted using Microsoft Teams with past cruise passengers on December 13th, 2021. The purpose of these workshops was to gather feedback from passengers on the SafePASS technologies and integrate input into the design of the technologies. Within this semi-structured workshop, a short emergency scenario was provided with participants asked how they would respond using current approaches. Following this a short overview of the SafePASS technologies was provided, the emergency scenario was re-presented, and attendees were asked to reflect on how they would respond with SafePASS technologies available. Open discussion followed, with questions posed determined in

collaboration with the technology partners and sought to compare passenger perspectives on emergency procedures with and without the use of the proposed technologies. Broader insight into the use of smartphones and wearable technologies within emergency procedures on cruise ships was also gathered.

2.5 Data Analysis

Survey data was analysed using Statistical Package for Social Sciences (SPSS), with basic descriptive analyses completed.

3 Results

Results obtained for the crew and passenger survey, and the community of practice workshop are presented in detail below.

3.1 Survey

Passenger Demographics: Passengers (*n*=215) were primarily aged 65-74 (26%), from the United States (43%) or the United Kingdom (20%) and spoke English (85%). Additional detail on participant demographics is presented in Table 1 below. In terms of past cruise experience, 32% of respondents had been on more than 3 past cruises (so were experienced cruisers), 72% had travelled on their last cruise with family, while 35% of respondents were accompanied by children. Low volume of additional access requirements or individuals requiring further assistance were reported across passengers (3.26%) and their travel companions (5.9%), with the individuals with additional access requirements mostly aged over 65 (60%). Most passengers reported having had taken part in muster drills while on board (88%), and were confident in being able to find their muster station from their cabin (81.5%).

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Table 1: Passenger Demographics

		N	%
Passenger Age	18-24	8	4%
	25-34	25	12%
	35-44	34	16%
	45-54	35	16%
	55-64	38	18%
	65-74	55	26%
	75+	20	9%
Nationality	United States	87	43%
	United Kingdom	41	20%
	Greece	18	9%
	Ireland	14	7%
	Italy	6	3%

	France	5	2%
	Other	23	24%
Languages spoken	English	209	85%
	French	27	15%
	Spanish	26	14%
	Greek	25	17%
	German	17	8%
	Italian	14	8%
	Other	26	13%

Passenger Perspectives on SafePASS Components: Passengers responded positively to the use of an official cruise app for directions (*M*=4.09, *SD*=.95), suggesting a willingness to use smartphone technologies as support in emergency scenarios. With regards wearable technologies, passengers responded neutrally towards the use of a wristband or wearable technology (*M*=3.78, *SD*=1.19). It is of note that for the wearable technology, 16% of passengers reported that they would be unhappy to use this. This differs from the use of an official cruise app with only 3.5% unhappy to use. This highlights a need for exploration as to how use may be best supported for this group.

Crew Demographics*:* A total of 876 crew members responded to the survey, of whom 30.9% were marine officers, 30.4% were hotel crew, 24% were marine crew and 14.4% were hotel officers – 'marine' refers to those with responsibilities related to the sailing/maintenance of the ship, while 'hotel' refers to those with responsibilities related to serving passengers. Officers have a higher rank than crew. Few respondents were concessionaires (0.3%), though this is to be expected in the context of COVID-19, with cruise ships broadly not in service at the time of the survey, and as such staff more difficult to contact (concessionaires are independent staff working in gift shops, casinos, activities/entertainment and not directly employed by the cruise line). Broadly, crew felt that they had received sufficient training in mustering/evacuation (*M*=4.25, *SD*=1.07) and were able to complete their duties in an emergency (*M*=4.39, *SD*=1.12).

Crew Perspectives on SafePASS Components: Crew responded positively to the use of smartphones and wearable technologies in emergency situations as part of the SafePASS solutions. Crew agreed that they would like a smartphone app to aid crew and passenger evacuation (*M*=4.14, *SD*=.99), more information on crew (*M*=4.49 *SD*=.85), and passenger location (*M*=4.2, *SD*=.85), and that they would use a smartphone app in safety training (*M*=4.09, *SD*=1.04). This suggests high acceptability of smartphone-based technologies for use in emergency scenarios. Additional detail is presented in Table 2 below.

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Table 2: Crew Perspectives on SafePASS Components

	Marine Officer (N=204)	Marine Crew (N=117)	Hotel Officer (N=91)	Hotel Crew (N=129)	Total (N=540)

Would like a smart phone application to aid the evacuation of passengers and crew	*M*	3.51	3.82	4.09	4.14	4.14
	SD	1.23	0.91	1.18	0.99	0.99
I would like to have additional information about the location of the passengers	*M*	4.15	4.16	4.41	4.18	4.2
	SD	0.89	0.77	0.89	0.79	0.85
I would like to have additional information about the location of the crew	*M*	4.2	4.15	4.49	4.24	4.49
	SD	0.89	0.78	0.85	0.83	0.85
I would use a smart phone application safety training	*M*	3.88	4.08	4.34	4.22	4.09
	SD	1.15	0.81	1.09	0.97	1.04
It would be useful to me to have information about the vital signs of the passengers	*M*	3.87	3.99	4.19	4.23	4.04
	SD	0.96	0.86	0.99	0.85	0.93
It would be useful to me to have information about the vital signs of the crew	*M*	3.87	4	4.23	4.24	4.05
	SD	0.99	0.85	1.04	0.82	0.94

