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D2.3 Social Impact Study

WP2 Business Cases, Environmental Footprint, Sustainability, Social Impact

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Abbreviations and Acronyms

Acronym	Description
AI	Artificial Intelligence
CTAM	Car Technology Acceptance Model
D	Deliverable
ECOSOC	United Nations Economic and Social Council
EMSA	European Maritime Safety Agency
EU	European Union
FPIC	Free Prior Informed Consent/Consultation
GDP	Gross National Product
HSC Code	High-Speed Craft Code
IAIA	International Association of Impact Assessment
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
Kg	Kilogram
Km/h	Kilometers an hour
M	Meter
MASS	Maritime Autonomous Surface Ship
MAVA	Multi-level Model of Automated Vessel Acceptance
MTOW	Maximum Take-Off Weight
NASA	National Aeronautics and Space Administration
NIMBY	Not in my back yard
NR	Number
OECD	The Organization for Economic Co-operation and Development
RCEP	Royal Commission on Environmental Pollution, United Kingdom
RMF	Risk Management Framework
RO	Remote operator

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ROC	Remote Operations Centre
SAE	The Society of Automotive Engineers
SAM	Social Acceptance Model
SDG	Sustainable Development Goals
SNM	Strategic Niche Management
SOLAS	Safety of Life at Sea Convention
STCW	Convention on Standards of Training, Certification and Watchkeeping for Seafarers
T	Ton
TAM	Technology Acceptance Model
TAM2	Extended Technology Acceptance Model
TBL	Triple Bottom Line
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Actions
TRL	Technology Readiness Level
WOS	Web of Science
WP	Work Package
WIG	Wing-in-Ground
UN	United Nations
UTAUT	The Unified Theory of Acceptance and Use of Technology

Table 1. Abbreviation and Acronyms

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EXECUTIVE SUMMARY

Wing-in-ground crafts that fly low, just a few meters above the ground using the ground effect to their advantage, have been developed since 1920s. The aim of the AIRSHIP project is to develop a fully electric unmanned wing-in-ground craft, suitable for interisland transport. This report investigates the possible social impacts such vessels may have in specific geographical and socioeconomic contexts.

This report analyses how AIRSHIP might influence the possible users and consumers, based on the interviews with residents and results of the reports 2.1 and 2.2 of project AIRSHIP. The Key Performance Indicators identified in report 2.1 of the project AIRSHIP are analyzed in comparison with the impact of such vessels on users and consumers, especially from the viewpoint of poverty, private economics, GDP, health, clean water and sanitation, availability of energy, leisure and free time. Main question to be answered within this report is: What can potentially change in different societal contexts when we introduce fully automated electric wing-in-ground crafts and how may this transform the lives of residents and consumers?

This report is divided into 6 chapters. First chapter describes the project and details of this report, second chapter describes the used methodology, third chapter describes the literature review process and findings, fourth chapter details the results of empirical studies, fifth chapter details the key performance indicators and influence on the stakeholders, and finally, chapter 6 demonstrates the conclusions.

This report is the result of cooperation between several authors. Carina Hartsenko planned and executed the survey and stage 1 interviews and wrote the first analysis on the subject. Kristin Kerem did the literature review, stage 2 and 3 interviews and focus group interview, and was the main author of the report. Riina Otsason did the thorough review and language check; professor Ulla Pirita Tapaninen supervised the process. All above mentioned are affiliated with Tallinn University of Technology (TalTech), Estonian Maritime Academy. In the final stage, Helena Robert i Campos, socioenvironmental researcher from La Palma Research Centre (LPRC) acted as external reviewer.

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1 Introduction

Technology has had severe impacts on the history of humankind and continues to influence our lives every day. The social impact research of technology has been developing side by side with modern inventions, becoming more popular in the 1960s, after being included as prerequisite in the environmental policy acts (IAIA, 2025). For example, Ithiel de Sola Pool collected and edited research of twenty-one scientists of effects and social change that was brought to society through the implementation of telephones (Pool, 1977). At the time, it was one of the first comprehensive reports on how one technology changes human lives. In 2021, Henk A. Becker, frontrunner of social impact assessment categorizes social impact assessment projects and offers methodology for policy-oriented social research (Becker, 2001).

According to Becker, social impact assessment "has evolved into a field of social research incorporating a) *ex post* evaluation of old social impact assessment projects in order to improve social impact assessment methodology; b) theory formation; c) code of ethics; d) professional organizations and international conferences" (Becker, 2001). It is often part of preparations for government actions as standard requirement in policy formation. The International Association of Impact Assessment (IAIA) defines the Social Impact Assessment as follows:" Social Impact Assessment includes the processes of analyzing, monitoring, and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment." (IAIA, 2025).

This report analyses how AIRSHIP will influence the possible users, consumers, based on the interviews with residents and results of the previous work packages. The key performance indicators identified in the first report of the project AIRSHIP (Kerem, Otsason, & Tapaninen, 2023) and business cases identified in our second report for project AIRSHIP (Kerem, et al., 2024), are analyzed in comparison to the results of the social impact study. The findings of the study and the comparisons are presented in this report.

In this chapter, the background of the social impact study is discussed – applicable theories and factors that are most influencing the social impact of an unmanned vessel that is being developed during this project – the AIRSHIP. This chapter is divided into subchapters, that give overview of the AIRSHIP project and possible methods and methodologies that have been considered while investigating the social impact of the AIRSHIP.

1.1 AIRSHIP project

The aim of the AIRSHIP project is to develop a fully electric unmanned wing-in-ground craft, suitable for interisland transport. This report investigates the possible social impact such vessels may have. Reasons for investigating wing-in-ground crafts lies on their ability to save energy for every mile moved compared to aircraft and ships (Paek, 2006). Due to air providing less resistance than the ship, they need less energy per kg for moving forward than a ship, and due to the low flight altitude, the ground effect reduces the power demand compared to high flying aircraft. Analysis has shown that WIG technology can reduce the need for energy by up to 80% (Opstal, 2021). In the case of the AIRSHIP, we additionally aim to use electricity as main source of energy – reducing the energy needs makes this a possibility with the technologies currently being developed. The AIRSHIP is intended for cargo transport in commercial settings - be it services for the residents like food or package delivery. Detailed description of the AIRSHIP is given in Table 2. AIRSHIP commercial crat parameters, compiled by authors based on the project partners' presentations (2023-2024) and Figure 1. AIRSHIP model, Consortium, 2025.

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Table 2. AIRSHIP commercial crat parameters, compiled by authors based on the project partners' presentations (2023-2024)

Parameter	Airship description
Wingspan	24 m
MTOW	12 000-16 000 kg
Payload	4000-7000 kg
Cruise speed	216-234 km/h
Range	1000 km
Cargo space measures	7,93-10x 2,22x1,88 meters
Voyage length in time	2 hours
Take-off and landing strip	600 meters
Maximum take-off wave height	0,7m
Flight height in ground effect	2,1m



Figure 1. AIRSHIP model, Consortium, 2025

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1.2 Basis of the social impact study

About 40% of the population of Europe lives in coastal areas (COPERNICUS.EU, 2025). In the United States (USA), the number is almost the same, which is about 129 million people. About 2,4 billion people worldwide live in coastal zones (OECD, 20231). It has been estimated that 9% of the world's total population, i.e., over 730 million people, live in island territories (Copilot, 2025). At the same time, 90% of the world's goods are transported at some stage on seas (Stopford, 2003). There has been an increased usage of waterways also for transporting goods on inland waterways and in short-sea shipping, due to the alignment with environmental sustainability targets. However, seaways have a considerable role in "greening" the land transportation industry as well as in improving road safety (Maharani, 2021). Hence, AIRSHIP will be part of such infrastructure and will influence foremost the people living in these coastal areas.

Overtime, studies have proven that people dislike changes and prefer to maintain a *status quo* (O'Brien & Crandall, 2005). Any new technology is usually met with a certain resistance to its use, sometimes even regarded as unnecessary and too complicated to use (Leirvik, 2023). During the first phase of the project AIRSHIP, the following social risk factors were identified:

- Changes in the demographics and in the needs of inhabitants
- Cultural preferences
- Changes in the workforce
- Need for education of the workforce
- Technology acceptance

Based on these social risk factors, the research questions were formed, and research methods were chosen, as described in Chapter 2 of this report.

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2 Methodology and research questions

The goal of this report is to investigate what kind of social impact AIRSHIP will have on users, mainly on residents on the islands from the viewpoint of affordable and fast parcel deliveries. Results of both economic and environmental analysis will be combined with the results of the interviews with the residents. The analysis will correspond to the key performance indicators set in the report 2.1 of the AIRSHIP project – poverty, private economics, GDP, health, clean water and sanitation, availability of energy, leisure and free time (Kerem, Otsason, & Tapaninen, 2023).

Based on the lack of actual experience with the wing-in-ground crafts, the following qualitative methods were chosen for the study:

- Literature review into the social acceptance and social impact theories
- Survey distributed among the stakeholders, to verify the results of the interviews against larger target group
- Focus group discussions with maritime professionals for additional input and their qualitative analysis.
- Interviews with the stakeholders
- Collection of statistical data and quantitative analysis of the key performance indicators

The empirical research of this study has been preapproved by the ethical committee of the Tallinn University of Technology with reference TEAD1698, and the ethical guidelines are followed during the process. More information on research protocols and details is available upon request by email from the authors.
The research is based on the social acceptance model (SAM) combined with the stakeholder theory and IAIA's recommendation on social impact assessment.

2.1 Literature review

Literature review was completed during spring-summer 2025 by systematic literature review method using three main databases – Google Scholar, Web of Science Core Collection and Scopus/Elsevier to extract data on possible theories that can be used for understanding the phenomenon of the social acceptance of technology.
The keywords and exact methodology are described within chapter 1.1 of this report.
Secondary literature review was carried out on the social impact, especially on the social impact of technologies. The systematic literature review method was used and in addition, the snowballing method was used using the references from the identified articles. The results were analyzed first based on keywords and titles of the articles, further by the abstracts and conclusions and the relevant articles' texts were analyzed in full.

2.2 Survey

The survey was conducted as anonymous online survey, with the target to collect information of stakeholder perceptions of potential benefits of AIRSHIP. The survey period was 08.03.2025 to 25.04 2025.
The survey contained 20 questions, some of these multiple choices, some of 4-point Likert scale and some with open ended questions. Multiple choice questions were used mostly for the collection of demographic data, 4-point Likert scale (strongly disagree to strongly agree scale) were used for the research questions and open-ended questions were used for giving the participants a chance to offer opinion on AIRSHIP that were not covered within the survey.

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Once the questions were developed, these were tested on two occasions and both times, modified depending on the results. The test group consisted of members of research group as well as members of the other faculties of the university. Once questions were finalized, these were translated into Portuguese, Spanish and Estonian. Microsoft Forms software was used for data collection. The survey started with the introductory form (Annex B), followed by the informed consent form (see Annex C). Survey questions are given in Annex D.
The survey was distributed by the project consortium members on their respective websites as well as in the maritime universities of the three selected comparison countries – Estonia, Spain and Portugal. The countries were chosen due to their diverse locations in Europe and different economic backgrounds as well as due to different sea and weather conditions on the islands of these countries. The sampling used was selected due to convenience, based on easy access and availability.
The results of the survey were analyzed using Microsoft Excel and RStudio.

2.3 Focus group study

Focus group study took place on October 30, 2025. The participants were members or representatives of the members of Estonian Maritime Industry Association and the group consisted of 3 representatives of island communities, 2 representatives of university, 2 representatives of shipbuilders, 2 representatives of fishing and other aquacultures. Some of the roles were overlapping, in total there were 6 participants and a moderator. The focus group method was chosen in conjunction to interviews due to the ability to collect information from a unique group of people who are professionals having worked more than 10 years in their respective fields and private interviews with each member would not have been possible due to time management issues.
The focus group study focused on 6 main questions and lasted for 45 minutes.
Focus group study followed similar introductory procedure as survey – short description of what is AIRSHIP with showing images and videos of the technology, following by open ended questions on 6 themes and one question for feedback on any subject that was important to the members of the focus group, related to AIRSHIP. The questions used were following:

- After hearing about AIRSHIP, which, in your opinion, are the biggest social aspects, when this vessel is operating (human, environmental, safety,)
- What is your opinion of changes in the workforce such vessels will bring?
- What changes would be required from the educational system to provide workforce equipped with skills for the new technologies?
- What would be the changes of AIRSHIP to local communities? How do you see that they would react? How do you think that the acceptance of local communities can be achieved?
- AIRSHIP is AI guided and therefore independent while in traffic. Which benefits do you see in that? Which problems?
- What would use of such vessel change in the work processes of your administration/port/company (choose the one applicable to the interviewee and his/her workplace)?
- Is there anything else that comes to your mind when you think of using AIRSHIP?

The content analysis method was used for the analysis of the focus group discussion notes, using categorizing, coding, quantifying the specific words, themes and concepts, to find the meaningful relationships and perceptions and prejudices that group members carried towards the technology and the possible use of AIRSHIP as cargo transportation vessel.

2.4 Interviews

Interviews were used to extract additional information from the community, to verify the results of the literature review, surveys and focus group study.

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The interviews were carried out in three stages:

- Stage 1: Officials of ministries and their departments connected with maritime or harbors, total 12 interviewees, interview period March-April 2024, total 8 questions, only in Estonia
- Stage 2: Maritime professionals, deck officers, pilots, port captains, total 7 interviewees, interview period March-April 2025, total 10 questions, in Estonia, Spain and Portugal
- Stage 3: People living on islands, Industry representatives, total 7 interviews. Interview period for island representatives was September-December 2025 and company representatives May-July 2024. Teams' meetings were used for the meeting with the company representatives from USA (2 persons) and the rest of the meetings were held in person in Estonia.

All interviews were semi-structured interviews with open-ended questions, aimed at gathering as much information from each interviewee as possible. In each stage, a different set of questions was used. The questions of all stages are given in Annex D. There were two interviewers – one interviewer worked during stages 1 and 3 and second interviewer during stage 2.

The interviewees were found through the targeted sampling, by first identifying the persons of targeted audience, then sending the invitations or contacting the targeted persons during events or via phone calls to agree interview times. Interviews were designed to last about thirty minutes and the target was achieved. All interviewees were participating out of free will and were given a chance to decline the interview or stop it at any given moment. The participants were anonymized during the transcribing process and are referred to as numbers only. The transcriptions were analyzed, and summaries were made according to the questions, similar themes were gathered and categorized, and results are represented as summaries only as per guidance of the Ethics Committee of Tallinn University of Technology. The list of interviewees is given in Table 3, Table 4, Table 5

Table 3. List of interviewees of stage 1 interviews, compiled by authors.

Code	Position	Country	Interview length	Interview language	Experience on the field
1	Managing director of shipping fleet	Estonia	30 minutes	Estonian	More than 10 years
2	Lawyer, specialized in spatial planning	Estonia	30 minutes	Estonian	More than 15 years
3	Lawyer, specialized in autonomous systems	Estonia	45 minutes	Estonian	More than 5 years
4	Legal Council, Ministry of Climate	Estonia	1 hour 15 minutes	Estonian	More than 10 years
5	Legal Council, Ministry of Justice	Estonia	45 minutes	Estonian	More than 10 years
6	Legal Council, Estonian Military, doctoral student	Estonia	50 minutes	Estonian	More than 5 years
7	Legal Council, Transport Administration	Estonia	1 hour	Estonian	More than 10 years
8	Head of Department, Transport Administration	Estonia	45 minutes	Estonian	More than 10 years
9	Lawyer, member of the Board of Estonian Maritime Cluster, doctoral student	Estonia	40 minutes	Estonian	More than 10 years
10	Leading specialist, Transport Administration	Estonia	35 minutes	Estonian	More than 10 years
11	Officer, Estonian Navy	Estonia	45 minutes	Estonian	More than 10 years
12	Specialist in drone law	Estonia	35 minutes	Estonian	More than 5 years

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Table 4. List of interviewees of stage 2 interviews, compiled by authors.

Code	Position	Country	Interview length	Interview language	Maritime career
1	Deck officer	Portugal	30 min	English	Less than 5 years
2	Deck officer	Estonia	23 min	English	Less than 5 years
3	Deck officer	Spain	32 min	English	Less than 5 years
4	Pilot	Portugal	20 min	English	More than 10 years
5	Pilot	Estonia	38 min	Estonian	More than 10 years
6	Pilot	Estonia	15 min	Estonian	More than 10 years
7	Port captain	Estonia	45 min	Estonian	More than 10 years

Table 5. List of interviewees of stage 3 interviews, compiled by authors.

Code	Position	Country	Interview length	Interview language	Experience with technology/lived on the island
1	Director of product strategy	USA	1 hour and 30 minutes	English	More than 5 years
2	Data Analytics Manager	USA	1 hour and 30 minutes	English	Up to 5 years
3	CEO of operating company	Estonia	45 minutes	Estonian	More than 5 years
4	COO of operating company	Estonia	45 minutes	Estonian	More than 5 years
5	Resident of Ruhnu, yachting specialist	Estonia	30 minutes	Estonian	More than 10 years
6	Member of the board, The Association of Estonian Islands	Estonia	45 minutes	Estonian	More than 10 years
7	Resident of Muhu, writer and literary critic	Estonia	35 minutes	Estonian	More than 10 years

3 Literature review

This chapter gives results of two literature reviews compiled for this report. First chapter introduces the theories of understanding the impact of technology and second chapter describes the results of the literature review on social impact studies.

This chapter has given overview of the majority of theoretical and methodical basis that is used in this report. By showing the development chain of the different theories and their interconnectedness, it enables us to understand better the complexity of social impact assessment of such technologies as AIRSHIP.

As literature review has indicated, social implications of wing-in-ground technology have not been researched within the maritime environment. Hence comparative methods are used, and information is gathered also from similar fields – autonomous ships, cars and drones.

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3.1 Theories of public and social acceptance of technologies

Social acceptance and non-acceptance are as old as humanity itself – having acceptation from others has been necessary to be part of the society for very long. The acceptance theories have been traced back to such texts as Buddhist Sutras, Bhavagad Gita, New Testament, Tao Te Ching, Yoga aphorisms etc. (Williams & Linn, 2010). Acceptance as such has been discussed in length within the field of psychology and social acceptance is one field amongst many. In maritime field, social acceptance has been researched most often in respect of ports (Moeremans & Dooms, 2025).

Theories identified during our study are listed in Annex F. All these theories have common ground in assessing the impact of change on the people and the differences come from the details of which aspects are considered important and of which level the theory is aimed at – person, company, country or international. For this report, as it is assessing technology and its impact, we investigated also the technology readiness and acceptance theories as also these have effect on how we analyze the possible impact.

While there are theories of social acceptance, there are also theories of public acceptance. This can be considered as subpart of the social acceptance theories that specifically target political and stakeholder acceptance. While technology can be accepted by peers and be on such technological readiness level that it could be rolled out as commercial, being allowed to be used through the policy measures is often a different story. There are many theories about why such situations happen and what can be done to mitigate these. However, the terms have been used interchangeably and in literature, it is hard to differentiate between the two. There have been suggestions to discuss the acceptance theories on the level of acceptance – personal, company, national or international – and on the level of whether it is acceptance in socio-political level, market acceptance or community acceptance (Rossi, 2023). The difference between the latter has been identified as acceptance of technology as a principle or acceptance of it in the level of everyday life.

In addition to social and public acceptance, there is also one phenomenon that sometimes overrules the findings of the previous theories- phenomenon of “not in my backyard”, NIMBY. This describes the situation where technology is accepted on social and public levels, but when the implementation process starts, people prefer it to take place far away from them, i.e. literally not in their backyards (Kinder, 2025). For example, projects of wind or nuclear energy have been accepted on larger scale, but when the actual place for such projects is being targeted, local community is against of these materializing close to their community (Wolsink, 2007), (Hu, Xie, & Zhang, 2020).

3.1.1 Technology readiness and autonomy levels

The readiness of technology is widely discussed and often means different things. However, the technology readiness levels (TRLs) have become in recent years *de facto* standard in describing technological readiness. The TRLs have been compiled by NASA, United States’ National Aeronautics and Space Administration and their use has become general for all types of technologies due to their ease of use (Manning, 2023). This enables us to evaluate the technology on the scale of 9 where the lowest level is 1 and highest is 9, as can be seen in the Figure 2.

While technology can be ready for operations, it often cannot do so without the acceptance by society. While the main social acceptance theories were described in previous chapter, there are some that are specifically targeting the acceptance of technology. The beginning of such theories can be traced back to Fred D. Davis and his article of usefulness, ease of use and user acceptance of information technology in 1989 (Davis, 1989). Though originally intended for the evaluation of information technology, it has become a standard for assessing acceptance of any technology in form of Technology Acceptance Model TAM. It is based on self-efficacy model, which supports ease of use and cost-benefit paradigm from behavioral decision theory. It suggests that innovations are adopted to actual usage if these are easy to understand and use. It is unique theory as it provides also practical step-by-step process for developing scales to measure perceived ease of use that is also tried out with a sample case. Following these steps makes it easy for anyone to assess their technology from the ease of

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use and usefulness perspectives. The model itself can be summarized as follows in Figure 3 (Worthington, 2021): The roots of technology acceptance theory lie in the theory of Reasoned Actions (TRA), developed by Ajzen and Fishbein in the 1960s and is based on the studies of persuasion models of psychology and is not connected to any specific technology (Momani, Jamous, & Hilles, 2017). The TAM model by today, has been developed further into TAM2 – Extended Technology Acceptance Model, which in addition, has subjective norm as additional construct, which has direct relations with the perceived usefulness and intention of use. In practice, this can be seen in form on experienced moderator who guides the user experience, hence having the influence on the outcome (Venkatesh & Davis, 2000). The TAM2 model is more complex, involving also the persons' previous experience and voluntariness that influence the intention of use as well as taking into consideration the factors that might influence the perceived usefulness like the relevance to the job, output quality, result demonstrability as well as the image of the technology itself (Venkatesh & Davis, 2000).

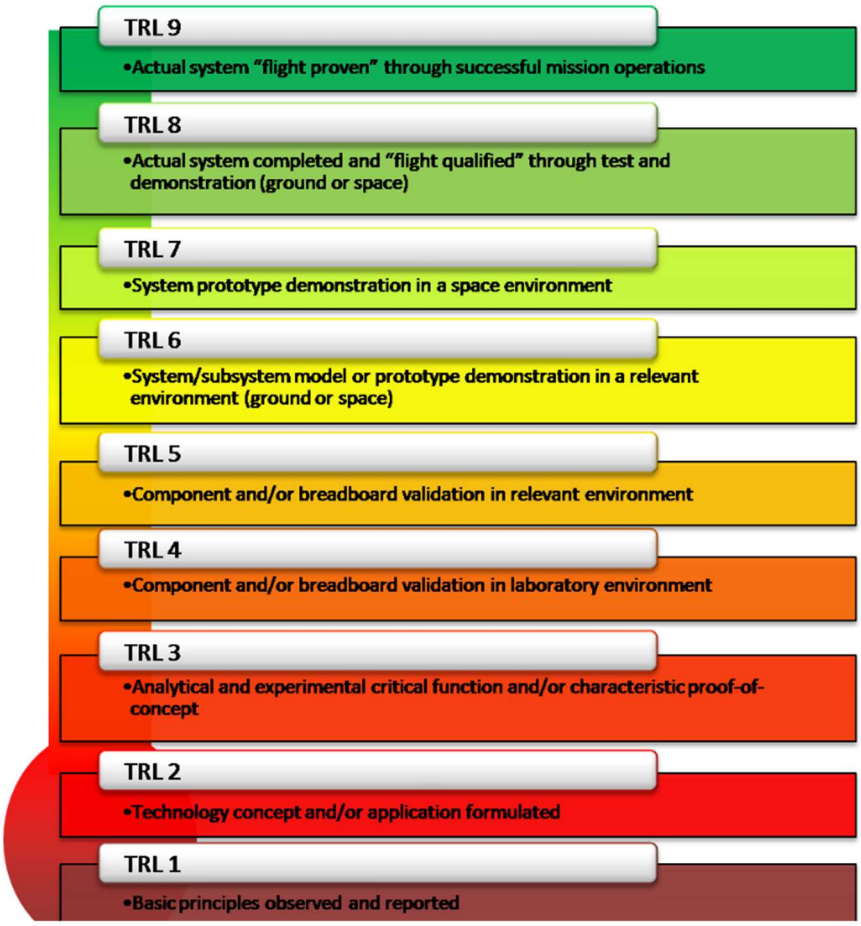


Figure 2. Technology Readiness Levels. Manning 2023

In addition toTRL, The Society of Automotive Engineers (SAE) has defined 6 levels of automation ranging from 0 (fully manual) to 5 (fully autonomous). The IMO has also defined the levels of automation, with one less than the SAE. JARUS, Joint Authorities for Rulemaking on Unmanned Systems has developed their own autonomy levels in respect of drones (JARUS, 2023). The Table 6 compares the autonomous levels of these systems. As a maritime ship, AIRSHIP will have to follow the IMO definitions. However, as technology does enable it to fly above flat land (ice, for example), it is good to note also the requirements of different types of organizations.

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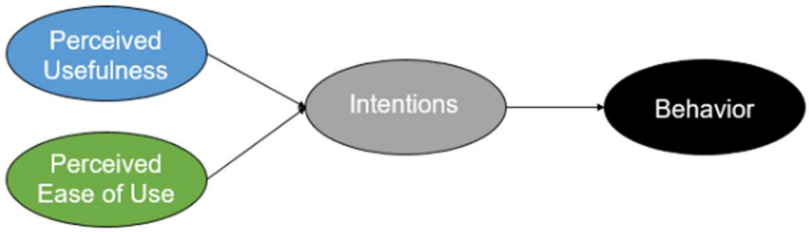


Figure 3. Technology Acceptance Model, drawn by Burgess & Worthington, 2021

Table 6. Automation levels by SAE, JARUS and IMO, compiled by authors based on IMO, JARUS and SAE data.

Autonomy level	SAE definition for cars (SAE, 2021)	IMO definition for ships (IMO)	JARUS definition for drones (EU Drone Port, 2025)
Level 0	No driving automation	No automation	Manual operation, no support from the machine
Level 1	Driver assistance, vessel features a single automated system for driver assistance, such as steering or accelerating (cruise control). Adaptive cruise control, where the vessel can be kept at a safe distance behind the next car, qualifies as Level 1 because the human driver monitors the other aspects of driving such as steering and braking.	Ship with automated processes and decision support. Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.	Functions at this level of automation are designed to assist humans in performing tasks. The machine operates in a supporting role outside the loop of human actions. Although humans are still in control of executing the function, the machine can provide limited assistance, such as providing relevant information.
Level 2	Partial driving automation, the vessel can control both steering and accelerating / decelerating. Here the automation falls short of self-driving because a human sits in the driver's seat and can take control of the car at any time.	Remotely controlled ships with seafarers on board. The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.	This level of automation involves shared control and monitoring between the human and machine with human on the lead, where the machine takes on an in-the-loop management role to help reduce the human workload and/or skill level required to complete the task.
Level 3	Conditional driving automation, Level 3 vessels have "environmental detection" capabilities and can make		At this level of automation, the machine performs the function while the human supervises and can intervene if necessary.

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Autonomy level	SAE definition for cars (SAE, 2021)	IMO definition for ships (IMO)	JARUS definition for drones (EU Drone Port, 2025)
	informed decisions for themselves, such as accelerating past a slow-moving vessel. But—they still require human override. The driver must remain alert and ready to take control if the system is unable to execute the task.		Humans are not aware of the machine's internal states but supervises the outcomes for safety. The machine leads the execution within a defined ODD, but the human continuously monitors and must have the necessary information to intervene if needed. Careful human factors system design is required to ensure that the human has all the required information to transition from "on-the-loop" to "in-the-loop" when necessary.
Level 4	High driving automation, the key difference between Level 3 and Level 4 automation is that Level 4 vessels can intervene if things go wrong or there is a system failure. In this sense, these cars do not require human interaction in most circumstances. However, a human still has the option to manually override. Level 4 vessels can operate in self-driving mode. But until legislation and infrastructure evolve, they can only do so within a limited area (usually an urban environment where top speeds reach an average of 30mph). This is known as geofencing. As such, most Level 4 vessels in existence are geared toward ridesharing.	Remotely controlled ship without seafarers on board: The ship is controlled and operated from another location. There are no seafarers on board.	At this level of automation, the machine performs the function independently and alerts humans only when an issue arises. Unlike lower levels, humans are not required to monitor the function in real-time but must be available and able to intervene if needed. Once the machine has proven its ability to perform the entire function effectively and respond to the environment, the crew may trust it to operate without human supervision within a specified ODD. Building trust requires ensuring the system's trustworthiness, including meeting safety expectations for reliability, integrity, and assurance.
Level 5	Full driving automation, vessels do not require human attention—the "dynamic driving task" is eliminated. Level 5 cars won't even have steering wheels or acceleration/braking pedals. They will be free from	Fully autonomous ship: The operating system of the ship can make decisions and determine actions by itself.	In a fully automated function, the machine assumes full responsibility for executing the task, while the human's understanding of operational parameters is minimal or non-existent. Human interaction with

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Autonomy level	SAE definition for cars (SAE, 2021)	IMO definition for ships (IMO)	JARUS definition for drones (EU Drone Port, 2025)
	geofencing, able to go anywhere and do anything that an experienced human driver can do. Fully autonomous cars are undergoing testing in several pockets of the world, but none are yet available to the public.		the machine is usually limited to providing strategic directives, such as pre-flight planning, and observing the outcomes. Additionally, without special authorization, humans cannot intervene in real time.

As can be seen, the definitions of the levels of autonomy differ greatly between the industries – while all see the ultimate level as completely autonomous, the shipping differs from others by viewing mediatory steps as human not directly onboard but guiding the vessel remotely. Such approach is not evident for the car and drone industry. This is also reflected in regulatory works done by the IMO (see page 26, international regulations for unmanned vessels).

3.1.2 Stakeholder theory

In previous deliverables, the stakeholder theory has been used. It is an organizational management an business ethics theory that argues that all groups of people that have influence in the company or product or are influenced by the company or product should be taken into consideration (Donaldson & Preston, 1995). The author of this theory is Freeman, who discusses in his 1984 book *Strategic Management: A Stakeholder Approach* (Freeman, 1984), the questions of corporate responsibility in the banking industry in Ghana. The ideas were developed further by Donaldson and Preston, who present the stakeholder theory as the output-input model of the suppliers, employees and investors input in the company will produce output for the customers, which can be quite a simplified understanding of how companies work. They themselves enlarge it into a stakeholder model, that includes more actors as can be seen in the following Figure 4. This is the basis of identifying the stakeholders that has been done in the reports 2.1 and 2.2 of the AIRSHIP project. For the AIRSHIP project, the stakeholders identified were the producers and operators of the vessels, ports, local communities, workforce and regulators. The same model is being upheld in this report.

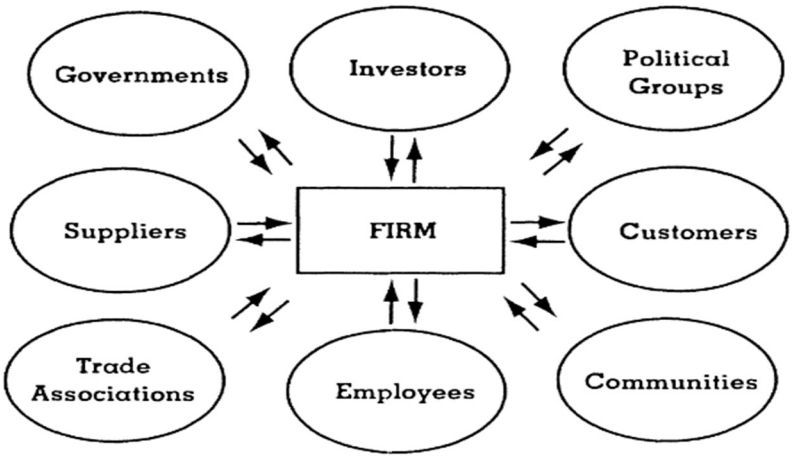


Figure 4. Donaldson's and Preston's stakeholder model (1995).

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Since the first days of stakeholder models, there is a variety of research done in stakeholder models for specific application – project management, supply chain management, operations management, reverse logistics, mainstream management, sustainability performance measurement and assessment, ethical marketing in block-chain based sharing economy (Mahajan, Lim, Sareen, Kumar, & Panwar, 2023).
Yoon (Yoon, 2020) has combined stakeholder theory with MASS and suggests an ecosystem that helps to understand the new stakeholders that will be related to MASS and its safe adoption and operation, defining also the links between the stakeholders as can be seen on Figure 5.

3.2 Literature review on social impact studies

The first glance into literature shows lack of research in social aspects of wing-in-ground crafts. The initial search in Web of Science and Scopus databases give no indication of any research being done before. As such vessels are just on the verge of public use, such results are not surprising. So, we set a target to understand how widely the social impact is studied on the fields close to the AIRSHP.
To widen the search to include also the thesis of different levels and reports written possibly about wing-in-ground crafts and their social influences, the search was done also in Google Scholar database. Sadly, the results were the same – while technical aspects of Wing-in-ground crafts have been thoroughly researched and there is some research of its use cases and possible business models, no research has done its possible value to the

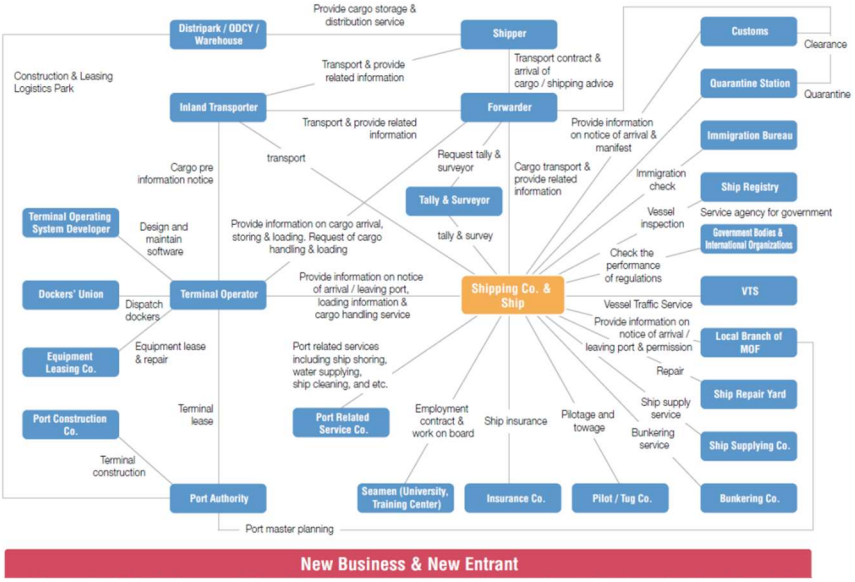


Figure 5. Stakeholders of shipping and port industries in case of MASS. Yoon, 2020

society. Due to the lack of research on the field, we took our novel technology into pieces and made new research in literature regarding use of unmanned vessels and their possible social impact; the AI guided vessels and their impact; electrical vessels and their impact.
The results of the search for the impact of unmanned vessels were promising - 411 items published about "maritime autonomous surface ships" and social aspect or impact published in Google Scholar were retrieved[1]. These articles were assessed first by titles. After initial review of titles, 169 items remained as relevant, of these, 88 were journal articles, 32 master thesis, 16 conference papers, 12 doctoral theses, 10 book chapters, 9 reports

[1] Search was done on July 20, 2025.