3.2 Community of Practice Workshop

A total of four community of practice members attended the workshop to explore their perspectives on location support technologies that are being developed as part of SafePASS. With regards to the as-is, or present-day scenario in the absence of SafePASS technologies, a reliance on smartphones during emergency situations was noted. Attendees reported that they would rely on their smartphones to remain in communication with their travel companions in an emergency, particularly if they are travelling with children. Phones would be used to ensure travel companions had successfully mustered, and to seek to reunite. With regards the use of smartphones more broadly, attendees were familiar with smartphone applications, and the use of smartphone-based navigation applications for location support. Concerns pertaining to smartphone use in emergencies included impact on battery, and requirements to have sufficient technology and internet access to allow for apps to be successfully downloaded and used. Concerns were raised regarding the acceptability of smartphone technology for senior citizens; however, it was felt that technological skill and comfort may have been positively impacted as a result of COVID-19. With regards to location tracking, an attendee noted that while they are familiar with these technologies, they would view them differently in the context of safety, and would be hesitant to have their location tracked at all times while onboard.

With regards to a wristband/smartwatch, attendees had no direct experience but were aware of these technologies. A preference for using mobile phones rather than

wristbands/smartwatches was noted, due to the multifunctionality offered by a phone, comfort with use, and due to the potential for those who wear reading glasses not having them to hand during an emergency. For example, the legibility of text on a smart watch may be too small to read. Attendees' willingness to use a wristband for other activities on board (i.e. to pay for items or to open cabins), was mixed with some viewing it as a convenience, and others associating it with burden, as they would be required to keep track of an additional piece of technology.

4 Discussion & Conclusion

Emergency evacuation information provided to cruise ship passengers is static and may be reliant on understanding a foreign language, which includes all passengers who don't speak English or the language of the cruise ship company. The benefits of dynamically providing real-time information to passengers in emergency situations is easily understood by maritime safety specialists. From the analyses conducted as part of this piece of research it is clear that these benefits are understood also by passengers and crew. Existing and ongoing studies have contributed to the development of either smart lifejackets[4,5] or mobile apps[6,7] which provide passengers with situational awareness and basic evacuation instructions. Their goal is to digitize most of the emergency instructions, though major aspects of the evacuation process are not considered. The SafePASS integrated system on the other hand has included all the components required for end-to-end evacuation or mustering management, which can be viewed as a beyond state-of-the-art achievement. The SafePASS location-support technologies are viewed as being broadly acceptable and usable by both crew and passengers. Workshops highlighted the need to account for passenger demographics in terms of planning the implementation of the technologies, especially as it pertains to the elderly. Similarly, this will need to be taken into account for passengers with accessibility requirements. The present study is limited by the low number of passengers with access requirements who responded to the survey and participated in workshops, despite sustained efforts to disseminate the survey on social media posts of charities and accessibility associations in the EU. This will be remedied in further activities following engagement and liaison with the European Network for Accessible Tourism (ENAT).

In general, the results of the passenger and crew survey were very valuable and were taken into account during the development of the systems. The key points and insights that were extracted from the survey analysis provided an initial assessment of the under-development components and assisted the technical teams to focus on specific aspects that were considered as the most important and critical by the end users. In parallel, the outcomes of the Community of Practice workshop and the workshop with industry experts were used as a crucial starting point for the evaluation of SafePASS systems and were taken into account during their validation in a real ship environment. A pilot

[4] https://cruising.org/~/media/Nawasena-Design-Report
[5] https://iopscience.iop.org/article/10.1088/1742-5468/aaf10c
[6] https://southpacificislands.travel/royal-caribbeans-safety-drill-goes-digital-with-new-app/
[7] https://www.decurtis.com/suites/mobile-assembly-suite/

demonstration was conducted on a Royal Caribbean Group cruise ship that was in its final stage of construction at the Saint-Nazaire shipyard in France operated by Chantiers de l'Atlantique (SafePASS consortium member). During this pilot, several evacuation scenarios were performed (based on the format deployed in the workshops herein reported) and volunteers participated using real prototypes of the SafePASS systems mentioned above. After the completion of the demonstration, the participants provided their feedback through evaluation forms (using the same format as the surveys used in this piece of research), both from the operational point of view and the actual use of the systems. In general, the results extracted both by the survey and the workshop provided a detailed and accurate description of how the location-support should be conducted during an evacuation process and this analysis was borne out in the events experienced during the pilot demonstration. The results of this study were helpful in designing the pilot demonstration and the holistic approach to evaluation is driving the specification of an implementation roadmap using the results of the pilot demonstration evaluation.

For a technology to be effectively applied, it must meet the needs of those for whom it is intended. To ensure that SafePASS technologies are developed in a manner which addresses end-user needs, engagement with stakeholders across the development process was employed. Inclusion of stakeholders in the development of SafePASS technologies will ensure that end-user needs, preferences and barriers to use are reflected in the technologies developed, enhancing marketability in a competitive market space. It will also support the transferability of findings across projects and sectors, through establishing how user involvement in design may be effectively applied, and through identifying key factors of importance to stakeholders in this space.

A further survey on implementation is the final investigation in the SafePASS project. Once again, all stakeholders (both a wide range of passengers and all crew roles) in the Community of Practice will be invited to take part. This implementation survey will provide crucial feedback on how the implementation roadmap will be received by those who will use the SafePASS system and how the human factors recommendations on acceptability and usability may inform future IMO regulation and SOLAS. From sociotechnical analyses conducted in earlier in the project it is clear that there are practical barriers to implementation posed by the SafePASS technologies – primarily centered around impacts on existing processes and procedures, requirements for information campaigns targeting passengers, and needs for training and consultation with crew [9]. All these factors need to be included in an implementation roadmap to ensure that SafePASS realises its potential and achieves meaningful impact on operational settings.

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