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and 1 licentiate thesis and one bachelor thesis. It was also clear that this topic is a growing trend – if 2017, there was 2 articles that covered some social aspect, by 2024, the number of articles had risen to 36. There were no articles found from before 2017 and there were 26 articles in 2025, showing the constant rise of the publications over the years.
In second stage, we examined these 169 articles in detail, identified keywords of different social aspects in their abstracts. In case abstract left a doubt whether the article was discussing a social aspect, the conclusion was checked to remove the doubt. Some of the articles covered several themes and this was noted during the process. As a result, following themes and number of articles per year were identified, see Table 7.

Table 7. Articles of social impact of unmanned vessels over the years, as published in Google Scholar 2017 to June 2025, divided into themes. Compiled by authors

Theme	2017	2018	2019	2020	2021	2022	2023	2024	2025
Maritime education		1	3	3	2	4	8	6	8
Human-Machine collaboration	1		2	4		3	2	6	7
Regulatory issues		3	4	3	2	6	3	6	2
Safety	1	1		3	2	4	1	6	4
Effects on residents			2	1	4	1	5	6	2
Job market				4	1	5	3	4	1
Remote operation center						1	4	2	3
Public acceptance								4	3
Stakeholder perspective				1		2	2	1	
Risk management	1			1		1			2
Gender perspective			2				1	2	
Artificial intelligence			1				1	1	2
Ports			1		2		1	1	
Security				1	2		1		
Engine room					1			1	2
Vessel Traffic Services		1	1					1	
Military									2
Mental health					2				
Environment							1		
Bridge							1		

As can be seen, education, regulatory aspects and human-autonomous vessel collaboration as well as local implications and safety are the main topics of concern, followed closely by the influence on the job market.
We checked our findings against Scopus and Web of Science (WOS) databases, searching for these same keywords. Scopus database returned zero results and Web of Science database returned 100 results. We used the same methodology to identify the relevancy of the articles and divide these into themes. This resulted in 78 relevant articles, but a longer period between the first and the last article – from 2013 to 2025. These articles were further analyzed by abstracts, and the results are shown in Table 8.

Table 8. Articles in Web of Science, 2013-2025 on social impact of unmanned vessels, sorted into themes by authors.

Theme	13	14	16	17	18	19	20	21	22	23	24	25
Regulatory issues						1	3		4	5	5	1
Artificial intelligence						1		2		3	2	2

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Theme	13	14	16	17	18	19	20	21	22	23	24	25
Risk management	1						4	1		1		3
Commercial					2		1		2	1		2
Human-machine collaboration						1	1		1	1	1	
Shipping operations		1		1			1		3	1	1	
Maritime education							1		1	1	1	
Stakeholder perspective				1						1	3	
Public acceptance					1		1		1		1	
Safety									3	1		
Environmental							1					

Similarly, we looked at the research done about electric vessels, as this is the second feature of AIRSHIP that is unique to this vessel. Scopus resulted in 1046 articles on social impact and electric energy, with earliest articles from 2002 and showing the growing trend. WOS shows 33 results on the same topic, while Google Scholar gives more than 1 million possible relevant documents. As the number of results was extensive, we limited our search to the year 2025 only and narrowed it down to "social acceptance" and "electric car" as research keywords. Results were narrowed to 209 articles in Google Scholar[2], of which 25 were review articles, of which based on the analysis of the titles, 15 were relevant to the social acceptance of electric cars. Searching for "social impact" and "electric car" gave similar amount of review papers, 26. However, we did not identify the relevancy of the papers or their themes as was done with the unmanned aspect of the vessel, due to the large number of papers, as the trends can be understood from the numbers retrieved.
This shows well how the importance of unmanned vessels grows in time and how the AIRSHIP, electric and unmanned vessels would be a growing topic in time. In the following subchapters, the identified themes are analyzed in respect of the identified literature.

3.2.1 Changes in demographics

While assessing the social impact of AIRSHIP, there is a need to understand the demographic situation in the regions that are studied. The results of previous research indicate that the technological acceptance is dependent on the age of the users – the older age groups tend to be more negative towards the change and also towards the implementation of new technology, preferring to keep the *status quo* (O'Brien & Crandall, 2005).
The studies of Department of Economic and Social Affairs of United Nations have collected such data and made projections on the demographic outlook of small island developing states for the 2000-2021 with projections for 2022 to 2050 (UN DESA, 2022). They expect population growth to slow down, however, there will be significant changes in the demographic composition. They expect the life expectancy at birth to raise from average of 63 years in 2020 to 72 years by 2050, while the number of births by a woman to go down from 4,5 in 2000 to 2,2 in 2050(ibid). Their population databases show the tendency of the number of people growing to live in the cities, rising from the average of 20% of population in 1950 to almost 50% by 2050. Such changes will have effect on the supply chains and the need for transportation becomes more urgent. Such changes in demographics will also have the effect on evaluating our research results as these need to be evaluated against the changes in the demographics of societies where AIRSHIP is implemented.

[2] Search was done on 04.11.2025

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As we have three countries that are used for this study as samples – Estonia, Portugal and Spain - we identified the possible demographic changes foreseen in these countries. The statistics used here are based on the UN Population research and estimation data (UN DESA, 2024).
Estonia's a country which in past decades, has declining population, being about 1,1 million in 1950, rising to 1,5 million by 1980, declining to almost 1,4 million by 2005 and is expected to continue decline to 1,1 million by 2050. In 1950s, Estonia had about 25% of its population living in cities and by 2050, the expected growth is up to 40%.
The general population of Portugal has been growing from 8,5 million in 1950 to almost 10,5 million by 2004 and is expected to decline below 10 million by 2050. Portugal is showing similar trends to Estonia in terms of population living in the cities – in 1950s, the population of cities was 20% of the total population and by 2050, it is expected to rise to 37%. The statistical estimate is that by 2050, the age group of 65+ will form more than 30% of the population, while the age groups of 0-14 years will see a decrease of 10% and the age group of 25-64 years will see a decrease of 10%.
Spain, being the largest in population size of the three compared countries, has had population of 29 million in 1950, rising to almost 50 million by 2025 and is expected to slowly decrease to 45 million by 2050. It had 30% of its population living in cities in 1950s, the number is expected to rise to about 55% by 2050. However, Spain is expected to see a significant rise in the age group of 65+ by 10% from 2025 to 2050, while the age group of 0-14 years is expected to decrease by more than 10%, following the existing trend of decreasing total fertility rates and socio-structural challenges for future upbringing plans (e.g. housing crisis, cost of living crisis).
All three countries show that there will be significant demographic change towards growing population group of older generations, and this may have an impact on the workforce and labor market structure as well as the social acceptance of introduction and use of new technologies.

3.2.2 Changes in workforce

The seafarer shortage has been known to rise for several years (Cahoon, Haugstetter, & Bhaskar, 2010) (Badawy, 2025). Yearly reports of BIMCO, Baltic and International Maritime Council confirm the findings as their empirical study carried out every five years confirm the same (BIMCO, 2021).
For 2015, this meant a 5.9% **deficit of seafarers**, which is equivalent to at least 27,000 persons. It is still difficult to secure skilled seafarers, in addition to the challenges in recruitment and retention. Such factors are key contributors to the growth in demand for maritime autonomous ships. As MASS (Maritime Autonomous Surface Ship) regulations and technical development advances, the challenge is to find the workforce suitable for operation of such vessels, especially as the crew will most probably be divided into land-based remote operators and onboard crew. This shift necessitates a rethinking of crew roles, where duties traditionally performed by onboard seafarers can now be divided between a reduced onboard crew and remote operators. The study of Vadim Goltsev in 2020 has indicated that the fully autonomous vessels could be operated with 50% less crew than a traditional ship (Goltsev, 2020). This means that through autonomy, the seafarer shortage can be reduced, but it would mean changes in education as well as the actual tasks of the workforce.
As AIRSHIP is an autonomous vessel, the seafarer shortage will have influence also on the possible employees working with AIRSHIP.
Second important aspect of the maritime workforce is its **gender inequality**. According to research, there is only 2% of females working on board for various reasons. The barriers for working on board are physical traits (need of strength, male-modelled job descriptions), psychological violence (bullying, intimidation, abuse, harassment) or of social nature (ships as isolated entities etc.) (ICS, 2020). Autonomy of the AIRSHIP could help to eliminate such barriers, especially as the manual operation becomes limited and is replaced with supervisory and monitoring tasks that can be carried out from land-based operation centers.
Thirdly, the autonomous vessels are expected to improve the seafarer job quality. The mental health issues, social isolation, stress, long work ships and fatigue are related to seafarer jobs, causing accidents and reducing life quality of seafarers (Nittari, Gibelli, Bailo, Sirignano, & Ricci, 2022). Automation is expected to help with these

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aspects and moving jobs to land may **improve the working conditions** as well as reduce working hours by adding flexibility (Cal, Bently, Zamani, Naiseh, & Sbaffi, 2023).

3.2.3 Regulatory issues

During initial study for the AIRSHIP project, the legal factors that might hinder the use of AIRSHIP were identified. Due to the complexity of the matter, the legal factors that have effect on the AIRSHIIP usage are viewed in this report through the lens of rules of International maritime organization, IMO, regulations of the European Union (EU) and national regulations in the countries where the AIRSHIP is intended to be tested as well as used for commercial operation. The legal factors are researched in form of documental analysis, evaluating the state of the art at the time of writing this report as well as indicating possible changes that might be needed for successful commercialization of the AIRSHIP.

The use of wing-in-ground crafts has been regulated in several countries and also on an international level. However, the AIRSHIP is developed as electric unmanned ship, aiming for total independence during the voyage with complete situational awareness. The prerequisite of having situational awareness of its voyage is use of artificial intelligence. Hence the regulatory aspects of using the AIRSHIP are more complex than just regulations of wing-in-ground crafts – review of applicable regulations must include regulations for unmanned vessels as well as regulations of artificial intelligence. (Kerem, 2024)

This chapter discusses the **regulatory demands** that exist today and the gaps that are within the regulations on three levels – international, European Union and national regulations within EU as much as such exists today. This overview is indicatory, as the field is quickly developing. At the time of writing this deliverable, EU is processing its laws about artificial intelligence, IMO is discussing regulations for unmanned vessels and national bodies have great variation on the laws applicable to their territorial waters. Therefore, this overview includes authors' views of possible problem solving within the currently discussed frameworks for the benefit of the use of the AIRSHIP as electric, unmanned cargo transport vessel, as described in Chapter 1 of this report.

3.2.3.1 International regulations

3.2.3.1.1 WIG craft specific regulations

The international guidelines for WIG crafts can be found in three main documents – IMO guidelines for wing-in-ground crafts (IMO, 2018), in the IMO's general principles and recommendations for the knowledge, skills and training requirements for officers on WIG crafts (IMO, 2005) and the Convention on the International Regulations for Preventing Collisions at Sea (IMO, 1972/2001).

The work for regulating wing-in-ground crafts on international level started in the 1990s (Paek, 2006). The first document to regulate the wing-in-ground crafts was adopted by IMO in 2002 as interim guidelines. Since then, it has been updated in 2005 and finally in 2018, the guidelines were accepted by the IMO. The guidelines carry no obligatory power as it is not a mandatory code, with the aim to provide flexible risk management basis with reduced emphasis on prescriptive standards to achieve comparable safety standards as SOLAS 1974 convention and 2000 HSC Code (IMO, 2018).

Though the guidelines state in its preamble, that the wing-in-ground crafts are not included in the HSC Code and that necessitated the creation of guidelines, the historical review of the IMO document database indicates that HSC Code was used as basis for the creation of the wing-in-ground guidelines, following the same order of chapters and in some places, even including the same wording. The guidelines set a rule of thumb for the size of WIG that is considered big enough to be developed under these guidelines – carrying more than 12 passengers or having full load displacement of more than 10 tons, unless expressed otherwise in the document. The AIRSHIP is planned to be with the ability to carry 4 to 7 tons of cargo and with total displacement in full load of 12 to 16 tons, hence the international guidelines are applicable to its development.

There are three types of WIG crafts per IMO guidelines point 4.45 – the type A, B and C. The type C, able and intended to fly higher than 150 meters, should in addition correspond also tot eh international aviation rules as per agreement between the IMO and ICAO. Type B can fly over the obstacles but will not exceed the height of

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150 meters from the surface and type A is intended to fly in ground effect only. The AIRSHIP is intended to be a type A craft; hence the international aviation regulations do not apply to the development and use of the AIRSHIP. In addition to the 2018 guidelines of WIG crafts, IMO has adopted in addition general principles and recommendations for training officers for the WIG crafts (IMO, 2005). The aim of these principles is to primarily assist the member states in developing their national requirements for WIG crew members. Hence the principles are not mandatory *per se* but depend on the implementation into the national legislation. For these recommendations, the WIG crafts are additionally divided into small (up to 10 tons), medium (10 to 500 tons) and large crafts (more than 500 tons), indicating further the similarities between the WIG crafts and ships, as major IMO legislation applies to ships of 500 gross tons or more. The qualification system is based on the Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW 1978), but opens also the possibility for the base training to be based on the Chicago Convention on International Civil Aviation. However, for the type A crafts, maritime education is preferred (IMO, 2005, Article 5), with the additional training of WIG specific features described in Chapter 4 of the general principles. As the AIRSHIP falls into the medium craft category, the specification of minimum standard of competence for officers of such size of craft is given in the table in the end of the general principles. It must be added that there does not exist today minimum standard of competence for small or larger crafts.

As a conclusion it can be said that on international level, the AIRSHIP will be considered a ship and must be developed according to the IMO rules that apply to seagoing vessels with the attention to the special features as per the guidelines of the WIG crafts from 2018 and general principles for training the crews from 2005.

3.2.3.1.2 International regulations for unmanned vessels

As AIRSHIP is an unmanned vessel, it is important to understand the limitations that current regulations pose to the use of such vessels. At the time of writing this report, discussions of possible regulations for unmanned vessels are ongoing and this chapter describes its current state and possible inclinations in future that might influence the development of the AIRSHIP.

The first international milestone for autonomous shipping was the approval of the Interim guidelines for Maritime Autonomous Surface Ships (MASS) trials in June 2019 by IMO Maritime Safety Committee (IMO, 2019). These guidelines list items that national maritime administrations should address when evaluating the potential trials of unmanned vessels. The aim of the guidelines is to help to guarantee the safety of the trials while protecting the environment. It relies heavily on risk management and compliance with the mandatory instruments – no trial should endanger the existing systems, environment or marine traffic in particular location. It emphasizes trial awareness and communication and reporting, to make sure that necessary parties know of the trials.

In 2021, the IMO finished conducting regulatory scoping exercise to understand how the existing regulations and various instruments would apply to the various degrees of automation of ships (IMO, 2021). The result indicated that there is a need to make several adoptions, either to the international conventions themselves or to the interpretations of certain articles of the regulations. At the time of compiling the current report, this has resulted in compilation of new code for MASS, Maritime Autonomous Surface Ship. As per IMO, such vessels are divided into four categories – ships with no automation and fully manned, ships with some automation and manned, ships with full automation and partially manned or human controlled and finally, ships that are fully automated and unmanned.

In December 2024, the IMO Maritime Safety Commission (MSC) agreed on a roadmap for the development of MASS code in several steps. First target is to complete and adopt non-mandatory MASS Code by May 2025 and continue after that with the experience-building phase, with the aim that 2028 results of it can be used for creating the mandatory MASS Code. According to that plan, by July 2030, the mandatory code is adopted and will entry into force on January 2032 (IMO, 2024). In March 2025, at the IMO MSC meeting, the MASS Code was developed further, carrying the main idea of keeping the human on the loop either as onboard or as a remote operator in land. This means that according to current way of developing the Code for unmanned vessels, AIRSHIP would be allowed to operate in international waters only under remote control.

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However, there are several international conventions that will need to be adapted before the autonomous vessels can be used in commercial shipping. One of these is UNCLOS, United Nations Convention on Life on Seas (Yoon, 2020). The problems with this convention are shown in the Figure 6. UNCLOS defines the sea areas that are under different control of the States – territorial waters where the States have exclusive rights, exclusive economic zone where States have limited rights, high seas where no State has jurisdiction over the waters. As the UNCLOS system depends on the system of rights based on the vessel's flag and crew and rights of the coastal State, the autonomous self-guiding vessel poses many questions – who is accountable, how to enforce the rights when there is nobody on board? The MASS Code is expected to tackle these problems.

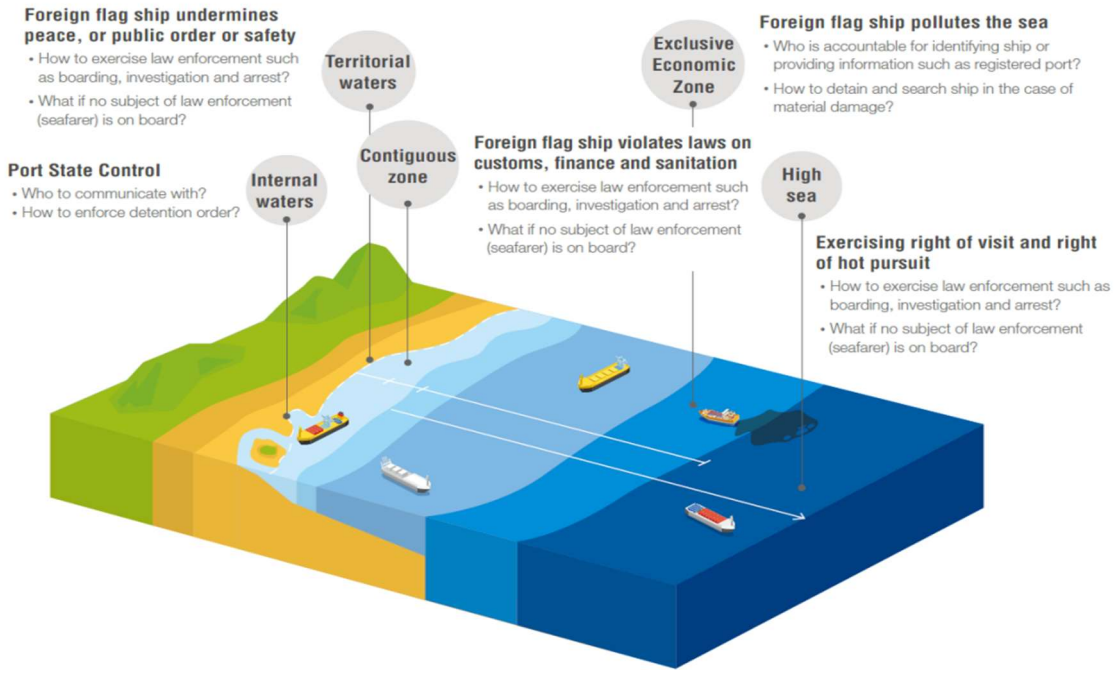


Figure 6. MASS and UNCLOS, problem areas. Compiled by Yoon, 2020.

3.2.3.1.3 International regulations for artificial intelligence

International regulations for artificial intelligence (AI) are evolving together with technology itself. At the moment of compiling this report, there are several international bodies that work with different initiatives to find the most suitable regulations for artificial intelligence.

According to the United Nations (UN) home page of AI, each organization and workgroup within the United Nations network works separately on their own with the possible influences of AI in their lives (United Nations, 2025). However, there is no unified, universal AI regulation or convention that UN has accepted. UN has worked with the AI theme on several levels – first, by gathering an advisory body on Ai to the UN Secretary General, including more than 30 country representatives and professionals on the field. This body concluded their work in final report suggesting the need to address gaps in AI governance as well as calling on the governments and stakeholders to work together to foster the governing and further development of AI. This work was continued by concluding the framework Global Digital Compact, adopted in September 2024 alongside The Pact for the Future, providing roadmap for global digital collaboration while upholding international law and human rights. The Digital Compact is result of negotiations of 193 Member State of UN and has a deadline of being implemented and presenting its review in the third quarter of 2027. AI Panel and Dialogue is part of this process, being an intergovernmental process co-facilitated by Costa Rica and Spain. One of the first results is the

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resolution adopted by the General Assembly of the United Nations on August 26, 2025, establishing the multidisciplinary Independent International Scientific Panel on Artificial Intelligence, comprising 40 members (selected for the terms of three years). The Panel is regarded as a platform for discussing international co-operation, sharing best practices and learned lessons in seven major domains – learning the implications of artificial intelligence, finding the governance approaches, keeping up human rights, having oversight of the AI systems in manners that complies with international law as well as development of the open-source software, open data and open artificial intelligence models. As can be seen from the targets, general AI regulation is not yet under discussion by the United Nations.

At the same time, OECD, the Organization for Economic Co-operation and Development, was adopted in 2019 and updated in 2024 its AI Principles as first intergovernmental standard on AI (OECD, 2025). These value-based principles promote the use of AI through five main topics – inclusive growth, sustainable development and wellbeing; human rights and democratic values, including fairness and privacy; transparency and explainability; robustness, security and safety; accountability. It also includes five recommendations for policy makers, on topics of investing into AI research and development; fostering an inclusive Ai-enabling ecosystem; shaping an enabling interoperable governance and policy environment for AI, building human capacity and preparing for labor market transformation; international co-operation for trustworthy AI. The current works of OECD on AI is gathered on a separate internet page, oecd.ai. This includes live data reports, overview of implemented policies and initiatives as well as tools and resources for implementing AI Principles. It also has collected data from the member states and showcases the international and national implementations of AI policies and initiatives, being the forerunner in facilitating AI related information and statistics.

3.2.3.2 European Union

3.2.3.2.1 WIG craft and unmanned ship regulations

European Union (EU) has no regulations regarding wing-in-ground crafts at the moment. However, European Union is investing into the technology through several projects that are funded by the EU funding mechanisms, both for commercial and military use (Airship, 2025), (Seawings, 2025). As EU member states are also members of the IMO, the IMO regulations are to be applied also within the European Union.

While WIG crafts as such are not regulated in European Union, the same applies to vessel automation. While EU has not accepted a mandatory regulation, there is many initiatives that are active under the European Maritime Safety Agency, EMSA. During 2019-2020, the project SAFEMASS was concluded to identify the existing regulatory gaps and emerging risks of the use of unmanned vessels. The results were presented in deliverables which included hazard identification, fault tree analysis and set of recommended risk control options and measures. This resulted in continuation project to create risk-based assessment tool RBAT in 2020-2024. The reports of the projects are available at EMSA website (EMSA, 2025).

However, EU has updated its existing legislation of vessel monitoring and traffic information system with provision for the autonomous vessels (European Union, 2025) and created an operational guide for the MASS trials (EU VTMIS, 2020), which is much more detailed than IMO analogue. While the IMO guidelines state the topics that must be addressed in 2 pages, the EU guidelines go into detail on each of those over 3 pages, including sample documentation and risk assessment principles.

3.2.3.3 Artificial intelligence regulations

European Union is a frontrunner in regulating the use of AI. After many years of extensive work, on 13.06.2024 the European Parliament and the Council accepted the regulation 2024/1689 on harmonized rules on artificial intelligence (EU, 2024). The regulation is first of its kind and is aimed at providers, deployers, importers and distributors of the AI systems as well as product manufacturers whose systems include AI. This means the commercially used autonomous and self-aware AIRSHIP would have to fulfil the demands and meet the restrictions of the European AI Act. However, using such systems for research and development without market availability is outside the scope of the European AI Act and therefore there is no restrictions for the development

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and training of artificial intelligence just for the purpose of the project AIRSHIP. The EU AI Act will come to full force in 2026 and its enforcement in member states of EU will be overseen by the European AI Office.
However, should the AIRSHIP reach the commercialization phase, the EU AI Act will have significant influence and needs to be considered in full, taking under consideration the internationality of maritime trade and the difficulties of litigation in possible cases over liability (Lee, Lee, Jeon, & Bae, 2024).

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4 Results of empirical study

This chapter presents the results of the empirical studies that were done during the research period.

4.1 Survey results

The survey results were analyzed from the perspective of different age groups, gender as well as by location people live in. The respondents were very varied and covered reasonably well the intended target groups. 42 respondents knew the technologies involved in AIRSHIP before, 68 respondents had not heard of such technology. 89 of the respondents lived in a city, 11 on an island, and 10 in the countryside. 46 of the respondents identified themselves as male and 62 as female, one preferred not to say and one referred as "other". 57 respondents lived in Estonia, 15 in Spain, 21 in Portugal and 18 respondents were from Panama, Luxembourg, Finland, Netherlands, Latvia and Belarus. 37 respondents were students, 8 of them specified that they were students in the maritime field; 5 respondents were working in university, 26 respondents worked in maritime fields and 43 respondents worked elsewhere.

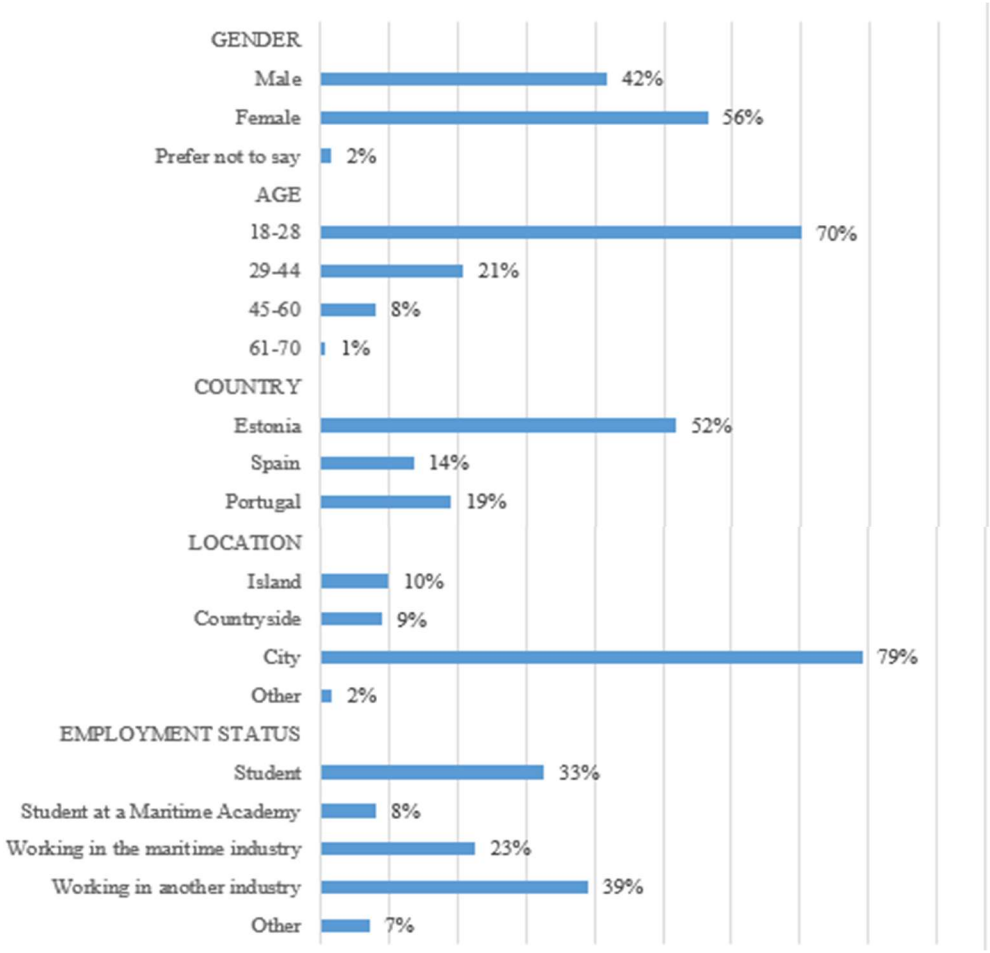


Figure 7. Demographic statistics of the survey, compiled by Carina Hartsenko, 2025.

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When asked who would **benefit most from AIRSHIP**, it was seen mainly as the tool for emergency services (78% of all respondents) and secondly as transport means for isolated communities (80%). There was no difference of demographics for this question – all respondent groups, came to the same conclusion after the brief introduction. When asked which regions would benefit the most, there was some variation between the perception of the age groups – younger generation (18-28 years) saw it foremost as tool for disaster zones and remote islands, 29-44 year age group saw it almost equally for all offered regions with slight advantage of the disaster zones and the age group between 45-60 saw it mainly as suitable for the places with poor infrastructure and remote islands. When the results were viewed by gender and age group, it stood out that only men in age group 45-60 saw the airship most suitable for places with poor infrastructure and in all other age groups, the most beneficial region was seen the disaster zones.

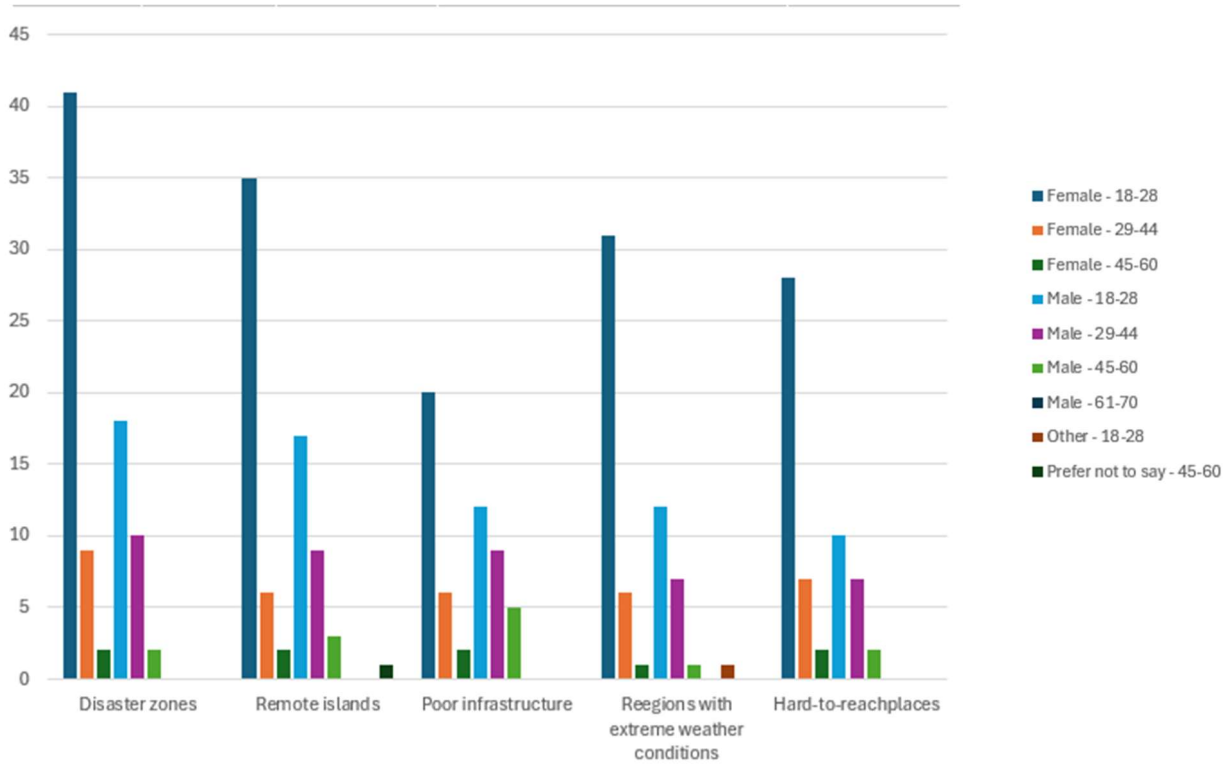


Figure 8. Benefits of AIRSHIP, by age and gender. Compiled by authors.

When asked directly about the benefit for the islands, it was seen mainly as help in bringing people together (62%), followed closely by options for helping with the economy as well as with environmental issues. While female respondents viewed the help with the economy to be of equal value to bringing people together, for the male participants, bringing people together was clearly more important. There were seven persons, who expressed that AIRSHIP would not change much for remote islands, the reasons given were varied – it was seen as seasonal vessel only and unable to manage with the winters, it was seen as too expensive and too exclusive to be successful in making a difference. In commentaries it was mentioned that while we have sea planes and helicopters, these are not widely used forms of transport an AIRSHIP will probably be like them. At the same time, another respondent saw AIRSHIP as possible reducing use of airways and train tracks and need for long distance delivery trucks. One respondent wrote in comments that "if AIRSHIP is really able to provide service at the speed of 200 km/h for reasonable price, in long term, all essential goods should be transported by this."
Second set of questions was targeting **environmental impact**. When asked to evaluate whether AIRSHIP would reduce air pollution compared to traditional cargo methods, most of the respondents agreed (38%) or strongly agreed (33,6%) with the statement (together 71,6%). 10% of the respondents did not know how to answer. There were no significant changes between the answers from the age groups, but male respondents tended to strongly

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agree, especially in the age group of 29-44 years. When asked about noise pollution, the respondents tended to rather agree than strongly agree, especially in female age group of 18-28 years. Male participants showed more level response and while 60% of men either agreed (30%) or strongly agreed (30%), 23% of men disagreed with the statement and 6% of men strongly disagreed with the statement. Statement of water pollution shared similar results with the air pollution question – majority of both male and female respondents either agreed (45%) or strongly agreed (35%, total of two 80%) and there were no differences between the age groups. When analyzed by country, the results were like the above mentioned for all three environmental impact details – air pollution, noise pollution and water pollution. It was also noted that there should be also flexibility for using other fuels (hydrogen) and if this is used, suitable charging stations and systems will need to be developed.

The **impact on local communities** was partly discussed as a benefit of AIRSHIP, but there were also some comments that referred to this theme separately. It was mentioned that harbors will need to be adapted so AIRSHIP can dock and get charged. There would also be need for loading systems, repair and maintenance as well as storage buildings as for any vessel. It was also mentioned that AIRSHIP will need specialized infrastructure, especially for charging. However, the infrastructure could also lead to cost reduction. It was noted that if AIRSHIP is intended as a premium fast service for premium price for people who can afford it, it would be "utterly useless". Also, the possibility of cyber intervention or lack of electricity were seen as possible issues with AIRSHIP. The issues of control and losing control over AIRSHIP can also be damaging for the local communities. It was noted that yachts and AIRSHIP might not go together, and AIRSHIP could reduce traditional hop on-hop off sea cruising and reduce the demand for yacht tourism. It was noted that AIRSHIP will need a landing and take-off strip in the waters close to the harbors. These areas might be then out of use for others or limited use areas. Probably it could be used as conventional ship near the harbors, but this way it would not be as effective compared to using it on maximum possible voyage in ground effect. One participant saw that there is little need to adjust the harbors, but there will be new logistical chains that develop, especially with islands and remote areas that do not have easy access. One respondent pointed out that there will be need for specialized ports, and the other respondent was claiming that no changes is needed to current maritime port provided AIRSHIP is a vessel. When asked to evaluate how important it is for them personally that the transport is changed into more sustainable versions, for majority it was important (46%) and very important (41%), so 87% of the respondents in total see sustainability as important feature. There was no difference in answer patterns according to demographics.

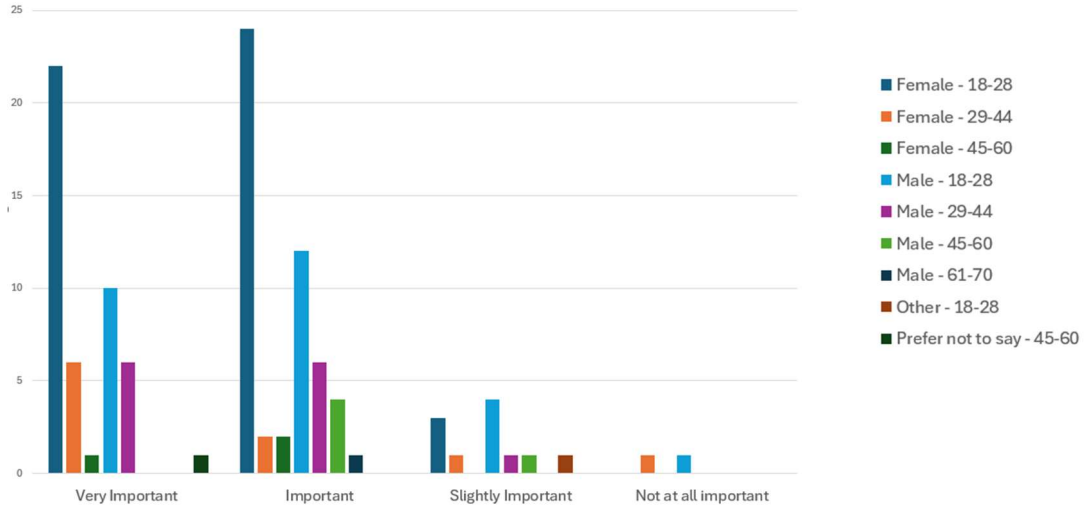


Figure 9. Importance of sustainable transport options by gender and age groups. Compiled by authors.

The impact that AIRSHIP would have on **workforce** was seen as generally as with little effect – 51% of the respondents saw AIRSHIP as adding some jobs and losing some and 7% of the respondents saw that there will be no effect on the workforce by AIRSHIP. At the same time, only 4,45% of participants saw AIRSHIP causing job loss.

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Female respondents were more eager to see the job loss than men. 36% of the participants saw that AIRSHIP would have positive effect and would only add jobs. However, there is difference how different countries see the effects on the workforce – while 18% of the Portuguese respondents believe that this will not change the job dynamics, only 5% of Estonians and Spanish share their view. 61% of the Estonian respondents see that AIRSHIP will create jobs in some areas and loose in the others, while 48% of the Spanish feel the same, but only 35% of the Portuguese respondents agree with this.

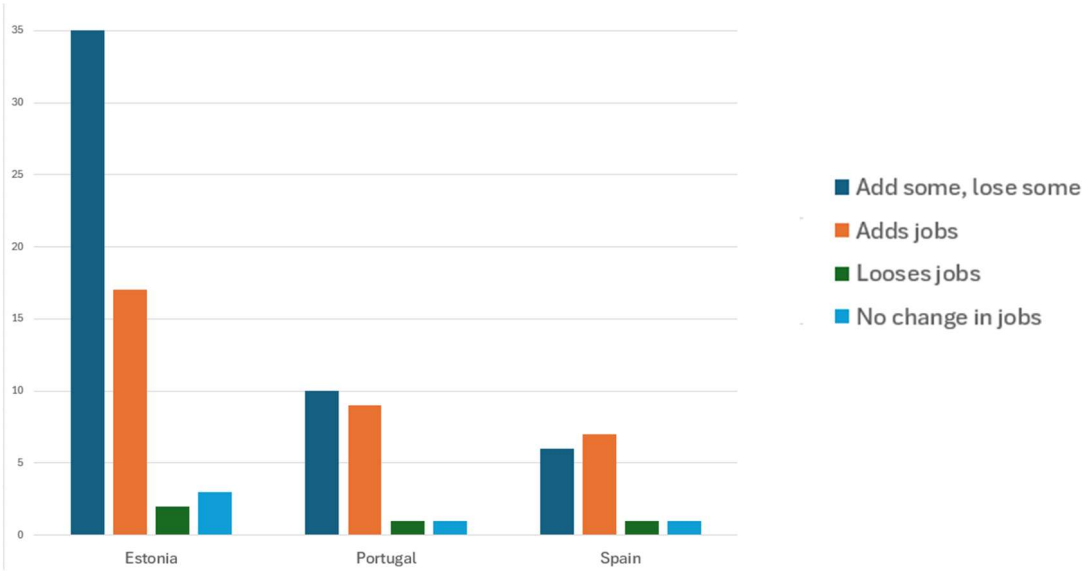


Figure 10. Perception of the AIRSHIP effects on job market. Compiled by authors.

When asked for **general impression** on AIRSHIP, only few of the respondents wrote their own ideas. It was noted that AIRSHIP is seen as short route vessel, and some concern was expressed in regard of its safety in vicinity of other vessels due to its speed. It was also said that there might be more noise due to being aircraft type and the expected noise level could reach the level of airports. AIRSHIP is considered niche means of transport for relatively close-set locations. It was also noted that it is important to consider where the energy that AIRSHIP is charged with is coming from. The same respondent is noting that provided the electricity comes from traditional plants, according to his opinion, it should not be called green. This respondent also pointed out that the operating costs of such vessel would be an important factor and there is interest in learning more about it. It was also noted that every vessel needs maintenance and there is a need for human onboard in case something breaks – human can think of some way to solve the situation, the machine is not prepared for it. According to the opinion of one respondent, unmanned vessels will become unusable in some stage.

4.2 Focus group results

The discussion during the focus group study was analyzed based on the themes brought up by the focus group members and divided into the themes during the analysis phase. The result of the analysis is presented in this chapter.

Two of the focus group members knew the technology before the start of the focus group discussions, two had some knowledge and two had no previous knowledge of AIRSHIP like technology. Focus group discussion started with explaining what technology is and how AIRSHIP differs from previously developed ground effect vessels. All participants had heard beforehand about the trial in 2016 of bringing the ground effect vessel into Estonia by company Seawolf and were wondering why this company did not follow through.

The biggest influence AIRSHIP could possibly have was to service the remotest inhabitable island that is serviced today from mainland with a 5-ton ship during summer period and aircraft during the winter. The focus group

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raised the issue that social influence of AIRSHIP would probably not have significant influence provided it is not demanding any changes from locals – should the locals change their habits, the story can be different. It was pointed out that small minorities that can have a loud voice can change minds and have heavy influence on the outcome of new service like AIRSHIP, affecting it both to positive and negative side depending on their interest. It was pointed out that special care must be taken to make sure AIRSHIP is safe for other mariners and can follow exactly the changing sea conditions. The sample area discussed – Liivi bay, is known for waves higher than 1 meter and rapidly changing weather conditions as well as changes of wave heights close to shore and in the middle of bay. AIRSHIP should be able to accommodate this and make maneuvers in a way that does not disturb locals. It must also be considered that communities are seldom rational, and their opinions depend heavily on opinion leaders as well as on the heresy and experience of their neighbors and people they respect.

Focus group did not see AIRSHIP having any influence on the workforce. It was pointed out that it can be monitored remotely and will need service and handling in harbors only. The locations discussed have several harbors that can accommodate such vessel and there is plenty of fishermen who have given up their jobs at sea as well as old captains who could do the remote tasks. Hence AIRSHIP was viewed as adding value and jobs, especially of high end and pay. The focus group saw no issues with education as it is anyway in continuous change with the market demand.

The reactions of local communities were rationally seen as minimal. As AIRSHIP is designed for transporting cargo, it will not influence directly the habits of residents of the islands and therefore has low impact. The transport companies and service providers were seen to appreciate direct deliveries to the island several times a day and perhaps reduce the need for road transport by delivering goods directly from the mainland to the main cities on the islands. It was also seen as additional value provided fresh produce could be delivered for the islands' tourism industry, especially restaurants and cafés in early hours of the day instead of refrigerating it. However, it was mentioned that all will come down to the cost – whether the cost is affordable and comparable to current transport solutions. The transport companies and solution providers on the island in general are flexible and in major islands, the current transport routes would still remain while the solution is best for the remotest islands that depend heavily on smaller vessels and have currently issues with delivery of goods and cargo as the everyday vessel can deliver only up to 5 tons provided it is not carrying passengers at the same time. If AIRSHIP were to provide passenger service, it could have special value in enabling island hoping routes that are not possible today. It could also serve as connection with the cities in the neighboring countries. Passengers could be reluctant to use it on first chance but provided someone from their circle of acquaintances has used the service and is content with it. It was pointed out that if the AIRSHIP could provide such passenger service that connects cities on islands with cities on mainland, enabling them to go from city center to city center, it would probably also reduce the use of passenger cars. AIRSHIP was also seen as easy to accommodate in existing ports and the loading and offloading procedures were found to be easy to handle with movable cranes or roller ways. It was considered a good idea to use containerized loading which would reduce the time AIRSHIP would spend in harbors.

The fact that AIRSHIP would be fully autonomous was seen as of no direct significance provided it can handle sudden changes on the route and be safe for the other seagoing vessels and pleasure crafts. The question of how safe it is for other passengers and whether it can avoid them was discussed in length. The option of having a route cleared for AIRSHIP at certain times of the day was considered as option but would prove to be difficult to maintain on the seaways that are having crossing traffic of leisure crafts or fishing boats. Also, the issue of the influence of AIRSHIP passing would have on the sailing yachts was raised – the loss of wind could have damaging influence on these vessels and it must be accounted for. The takeovers would have to be done on safe distance for other vessels and with minimal impact on the habits of locals, if successful implementation of AIRSHIP is sought for. It was pointed out that for AIRSHIP to be effective and able to manage with traffic and collision avoidance, it would need extreme data management power. The sample was given of a Singaporean company that has made a situational awareness camera system that includes 35 cameras, but even they are having problems with handling the data management. Provided AIRSHIP aims to keep the speed of close to 200 km/h, it would need to be very quick with data management to be able to effectively make decisions – some concern was expressed whether technology is advanced enough for this.

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In general, the focus groups saw that AIRSHIP could provide additional value but would need to showcase technical readiness first. The experience with previous ideas to provide service with similar vessels was well accepted by the community and the focus group members did not see a reason why it should not be accepted in case of AIRSHIP.

4.3 Interview results

4.3.1 Stage 1

During the first phase, total 12 people were approached for the interviews, of which 3 declined on the first instance claiming they do not know enough about technology, but agreed to continue provided they could answer the questions based on their current knowledge without having to go in detail of the use of AIRSHIP. Some interviewees used the possibility to skip the questions they did not feel comfortable with, and this is noted in the interview protocols. Their answers were analyzed, and main points are summarized (see Annex E for questions).

The first set of questions was targeting the **regulative procedure** in Estonia. It was foreseen by all participants that legislation will need changes, and the regulations will need to be adapted to new technologies. However, it was pointed out that regulatory procedure is always behind the developments in technology and therefore the processes of creating new or changing existing regulations is a lengthy procedure. It was also noted that Estonia is member of several international bodies, has joined several international conventions and, as a member of European Union (EU), the EU regulations are directly applicable, so the situation with the regulatory process is not straight forward and will need careful considerations. The regulatory process in Estonia is minimally one year, but it can take 2-3 years provided there are interest groups that are opposing the legislation. It must be noted that change of government will halt the process and with the confirmation of new government, it has the right to choose which initiatives are continued with and which are dropped. It was also noted that the regulatory process should not be forced and should not be started too early as this can inhibit technological innovations and can devaluate the effect of regulations, especially in cases where governance and enforcement models are not developed. As AIRSHIP will be integrated technology of several fields – autonomous, electric and wing-in-ground, including both maritime and aviation regulations – it will need careful planning and their jurisdiction can vary between different regulators depending on their mode of operations, similar to the ships that service the oil platforms – while connected to oil platforms, these are regulated as platforms and when in move, these are regulated as ships. In general, the interviewees agreed that Estonia should wait and see what is done by international bodies and in other countries before making own regulations, due to the size of Estonia, lack of specific knowledge and it would be too much work and too costly to first do own version and then change it to correspond to international legislation. However, it was noted that Estonia should be actively participating in the discussions in international bodies, to guarantee best starting platforms to our developers. It was noted that best method to regulate new technologies would be to use combined approaches of descriptive/normative and risk-based approaches. The negative effects of using only one of these were rather similar – need for resources and knowledge.

Second set of questions targeted the **readiness for unmanned, autonomous vessels.** First of the questions asked the perception in 30-year perspectives, which automation level of ships would be then in Estonian waters. One of the participants did not answer to this question and almost ¾ relied on that in 30-year perspective, completely autonomous robot ships would be a reality. As one of the interviewees mentioned, remote operated aerial drones are already reality and the aerial drones that would move in specific lines and flight corridors are already under development. Another interviewee draw attention to the fact that one autonomous vessel is already in test phase in Estonian waters, so it might take 4-5 years before first ones are ready for operations. Estonian streets have already seen autonomous packet delivery vessels as well as autonomous bus, added third interviewer. At the same time, the problems with possible cyber security risks and overtaking of the driving were pointed out and in general, the opinions reflected that step-by-step approach is required. Only one of the interviewees was skeptical of 30-year time frame, expecting it to take more than 30 years to achieve complete

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autonomous vessels. According to this interviewee, this would be gradual process of reducing manning on board until there is none needed. In addition to the technical readiness, the influence analysis was deemed to be necessary before allowing autonomous ships into operation, evaluating the influences on security and safety, especially from the perspective of being safe to other mariners. It was noted that such vessels as AIRSHIP will bring along also changes in the job market, especially in the fear of losing jobs. However, it was also noted that most probably, the job profiles will change while the number of jobs will remain the same or rise. One participant also noted that if there are passengers on board, there will also be crew. When asked to specify, which advantages would Estonia have in front of other countries due to new technologies, the main opinion was that this would enable to rise the export levels as well as fulfill the climate targets and create competition advantage due to lower transportation costs. However, four of the interviewees, the ones who were not that familiar with technology, chose not to answer this question. It was pointed out that shipping as an industry is fast developing and to keep up with the pace, the state should provide also some initiatives and support. When asked to specify on the use of AIRSHIP, the answers were asked first to define which problems such craft would solve and only after that could the decisions be made on its usage and regulative issues.

Third set of questions inquired the **perceptions of the regulations needed to operate AIRSHIP**. Most of the interviewees were sure that AIRSHIP should follow both maritime and aviation regulations and 1/5 of the interviewees had an opinion that it should be purely maritime vessel. It was also marked that more important than the legal jurisdiction is its environmental sustainability and it needs to be evaluated if such fast moving vessels are proper solution in environment where *slow steaming*, i.e.. lowering the speeds is one direction the maritime community is moving to. It also needs to be evaluated how safe it is towards other vessels in the region -it all depends also on the context and there is too little information today to make final decisions. None of the interviewees agreed with the statement that AIRSHIP should be under jurisdiction of aerial drones or solely under the jurisdiction of aviation authorities. When asked about the possible qualifications for the remote operators for the drones, the majority agreed on the need of having knowledge of both, maritime as well as aviation regulations and experience for both, 1/5 of the interviewees were on opinion that such training programs will need to be specifically designed. Two of the respondents did not express their opinions. One expressed that it is too early to decide as there is no practical experience, and the other believed the requirements must be discussed first on the international level after understanding the exact needs and only then can the opinion be formed. In addition, it was mentioned that robot crafts like AIRSHIP is something that people fear as it will have effects on human workforce and people are afraid of losing their jobs. It was also expressed that the jobs will become more difficult, and workforce will need additional training to raise their qualifications to meet the new, changing job descriptions. This again brings along need for continuous need for adjusting the regulations.

Additionally, it was mentioned that for the **implementation of new technologies**, it is important to have working relationships between the partners and regulators, so the people working with the regulations have good working knowledge of the new technologies. There is also need for test areas and innovation areas, which will again help to solve the issues with safety and security of such technologies. There is a need to guarantee that new technologies fulfill the sustainability and net zero criteria and use efficient new net zero fuels. And finally, while the regulations are important, their implementation, governance and enforcement should not be forgotten – regulations can be viewed as a starting point in that matter. To achieve best results, only the part that really needs to be regulated should be written into the legal acts as regulating too much preliminary will suppress the innovation. Every regulation brings along also costs – not only for creating the regulation, but the continuous costs of the implementation and enforcement. So, every regulation should be evaluated according to the main criteria of proportionality – is the restriction appropriate, is it necessary and is it moderate enough.

4.3.2 Stage 2

During this stage, one interviewee did not have any knowledge of WIG technology, two interviewees knew ekranoplans from before and three had somewhat knowledge of WIG technology and its possible application. In general, careful optimism was expressed about the specific niche of AIRSHIP and its effects on the job creation and adding economic growth, while there were pessimistic notes about the reliability of such technology and

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readiness for handling real life situations. The Interviews were analyzed in respect of 6 subthemes and general question enabling to answer on any topic that was relevant to them but did not fit into the questions asked by the interviewers. The answers to the last question are distributed among the 6 main questions according to their theme.

Technical readiness – interviewees expressed both, concern and interest in the concept, trying to analyze its suitability for the locations that they knew the best – unpredictable waters of the Atlantic Ocean near Madeira, Portuguese coastline, Gulf of Finland. Practical concerns were raised on the suitability for busy maritime zones and ability to withstand the unpredictable weather. Main concern, however, was the full automation and readiness to be autonomous, especially in conditions where satellite connections might be disturbed and the vessel cannot be accessed remotely and will need to make its own decisions. One interviewee pointed out that ground effect technology as such was not new, it has existed for quite a while. In general, cautious optimism was expressed towards automation and innovation within AIRSHIP, while the importance of human remaining in the loop was seen as a necessity. Due to the weather, waves and technology planned to use in AIRSHIP, one of the interviewees believed that AIRSHIP would have limited operational range and deployment period. It was also expressed that extensive testing and surveys will be needed before it can be deemed safe for operation. The special care must be taken that it is safe for people, wildlife and the environment before allowing its use. For one interviewee, the technology Is far from ready and the main drivers seem to be academia for now, not the market itself.

AIRSHP as a transportation means - All interviewees saw AIRSHIP as beneficial for remote or hard-to-reach locations, mainly servicing islands or distributing goods within the island groups. It was suggested that it could transport precious and scarce supplies that are in high demand, as perishable goods, for example refrigerated fruit, and medical supplies for example vaccines. It could also be used as mid-level transport means to as feeder service from bigger ports as Rotterdam or Kotor to smaller regional destinations. AIRSHIP was seen operating close to shores mainly and not as a ocean-going vessel. Secondly, it was seen as a vessel that can be used for delivery missions in the national disaster zones as for example after earthquakes or hurricanes; cargo transport to areas that have low population and are hard to reach or lack infrastructure for ships and airplanes or are used for completely remote serving as meteorological stations for example. At the same time, three of the interviewees expressed concerns about possible use due to weather, existing ferry traffic, and the lack of suitable ports. It was also pointed out that there must be preparations for satellite and GPS signal disruptions, connection issues. Some skepticism was expressed in connection of the preparation of automated systems for unpredictable scenarios, as these would lack human-like judgement and would raise the question of accountability. It was noted that while AIRSHIP might offer additional transport possibilities, it is not seen as replacement for traditional shipping. Need for comprehensive studies of its uses as means for logistics is necessary.

Environmental effects – the use of electric engines with battery power was seen as advantage that lowers the air emissions compared to any other means of transport, providing the batteries do not take up too much space and do not reduce the payload significantly. AIRSHIP flying above the water was seen as means to reduce underwater noise. The noise level of the AIRSHIP was compared to the drones used by Portuguese Navy, that is on the level of small aircraft despite of being electric – noise level is not only related to the engine, but also how the propeller interacts with the air. It was seen also as help with the water pollution avoidance provided there is no ballast water involved. At the same time, it was noted that speed and wave generation can have effects on their own and these must be considered while calculating total effects. It was also mentioned that while the use of electric engines and batteries reduces the emissions, it will never be zero and in total life cycle calculation, also the acquiring and disposing of batteries must be considered as well as the source of energy generation itself. It was also noted that the effect on marine life is hard to estimate. Using AIRSHIP alone is not seen as means to net zero, unless there will be less traditional shipping as result. None of the interviewees raised the question about birds and effects high speed craft might have on them. It was also noted that alternative fuels as gas or hydrogen could also be considered as possible fuels.

Deployment in disaster situations – the perceptions of AIRSHIP as a transport solution for disaster situation had varied results and it was mainly seen as secondary solution. Two of the interviewees struggled seeing it as a

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disaster relief solution and preferred drones over it as these have already shown capabilities to be used for such deliveries. It was also noted that the autonomous nature of AIRSHIP would not enable it to be used for saving human lives which is most important task in any disaster recovery situation. At the same time, it was seen as an option to reduce risk to additional human lives in dangerous situations while delivering aid, for example in earthquake situations. AIRSHIP was also seen as possibility to be used for firefighting or as surveillance for the civil protection agencies. Four of the interviewees mentioned autonomous actions as something that might hinder the use of AIRSHIP as disaster recovery or delivery craft as the AI today is programmed and not ready for achieving situational awareness. One interviewee pointed out that while rescue services that involve humans can be prejudiced and the mistakes can be made due to the emotions or misjudgments, AIRSHIP in such cases would be without emotions and could act solely as programmed, therefor avoiding mistakes – the same can be its biggest fault, not being able to assess new situations.

Influence on public spaces – AIRSHIP as seen as means to engage local communities, leading to increased investments and interest in the technology. Precondition for this is the technical readiness and demonstrated effectiveness of the technologies used. The use of AIRSHIP would require changes in port infrastructure, especially docking facilities. Provided AIRSHIP fulfills the expectations of noise reduction, it would help with maintaining clean air in the harbor cities. At the same time, AIRSHIP needing a takeoff and landing strip would cause redirection of port traffic and might complicate the traffic situation in the ports. It was also noted that use of AIRSHIP should not disrupt the existing maritime traffic. As the city centers are usually increasingly crowded, the use of AIRSHIP could be outside of city centers.

Effects on public and job market – to achieve public support, the proven technical readiness is seen as first step – people accept AIRSHIP if they see it working and it demonstrates the assumed advantages. AIRSHIP is seen as job creator, especially in engineering sector. While the autonomous versions might replace some jobs, interviewees did not feel the risk of losing jobs personally, as use of AIRSHIP would require new skills and knowledge, especially in IT sector and engineering. It was noted that there might be loss of low-paid jobs and some traditional maritime jobs would be lost as there is no crew on board. It was also noted that there will always be necessity for the repair and maintenance crew - it should be evaluated how long AIRSHIP can operate without additional maintenance. It was estimated that self-sustainable travel without human intervention was roughly about 10 hours, and longer periods were considered as adding significant risk. The concern about the legal and regulatory perspective were expressed, especially in regard of port authorities and restricted airspaces. It was noted that regulatory readiness for the use today is lacking and will need comprehensive research before the legislation can be adapted. Also, one interviewee raised questions of liability in case of incidents, traffic management issues and high investment costs. At the same time, AIRSHIP could improve port productivity and connectivity in isolated regions, potentially therefore encouraging rural settlement. It was noted that the operators must be well familiar with the areas of operations to be able to manage AIRSHIP remotely.

In total, interviewees were cautious about the technical readiness of AIRSHIP and expressed need for thorough testing and making sure it functions the way expected also in real life, not only on paper. They were not fully convinced that it would be a suitable means of transport and at the same time, expressed encouragement as need for such transport that would fit between the aircraft and ship is needed. Persons involved with the islands further from European mainland (Portuguese interviewees especially) were more supportive and seeing more value in the possible operations of AIRSHIP as cargo vessels. It was seen mainly as job adding way of transport and requiring a specialized workforce with education from both, maritime and aviation fields. It was noted by many respondence that AIRSHIP would have effect on public spaces. Reduction of noise and pollution were welcomed provided it is later proven in action.

4.3.3 Stage 3

The interviews were made with one company representatives (two persons) who are developing WIG crafts with hydrofoils in USA, with two persons who had tried to implement WIG crafts on two different routes in Estonia and three persons living in the islands in Estonia. As the interviews turned out to be completely different of each other, hence the analysis of this part is given by interviewees.

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In 2016, the Seawolf company was trying to establish passenger transport routes to connect Estonian islands to Latvia (Ventspils – Roomassaare line) and to connect Tallinn, Estonia with Helsinki, Finland (Seawolf, 2020). The company made presentations on the islands as well as had extensive news coverage in Estonia and then vanished. When asked to give an interview, they said that while the project has been on hold for almost 10 years, they are still looking into it as they had got a lot of positive feedback in the planning phase. The main reason why the Seawolf's plans never materialized, was technical – the producer of the WIG craft that they had made contracts with, could not deliver the product. They had already achieved a state that they were looking for employees who could be trained to use the crafts as the delivery time of first two vessels was agreed into 2016, but there were delays after delay. Today, the producer has changed country, and they are still keeping in touch with them. The reason for developing this was the need for faster travel. The biggest impact they could have, was visible when they had informatory articles about the Ventspils - Roomassaare line – there were phone calls asking for ticket price, whether it would be acceptable to have bicycles on board etc. Reason being that there is no current planned traffic in this location and it would have **added value to local community** and enabled them to make day visits to Latvia. Hence the effect would have been on **enabling mobility of island residents.** According to them, local communities were very welcoming and easy to talk to - they did not meet resistance, quite the opposite. There had been many questions about when the operations would start. When looking for workforce, they had no problem finding people who were willing to learn. They did also not see a need for many changes as the vessel that they planned to use was intended to be used by marine specialists with similar education as maritime officers, with some specialized training by the producer. As they had been aiming for passenger traffic, they were indifferent for AIRSHIP and its use as cargo vessels. They had no objection to using it as a cargo vessel but were sure it would be more utilized as a passenger vessel.

In 2020, REGENTC Crafts was founded in USA with the aim of producing WIG craft that could be sold to different operators around the world. Since then, they have secured more than 10 billion USD worth of orders for the craft that made its first maiden voyage spring 2025 for testing. The company is heavily backed by well-known investors and has also contracts with USA Marine Corps (REGENT, 2025). This craft is intended to be manned and electric. It is intended mainly for passenger transport, but they have been thinking also about cargo transport options, especially high end like parcels, time-sensitive or medical supplies and devices. They are not planning to utilize AI during flight but do use it for design and engineering studies. When asking about social perception and effect that such craft would have, they introduced their initiatives that are preparing the remote island areas for such vessel. They have signed several partnership agreements with island communities, as well as letters of intent with several airlines and shipping companies, therefore securing support in the communities and among the operators. In the community, they have been looking for partners and to reach an agreement has taken 2-3 years of preparation, finding suitable partners who share similar values. They aim to start the initiative, find the partners, then make the local partners take over so they are responsible later for the infrastructure development, community acceptance and regulations. Such co-operation projects enable them to look together with the future operators to understand which lines, ports and passenger flows could be serviced and plan the craft accordingly. They see the main value of this craft in its environmental aspect and in enhancing coastal travel by reducing the cost and transport time. The value is also seen in the low operational costs compared to aircraft. At the same time, the biggest challenge is the regulatory issues, mainly the issue that the WIG craft is flying above the water which makes it interesting to be regulated for the aviation as well as shipping. Their plan is to use this craft as a vessel having maritime certification, maritime license and master mariner as well as first officer on board together with passengers.

People living on the islands had varied views, depending on the **size** of the island, their **experience** with different types of maritime vessels and their **occupation**. After brief introduction of AIRSHIP, one of them knew the technology from before, for the other two it was new. The ones not familiar with AIRSHIP saw the biggest social aspect of AIRSHIP as the possible solution to the transport problems. Estonian islands are very much depending on the connection with the mainland Estonia. During the summer months, the islands are visited by the intra-Estonian as well as foreign tourists and the connections to the islands can be prebooked and there might be waiting times in the ports on both sides for the crossing. The person connected to Estonian's most remote island,

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pointed out that there is need for transport in case of bad weather, when the ships are out of service due to repairs or ice and the aircraft are not available to make any deliveries. The ones living on Estonian main island Saaremaa, hearing that AIRSHIP is intended as cargo vessel, did not see any advantage or change that AIRSHIP could provide to their lives – how transport companies deliver their goods does not have direct influence on their life in general. When discussing further the changes that AIRSHIP could bring to the lives of residents, the additional jobs created in harbors were seen as an advantage. Residents of the islands did not feel comfortable offering opinions on the effects that AIRSHIP might have on **educational systems**. However, when asked what changes AIRSHIP as an autonomous, low flying vessel could bring to the local communities, the situation was different. As the island Saaremaa has had long discussions about the bird migrations and is surrounded by a few wild bird protection areas, the effect that low flying vessel can have on the birds and birds can have on that vessel were brought up. **Environmental study was seen as a core necessity**. Provided AIRSHIP would fulfill the promises of being sustainable, using electric engines and not creating additional noise, it was seen as something that does not make much difference in the lives of the locals. The interviewee who worked in local government was more skeptical in regards of quick social acceptance, noting that there are groups of people who are against of any innovation in principle and their actions can lead to negative impact – should they decide to oppose and use media against AIRSHIP, the implementation could be delayed despite showing excellent results and being a good solution. AIRSHIP using AI for guidance was seen as something from far future and all residents saw it as "*too raw to be actually used in transport vessels for quite some time"*. Regarding the changes in the work procedures or changes that AIRSHIP would bring along in their lives, the answers varied again. Interviewee who is working for local government saw AIRSHIP as possible solution in case the other transport options fail, especially when there is need for urgent deliveries of medical supplies and there is no other fast possibilities of transport as nobody wants to risk additional people, like at the time of COVID restriction. The residents of the islands repeated the previous answers that they cannot evaluate the cargo transport option as it probably will not have direct influence on their lives. When asked for additional ideas, there was a question when it can be seen in real life.

In total, **interviews confirmed the results of the surveys and focus group study**. As the answers were so varied, especially among the residents, more thorough, possibly longitudinal study would probably be a reasonable next step to fully understand how the perceptions and acceptance of AIRSHIP would develop across different socioeconomic and geographical contexts. For the wider audience, AIRSHIP was not a well-known technology and that resulted in a small number of residents of the islands agreeing to express their opinion. Therefore, more dissemination about AIRSHIP developments and future prospections directly in these territories would possibly highly benefit the development of social impact studies' research. When we approached the possible interviewees with the question of giving their perceptions on the island and its transport connection to the mainland, people in general were positive and agreed with the interview. However, 14 out of 17 people who had initially agreed to interviews, later refused to be interviewed once AIRSHIP was introduced, claiming that they know and understand too little of this technology.

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5 Key Performance Indicators and impact on stakeholders

5.1 Influence on SDGs

In the initial phase of the AIRSHIP project, 9 SDGs out of 17 were identified as possible targets that the AIRSHIP might be able to influence. This chapter studies each of these SDGs in detail, comparing the impact of these to the empirical studies carried out during 2025 to understand if our preliminary thoughts are substantiated. The results of the study are presented by the SDG, compared to the initial impact target and if possible, compared with the feedback from the regions where wing-in-ground crafts have already been implemented, either as recreational vessels for limited use (Australia) or are being in the test phase and there is enough evidence of their actual influence on the SDGs.
The results of initial research and our current findings have been summarized in the following table:

Table 9. AIRSHIP's influence on the SDGs, compared to initial report from 2023 to current state in 2025, compiled by authors.

SDG	Initial description	Findings of empirical research
2 Zero Hunger (2.1)	Enabling transport to areas, that are difficult to reach, and paying its main attention on providing automated solution for the cargo transport, AIRSHIP is also assisting in fighting the hunger in the world through being suitable for fast deliveries of short shelf-life goods	The findings confirm that AIRSHIP is seen as transport vessel for the remote and hard-to-reach areas. It was also seen as a solution for the remote islands that lack infrastructure for ships and aircraft. Its fast travel time makes it suitable for fast deliveries of short-shelf-life goods.
3 Good Health and Well-Being (3.4; 3.6; 3.9)	Sustaining traditional habitats by enabling another fast means of transport to areas that are difficult to reach. This helps to provide medical equipment and medicines in a fast and effective way.	It was noted on several occasions during the empirical study that AIRSHIP can be used for emergencies as well as for delivering medical equipment and supplies. As possible passenger transport, it could also be utilized as shelter at the time of accidents, when the location is remote and other means of transport do not reach it in time or the situation is too dangerous to risk additional lives.
5 Gender Equality (5.1, 5.5, 5a; 5b; 5.6)	-	This SDG was not identified during the initial study but must be added as AIRSHIP creates jobs on the shore side, hence making it possible for women to work without having to leave home for several days (or months) at the time. Working on land-based jobs enables better work and family life balance that is crucial for

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SDG	Initial description	Findings of empirical research
		caregivers (overrepresentation of women) when making career choices. Using AI solutions and communications technology, it does not limit the workplace in any way, making it more flexible than traditional maritime jobs. (Kin, Sharma, Gausdal, & Chae, 2019)
7 Affordable and clean energy (7.1, 7.2, 7.3, 7a, 7b)	The Airship project aims to build a vessel that will not use fossil fuels to operate.	The initial plans for developing fully electric vessels have been researched and while there is an idea of researching alternative green fuels due to the current lack of large enough batteries, the aim of using clean energy remains. Therefor AIRSHIP is fulfilling the targets of the SDG 7, especially enhancing the international co-operation on zero emission fuels and clean energy.
8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (8.2; 8,3; 8.5; 8.6, 8.8; 8.9)	By enabling transport to difficult areas, it helps to create workplaces related to shipping as well as in transport sector. Autonomous vessels have the benefit of operators living and working on dry land, hence improved work conditions compared to two weeks at sea without seeing one's family. Adding transporting capacity helps to increase also economic growth through offering faster and safe transportation option.	The aim of AIRSHIP being autonomous vessel guided by AI has proven to be acceptable for society provided the safety features are in place. The option to work close to families on shore side has been approved by communities. Our research shows that also target 8.3 can be added as AIRSHIP is seen as job creating and innovative solution. In addition, AIRSHIP's land-based jobs can be seen as promoting safe and secure working environments (target 8.8) and enabling connections to remote communities will also help with promotion of sustainable tourism (target 8.9)
9 Industry, innovation and infrastructure (9.1, 9.4, 9.5, 9c)	Transport as such is part of infrastructure that enables industries to have the much-needed supplies as well as enabling fast deliveries to remote customers. Airship as such is innovation in transport in all aspects.	The initial aim to help to develop transport infrastructure that supports economic development and human well-being – our research indicates that AIRSHIP has high potential of positive influence, providing one more option for transportation under difficult circumstances.

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SDG	Initial description	Findings of empirical research
		While AIRSHIP upgrades the resource-use efficiency, it has also positive influence on scientific research through developing new solutions and encouraging co-operation between the sectors and researchers (target 9.5). The business case study of AIRSHIP in 2024 demonstrate that AIRSHIP can be used for providing Internet access, hence helping also with target 9c.
10 Reducing inequality (10.3, 10.7)	-	While this was not identified as a target SDG for AIRSHIP in previous reports, our research indicates that by offering new job opportunities AIRSHIP can help achieve equal opportunities and may reduce the inequalities of income. It also helps to facilitate mobility of people, especially in remote or difficult to access regions.
11 Sustainable cities and communities (11.2; 11.6; 11.7; 11a)	Being sustainable on all possible ways, Airship helps the cities to be sustainable – having low pollution levels means possibility to have connections from city centers to city centers, hence enhancing communication and transport between communities.	The research shows that AIRSHIP provides sustainable, safe, accessible and affordable transport solutions. It also helps to reduce the air quality problems in the cities (target 11.6) aid in providing safe and green public spaces as it does not need excessive facilities in the ports (target 11.7). As identified in previous phase, it does support positive economic and social links between urban, per-urban and rural areas by offering sustainable travelling options.
12 Sustainable consumption and production (12.2; 12.4; 12.5; 12.c)	Through usage of optimized production lines and careful design of the airship enable minimum consumption of natural resources during production phase as well as later while in service.	As this report concentrates on the social aspects, the environmental aspects of AIRSHIP will be analyzed in later phase of the project.
14 Life below water (14.1; 14.2; 14.7; 14.b)	As AIRSHIP does have minimal impact on the waters, creating minimal waves and having no contact with the water during its	AIRSHIP is intended to fly above the seas, without using bilge water, hence it will have minimal impact on the waters. However, our research

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SDG	Initial description	Findings of empirical research
	flight time, it fulfils the criteria for having minimal impact on the lift below waters.	indicates that AIRSHIP will enable fast transport of short shelf-life goods like fish, and therefor can provide small scale artisanal fishers access to additional markets (target 14b)
15 Life on land (15.8)	The AIRSHIP will have some effect on life on land. Due to its speed, it may affect birds, and it may have effect on the existing traffic on its route.	This aspect will be assessed in the report about the environmental effects of AIRSHIP in 2026.

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5.2 Impact on stakeholders

In previous reports for AIRSHIP in 2023 (Kerem, Otsason, & Tapaninen, 2023) and 2024 (Kerem, et al., 2024), the stakeholder analysis was performed to see who is involved with AIRSHIP and who will AIRSHIP influence and in which way. This time the stakeholder analysis is updated according to the data acquired during the literature review and empirical study of social influence of AIRSHIP.

The stakeholder mapping was first done in 2023 and had identified following categories: owners and operators, ports, production facilities, regulators, local communities and employees. In 2024, the categories were changed to producers, owners, operators, employees, local communities, regulators and ports. Based on the stakeholder mapping of Theotokatos et al, the same procedure was done this time and in addition, the clusters and initiatives group was identified (Theotokatos, Dantas, Polychronidi, Rentifi, & Colella, 2023). This list was compared to the UK MASS stakeholder list, compiled by Lynch, see Figure 11 (Lynch K. M., 2025). As our analysis is specific for AIRSHIP and specific for the social impact, we made some corrections after the comparison and reduced categories to the ones where social impact is most evident – producers, operators, workforce, local communities, regulators and ports. For regulators, we combined the international, national and governmental levels of Lynch analysis. Industrialists and providers are viewed as operators and producers and end users in our case are local communities and workforce. The employees are now described as workforce as it is summarizing all effects that AIRSHIP will have on the employees of various stakeholders. As the environmental study of AIRSHIP is planned for 2026, these aspects were not studied in the current report.

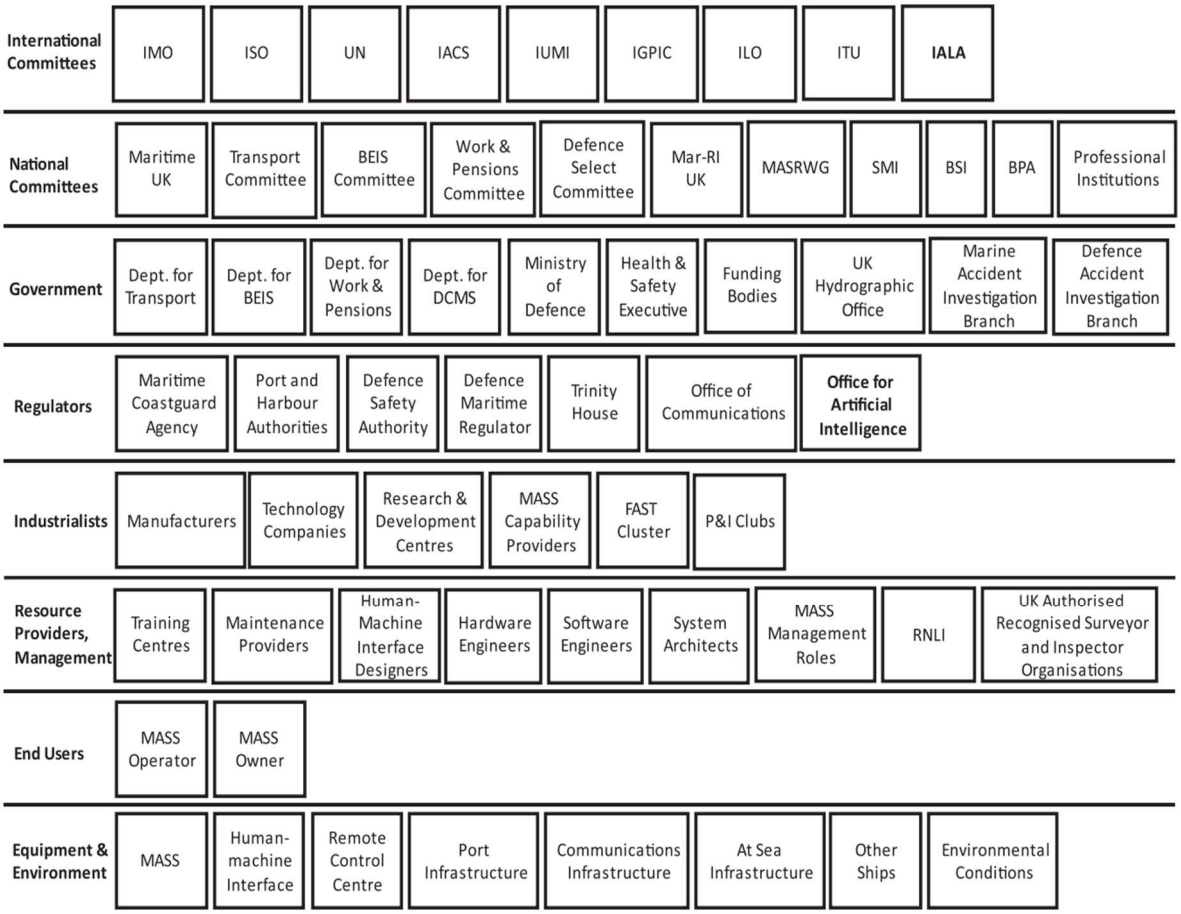


Figure 11. British view of MASS stakeholders, Lynch, 2025.

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The Rasmussen's Risk Management Framework enables the analysis of through the six levels, and it correlates with the analysis of this chapter – looking at the government, regulatory, company, management, end user and work environment level. While this chapter discusses also other matters related to each of the categories, the possible risks that each of these present to AIRSHIP are also discussed in the subchapters.

5.2.1 Operator

As there are no operators of WIG crafts today, we could study the one company that has tried to make regular traffic with WIG craft on some routes (see stage 3 interviews for detail). From the operator viewpoint, they see that AIRSHIP has a potential for changing a lot for the society – by providing transport to places which are difficult to reach and doing it in more economically feasible than air transport and faster than water transport by traditional ships. Being autonomous provides it challenges – it can be used only for cargo transportation. The interviews with the stakeholders indicated the need for passenger transport and saw passenger transport as the most profitable from the operator's viewpoint. Also, the study done by Otsason et al (Otsason, Hilmola, Tapaninen, & Tovar, 2024) and simulation model by Hilmola (Hilmola & Heljanko, 2025) showcased that the cargo transport alone might not be feasible enough for the operators.

When the social influence was discussed with the interviewees who were planning to operate, they saw public accepting the idea of WIG craft without any issues. The literature review indicated that as most of the public views about maritime affairs differ greatly between the nations, so generalization of one case studied in Estonia cannot be made (Roberts, et al., 2021). However, it is indicator that with correct communication and without overpromising, the public opinion can be favorable before the project itself is started. It was noticed that the Estonian implementation failed as craft was not delivered on time and it can also be noted that the American producer has postponed the delivery times of its crafts. Hence special care must be taken when evaluating the readiness of AIRSHIP for commercial use by operators. The helicopter use case in Estonia showed that with novel technology providing public service, one accident is enough to destroy the field for several years as the technology loses public trust (Vikipeedia, 2025), (Vikipeedia, 2005). At the same time, operators can do a lot to prepare the community for the new technology as was showcased by one interview done in stage 3.

5.2.2 Producers

During the last year, there have not been significant changes in the work of other producers. The REGENT Crafts has started water testing of real life 12-seaters, and they are in preproduction phase with that craft. However, the delivery times for first crafts to operators will not be in 2025, but later – the last beam of the production unit was put in place in November 2025, and the building will need to be finished before the production units can be installed and first ones can come off the line.

Interviews with producers indicated that WIG crafts are seen as tools for maritime decarbonization. Use of electric engines by other producers indicates the importance of net zero for the new technology. Though there are various models of WIG crafts in the world today, none of these are in mass production and most that have been developed into pre-production state have yet to prove the technological readiness.

The social acceptance of WIG producers was not discussed during the empirical study, but it was evident that any region is interested in additional jobs, and this is one way of creating these.

5.2.3 Workforce

Our empirical study indicated that AIRSHIP is perceived as bringing along a change in the job market, especially as an autonomous craft. It was indicated during the survey and interviews that AIRSHIP would need constant monitoring and technical oversight to keep it running in good condition. While its operations may be fully autonomous, there is still need for repair and maintenance. Since last report, the regulations have been developing, and it will all have effect on how AIRSHIP can be operated in near future. IMO has been discussing in length the MASS Code with currently one option - remotely guided vessels. The fully automated AIRSHIP is planned, are not under consideration of IMO today. However, while AIRSHIP is autonomous during the voyage,

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there is no reason why it cannot be monitored from remote operation center and its actions taken over by a land-based operator if needed, provided current legislation will so demand.
Literature reviews indicated that autonomous operations would change the traditional maritime workforce and have direct influence on their tasks. Empirical study also confirmed these findings with more than half of the respondents of the survey stating that according to them, AIRSHIP will create and lose some jobs. Ly and Yuen have found in their study that autonomous implementation of vessels will influence the workforce on several levels – it will affect the labor demand, which includes new employment regulations, change of task contents and change on required skill levels; it will influence the labor supply as well as occupational health and safety; it will influence the safety performance as risks involving humans will change completely. On the other hand, it will also change the needs for education and training as well as regulations. While IMO is discussing MAAS Code

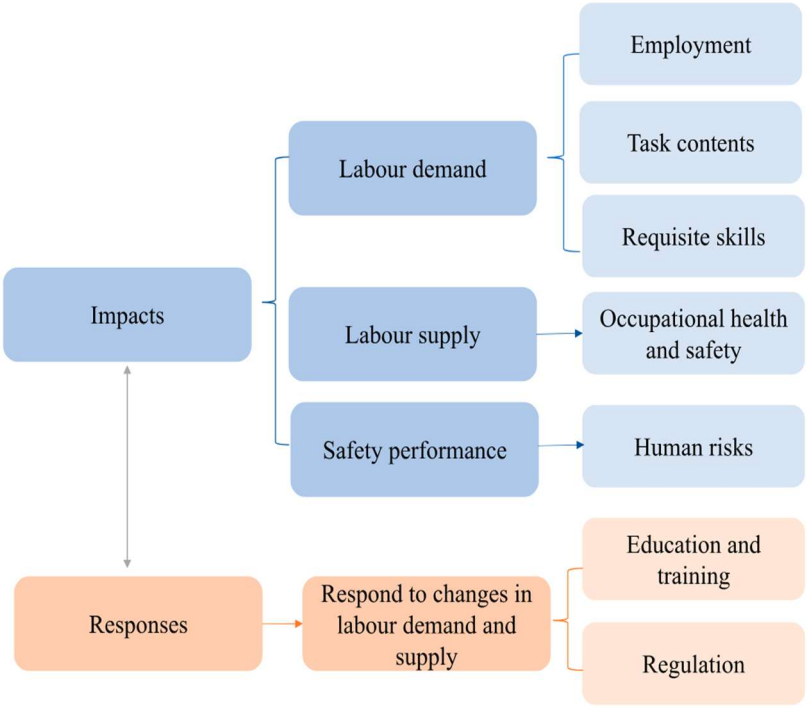


Figure 12. Scheme of how autonomy affects workforce by Xue Li and Kum Fyai Yuen, 2024

for international voyages, the regulations for smaller vessels and cabotage will need to be created locally by every nation. (Li & Yuen, 2024).
This chapter is divided into three chapters – labor demand, changes in education and implications on workforce that rise from remote operations.

5.2.3.1 Labor demand

As literature review indicated, there is shortage of employees for maritime jobs, and such trend is expected to continue. In a situation where there are not enough people to do all available jobs in maritime domain, it is reasonable to search for ways to automate. As changes in demographics indicate, the population of Europe is aging, the growth of population comes from the ones living longer, not from more births. This means lack of workforce is growing trend and there is need to adapt the jobs according to workforce available. Traditional maritime jobs on board the vessels have demanded long times away from home – contracts varying from 2 weeks on-two weeks off for ferry personnel to 6 months on board for cruise vessels. Changing these now to land-based jobs at least to some extent makes it possible to use part-time workforce as well as people who cannot stay away from home for longer periods, like parents of children. Working certain hours in a day and then returning home enables them to continue their chosen career path during these periods of life. As our empirical study indicated,

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older generations have more experience in life and are in general more careful in accepting new technologies. This might affect the social acceptance of AIRSHIP by demanding more proof of its safety and suitability as means of transport.
In addition to the aging populations, there is also unwillingness of the younger generations to work in maritime solely because it demands extended periods away from their friends and family. As discussed before, this can also be solved through automation and change of work location from ship to shore.

5.2.3.2 Changes in education

In parallel to the discussion of introducing the MASS, autonomous shipping, there has also been discussions in regard of need to change the educational system of maritime trade (Campos, Sanabra, & Boren, 2025). While some see the need to start with changes in the educational system immediately, other see that there should be clear first what will be the MASS regulations and only after that, suitable training programs can be developed (Cinco, 2021). The waiting approach might lead to the case that we have technology, we have regulations, but we do not have people qualified to work with such technology. Hence some countries have started to introduce the changes into their curricula even though they are not demanded by the regulations.
At the same time universities and vocational schools are already introducing programs that are proactive. For example, Belgium has introduced education where the watch officer and master educational programs are combined, and master and chief mate programs are combined (Mobilit.Belgium, 2025). Graduates of such courses have more opportunities to find jobs and are also more sought after – they can fulfill two roles and therefor can replace also someone else on board in addition to their own role.
Additionally, there are educational units that are preparing their students for the cyber security issues, for example Estonian Maritime Academy and Latvian Maritime Academy have introduced a special course on cyber security into the studies of future masters (LMA, 2025), (EMERA, 2025). However, these are small drops in the ocean of cyber security issues that the maritime field faces and for the autonomous vessels to be fully implemented, need for cyber security specialists as well as knowledge of cyber security among the current employees of shipping companies will need to be extended.
While literature review supports the need for changes in education, the results of the empirical study show the trend of wait and see to be prevailing.

5.2.3.3 Remote operations

Currently, IMO is preparing the MASS code. As AIRSHIP is an autonomous vessel, it must also adhere to the rules of future MASS code. While IMO has defined 4 levels of autonomous vessels, the MASS Code is prepared for one of them, remote controlled vessels.
There are several studies appearing on the educational programs and requirements for the staff of the remote-control centers (RCC). Yet there are many themes that need to be discussed in detail. In general, literature sees the remote center operators as people who have extensive maritime knowledge and experience, which enables them to foresee the problems and possible solutions while sitting behind computer screens. At the same time, for example Finnish Maritime Pilots' Association is already discussing possibilities for remote pilotage, which could be considered as a first step on the way to the remote operation centers (FinnPilot, 2025). Novia Academy in Finland has taken this one level further, by developing master program for autonomous shipping management (Novia, 2025). Their program is one sample which subjects will be considered important in future, when training people who work with MASS – risk management, cargo management, shipping economics, safety, cyber security, artificial intelligence, machine learning and machine-human interaction, maritime administration and autonomous vessels, human factor in autonomous shipping. This is list of interdisciplinary subjects that goes well beyond traditional education of mariners. This requires shift of paradigm in the training – both, by the interdisciplinary subjects, but also by changing methodology of teaching. For AIRSHIP, one should add to this list specifics of aviation – how to keep AIRSHIP in the air, how to do maneuvers in the air etc. So, for the WIG craft, there will be extra requirements also for the remote operation centers. IMO has accepted already in 2005 the general principles for training the WIG officers, but it has not been updated since (IMO, 2005) and there is

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currently no training facilities in Europe whose training programs include preparation of WIG craft operators or officers. Hence that might be one limitation on the possible implementation of AIRSHIP, as creating the educational programs on suitable level will take time.

5.2.4 Local community

For any new technology, acceptance by the community is always crucial for their success. AIRSHIP will move on the seas and most of the time, it will not be visible for the ones living ashore. As a cargo vessel, people will see it most probably in the harbors, with the exception being maritime professionals. Hence for its success, most important part is the acceptance of maritime communities and people living on the shore side.

The literature review revealed several theories that discuss the acceptance of technology by communities. Having social license to operate sees the acceptance as ongoing on two levels – on the level as having opinion about it or willingness to tolerate it. AIRSHIP is designed to be sustainable, electric engines are usually quiet, hence it should be easy to tolerate. The empirical study done was mostly favorable to such features, provided these are true in life when AIRSHIP is ready for operation. It also showed that people agree with ground effect technology as such quite easily provided it demonstrates safety and reliability first. AIRSHIP corresponds also well to the meaningful social impact theory – it would have minimal direct impact on people living at the shores but would have extensive social impact on people living in rural communities and on the islands, that today lack fast enough connections to the mainland. From the perspective of Social Acceptance Model, AIRSHIP must correspond to their three-pillar system – first, have the acceptance from public and key stakeholders as well as policy makers. Literature review of the legal regulations involving AIRSHIP confirms that WIG crafts are accepted by the policy makers, however, the autonomous part is under discussion now. As AIRSHIP is not yet ready to be demonstrated to the public, it is also hard to have acceptance from public and key stakeholders today, though our empirical study indicated that the perception of AIRSHIIP by the stakeholders and maritime community is in general positive. Hence it is impossible to analyze how AIRSHIP is valued according to second (community acceptance) or third pillar (market acceptance), as there is no practical experience. UTAUT, CTAM and MAVA models can each be used for more exact understanding of how AIRSHIP influences society, with MAVA being the most comprehensive of the models. However, it was intended for the automated cars on the first hand and would need major modifications to fit AIRSHIP. As the literature review revealed, this is first social implication study on wing-in-ground crafts as such have not been completed before.

Our empirical study demonstrated that in general, AIRSHIP is perceived as sustainable travel option and even the most skeptical participants on the surveys and interviews confirmed that in some use cases, AIRSHIP might be feasible and accepted by the society. For example, in situations of disaster recovery from remote locations while sending another person to help would mean endangering additional lives, autonomous AIRSHIP would be quite suitable for deliveries of first aid, medical supplies and food products. Our previous report demonstrated also possible use as internet and communications provider, especially for the regions that do not have landing strips for aircraft, it is too risky to fly by helicopter and ships would take too much time to arrive. The ability to land in the water and move in the water as well as in the air is unique benefit of AIRSHIP. When discussing the acceptance of AIRSHIP as cargo delivery vessel, the focus group interview indicated clearly, it would have no influence on the acceptance by the community – as last mile would be delivered anyhow by other means, it would not be an issue for average person how the deliveries are made.

At the same time, mariners expressed worry over the safety of the seaways, safety of the other vessels, especially from the possible collision, but also from the airwave perspective. For example, small yachts might have problems provided AIRSHIP would fly too close and influence the wind currents. Also, the need for landing and take-off strip was brought up by the members of focus group, during the interviews as well as in the survey. It was also pointed out that autonomous vessels could be hacked, and cyber security might be compromised, which can lead to loss of control over the vessels. This could become major issue if control over AIRSHIP is lost and it hits coast or other vessels at full speed. Such precautions must be taken and preplanned to avoid such accidents. This must be taken into consideration when planning the seaways for the AIRSHIP and communicating this to the residents and mariners.

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Empirical study also pointed out that AIRSHIP would be beneficial for the local communities only if its prices for deliveries were within the affordable range. The producers and possible operators pointed out that such vessel is most feasible provided it offers a passenger service, and our previous research has confirmed the same. If AIRSHIP would not be affordable, it would be disregarded and would never become a commercial success.

5.2.5 Regulators

Literature review demonstrated the current state of the regulations in regard of wing-in-ground technology as well as the autonomous vessels. While there are some regulations for WIG crafts, these are intended for the vessels that are manned. There are no regulations today for fully autonomous WIG crafts. At the same time, IMO is developing MASS Code, to regulate the autonomous vessels. AIRSHIP would need to follow both types of regulations. This creates a possible conflict in situations where regulations contradict themselves. Neither of the regulations is planned to address the fully autonomous vessels, as IMO MASS Code is intended for the remote operations. In addition, it needs to be remembered that the IMO codes are for international voyages in international waters. Each of the countries will need to create their own rules for the territorial waters, access to the ports etc. The results of interviews with the WIG producer and operator demonstrated how regulatory limitations have made realization of their plans more difficult. At the same time, the regulations cannot be made in too early phase, without knowing the specifics of technology as that would limit the possible innovations. Hence, the balance between the regulations and what to regulate and what not to regulate, needs to be found. To regulate AIRSHIP in proper way, the empirical study implied the need for safety demonstration, so the ones creating the regulations trust the technology and see that the necessary safeguards for its safe usage are in place. In the initial report from 2023, the following factors were brought up as political factors that might influence success of the AIRSHIP (Kerem, Otsason, & Tapaninen, 2023):

- Political factors can be described on local, national and international level as all these can set the policy for the use of such vessels.
- The most common issues identified on the local level were connected to permits of operation and use of ports and port facilities as well as the pollution of noise and light to the local citizens.
- On national levels, the elections were seen as possible factors influencing the use of such vessel, especially in the countries where law demands all procedures of legislation to be restarted at the time of government change.
- International factors such as relations between the countries within and outside the boundaries of international organization were identified as influential to the final versions of the regulations.

Empirical study has confirmed that such factors are relevant also today and will need to be addressed during the implementation phase of AIRSHIP.

5.2.6 Ports

Socio-economic functions of ports have been researched in length over the years from various aspects – sustainable transitions, port management, impact on stakeholders and local communities (Moeremans & Dooms, 2025). IMO Secretary-General Kitack Lim highlighted that to develop interoperability between MASS and the port, the communication between the ship and the port should increase not only in security issues but also in port services matters (Higgs and Macpherson, 2018). Although pioneer applications of autonomous systems are envisaged to be implemented on research vessels and offshore support vessels, the trial voyages conducted on cargo ships reveal that it might be feasible to integrate mostly short-range cargo ships into autonomous systems (Burmeister et al., 2014; EU, 2015). Subsequently, promising findings of trial voyages raise expectations for the use of MASS in deep-sea voyages, which is the main market for larger cargo vessels (Grzybowski, 2021). Also, the integration of larger cargo ships into autonomous systems can play an important role in improving the interoperability of global ports with MASS. Global port operators have the potential to provide regular, continuous, and big data on the port operations of MASS, due to both the variety of operations carried out and the size of their scope and scale (Baker, 2018; van den Boogaard et al., 2016). The variety and size of the data obtained from the port operations of MASS can offer significant benefits for the development and improvement

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of MASS-port interoperability. (Kurt & Aymelek, 2024). Kretschmann et al. (2017) argued that MASS's port operations could not be completely human-free, even if the ships became unmanned. Some operations carried out on board could be performed without the crew with the development of ship automation; however, some other operations are expected to be carried out by a port-based team. It was predicted that this port-based team would especially carry out regular and periodic maintenance of MASS, thus adding a new field of activity to MASS-port interoperability issues (Higgs and Macpherson, 2018). (Kurt & Aymelek, 2024). As AIRSHIP is autonomous and MASS regulations will be applicable, all developments of MASS in regard of ports will be applicable also for the use of AIRSHIP.

During our empirical study, the focus group expressed sincere interest in using AIRSHIP in smaller ports that are underutilized today. AIRSHIP was seen by them as means to connect remote islands and communities to mainland or to the other islands. While cargo ships and aircraft will need extensive investments for creating ports, AIRSHIP is much more flexible and does not need great investments. Focus group pointed out that for onloading and offloading, simple crane on the car would be enough. As AIRSHIP can utilize shallow waters, it would not need extensive work on harbors and can be used with pontoons as landing stations (see report 2.2 of AIRSHIP (Kerem, et al., 2024)). The focus group draw also attention to the fact that if people do not have to change their habits, they are more inclined to accept the changes around them. As residents of the port communities are used to the actions taken within the port, the use of AIRSHIP might be easier to accept than in places where there has been no port before. However, the survey results, interviews and the focus group study confirmed that there are plenty of ports that people see as underutilized or small enough to be able to accommodate AIRSHIP without need of major modifications, hence making the social acceptance easier for the port communities. Also, creation of additional workflow and cargo flow in the ports was seen as added value to local communities – who would not prefer their fish arriving fresh instead of being frozen.

5.3 Performance-related key performance indicators

There were several groups of key performance indicators (KPIs) identified during the initial study into sustainability frameworks in 2023 (Kerem, Otsason, & Tapaninen, 2023). In this chapter, only the social indicators are discussed. Initially, the social KPIs were divided into three categories – safety, regional and work. Each of these will be discussed in separate subchapters, in respect of the findings of the literature review and empirical study.

5.3.1 Safety

In 2023, the following safety KPIs were identified – number of complaints, customer satisfaction score, accident rate, fatality rate/passenger injury rate, fire incidents, navigational incidents, cargo related incidents, crime, cyber incidents. The basis for these KPIs was the KPIs used in shipping and aviation, combining these into one system. During the social impact study, we evaluated these based on their influence on social acceptance. The results are given in Table 10.

Table 10. Safety KPIs and their influence on social acceptance, compiled by authors.

KPI	Initial description	Findings of empirical research
Complaints (nr)	Total number of society and local complaints	It was indicated that as soon as AIRSHIP forces people to change their habits, the number of complaints would rise. Hence it is important to keep in mind local people and their habits when planning the routes, ports, time schedules etc., to reduce possible number of complaints.

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KPI	Initial description	Findings of empirical research
Customer satisfaction score (%)	Feedback level of the customer satisfaction	While the factors that reduce complaints number, the feedback of customer satisfaction levels depends on the timely operations, preferable all year round. It was indicated during the interviews and survey that delays or days when AIRSHIP would not operate would be seen to its disadvantage as continuous stable operation is preferred.
Accident rate (nr)	Incidents resulting damage or injury	Accidents should be preferably avoided. This parameter will need to be defined more accurately as there would be a need to follow also near misses, possible dangerous situations before the damage or injury occurs (additional category necessary).
Fatality rate /passenger injury rate (nr)	Occurrences of death by accident	As demonstrated by the helicopter case in Estonia, even one accident can end operations due to distrust from the society. Hence it would be important to avoid accidents at any cost.
Fire incidents (nr)	Incidents involving smoke, heat, flames, causing damage	As with any incidents, it is better to avoid incidents involving fire. However, by using fire retardant materials as described by the IMO SOLAS convention, such danger could be minimized.
Navigational incidents (nr)	Incidents resulted by navigational errors	AIRSHIP is autonomous vessel, and any navigational incident must be analyzed in detail. It is of utmost importance that AIRSHIP, as fastest vessel, makes evasive maneuvers correctly and follows all international regulations. In addition, it would be preferred to monitor also the cases where the remote-control operator must interfere.
Cargo related incidents (nr)		During the empirical study, cargo related incidents were considered minor, as this would be just physical damage of goods. It was advised to have insurance for such cases that would cover the cost of lost, damaged or delayed cargo.
Crime (nr)	All actions which constitute an offence and are punishable by law	The crime was not discussed during the empirical study, and it did not come up as a topic during the interviews and focus group.
Cyber incidents(nr)	Number of cyber incidents occurred and managed	Cyber incidents were seen as serious threat – that would enable to take over the craft, possibly endanger the shore communities. Hence, the cyber incident would have serious implications on social acceptance.

Most of safety KPIs have significant influence on the social acceptance of AIRSHIP and would need to be seriously considered when planning the autonomous features and AIRSHIP operations.

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5.3.2 Regional

In 2023, only two regional KPIs were identified – perception and awareness of coastal communities towards risk management and expected developments related to airship, both without any measurement unit or further explanation. These two have been analyzed in Table 11.

Table 11. Regional KPIs and their influence on social acceptance, compiled by authors.

KPI	Initial description	Findings of empirical research
Perception and awareness of coastal communities towards risk management	-	Risk management, perceptions and awareness of coastal communities deserve each to be measured on their own as separate entities. The perception measure will indicate the emotional feeling towards AIRSHIP; awareness study will indicate how well people understand technology and what it can do; risk management, as showcased by the empirical study, is critical component for successful implementation. Therefore, this part of KPIs needs further development, preferably in form of several longitudinal studies.
Expected developments related to AIRSHIP	-	This should be defined in measurable format, possibly several. For example, as SDG 11A is about transportation options to support economic, social and environmental links between urban, peri-urban and rural areas, it could be measured as number of lines opened, number of AIRSHIPs in service, number of packages delivered etc.

In addition to the measurements given in the table, the literature research indicated also the need to follow the development of state regulations and port regulations that enable the implementation of AIRSHIP in specific regions/countries.

5.3.3 Workforce

In 2023, seven indicators were defined – labor conditions, employment, income, worker commuter time, training, work accidents and personnel. These KPIs are intended to measure the efficiency of the operator's personnel. The defined KPIs are compared to the findings of empirical research in following Table 12.

Table 12. Workforce related KPIs and their influence on social acceptance, compiled by authors.

KPI	Initial description	Findings of empirical research
Labor conditions (work-life balance)	Quality of working environment	Literature review indicated that AIRSHIP should be able to enhance the quality of working life as well as improve the work-life balance through moving the jobs from AIRSHIP to land-based centers.
Employment (% of change)	Influence of occupational rate	While employment can be measured within the company through the growing or diminishing numbers, this KPI could be measured also from social influence perspective,

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KPI	Initial description	Findings of empirical research
		investigating how many jobs are created within the logistical chain that AIRSHIP creates.
Income (% of change)	Influence on earnings	Income per employee or employee group in AIRSHIP-related company can be compared to similar values of shipping companies and aircraft companies. One of the hypotheses that emerged from discussion in focus groups and during interviews was the perception that AIRSHIP would create higher income jobs.
Worker commuting time (distance ship-home)	Total journey employees take from home to work and back again	This measure was not discussed during the empirical study and did not come up during the focus group discussions, nor during interviews.
Training (time/staff)	Time invested in teaching employees a particular working skill	This measure could be divided into several measures, based on the job descriptions. Literature review indicated that while training does not have direct influence on social acceptance, the ease or difficulty to learn the skills needed for working within the AIRSHIP industry can affect the interest in working on the field. Should the training process be too lengthy or too complicated, it would be harder to find employees for such task.
Work accidents (time/staff)	-	While this was not discussed in detail, it is good tradition of shipping companies to keep counting the days that have passed without any work accidents. Some companies have added to this also monitoring how long it has been since someone from the team members was on sick leave. As an indicator, it can influence future employees when deciding to join the company.
Personnel (nr)	Number of officers on board	As AIRSHIP is intended fully autonomous vessel, there will not be any persons on board, so this KPI will be irrelevant in the future. However, it can be replaced by measuring how many AIRSHIPs can one remote operator manage.

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6 Conclusions

This report summarizes the research into potential social impacts of the ground effect WIG craft AIRSHIP. The research included extensive literature review, study of social impact theories, empirical studies, comparisons with previous reports about AIRSHIP and finally analysis based on the stakeholder theory and Key Performance Indicators that were identified during the first year of the project AIRSHIP and summarized in the report of the first year.

The result of the social impact study and answer to the main question of this report - What can potentially change in different societal contexts when we introduce fully automated electric wing-in-ground crafts and how may this transform the lives of residents and consumers? – can be summarized quite shortly. Literature review shows that there has been long standing interest in the WIG crafts, but their social impact has not been studied before. At the same time, there are many stakeholders and interest groups who are ready to accept such a vessel and see great advantage in the possible services it can provide. These groups are mainly from remote islands and remote locations that are hard to reach with current transport technologies within reasonable price and time. AIRSHIP, offering a sustainable transport solution and hence being net zero in regard of emissions, would help to make our sea transport greener and climate neutral. This aspect was shown to be important throughout the empirical study in all its stages – interviews, focus group study, and survey. Hence the results show that consumers and stakeholders are ready for AIRSHIP, but it needs to be technically ready and have a proven safety record as well as transparent regulatory and environmental standards' compliance, before it can be fully integrated into the market as commercial vessel.

Our study has indicated that AIRSHIP influences more and broader sustainability goals than those initially identified during the first year of the project. Reducing inequality and redressing the gender balance, were identified during the empirical study as potential beneficial outcomes of introducing AIRSHIP as a factor of societal transformation. For example, being autonomous, it offers some long-waited changes for the employees in the maritime industry, who have so far been exclusively working and living on vessels for extended periods of time – e.g. no need to be away from family, no need for longer working hours, better social life and work-life balance, regardless of the person's gender identity and caregiving status. Importantly, it would enable professionals identifying as women, given the challenges and obstacles to these work domains for women currently (i.e., mostly assuming the caregiving responsibility in heterosexual couples due to social norms). Nevertheless, it also brings along challenges for the workforce – one needs to have more interdisciplinary knowledge, there will be a reduction of traditional seamen roles, and the workforce will need to be aware of several new disciplines – in addition to maritime, they will need some knowledge of aviation as well as cyber security, for example. This clearly elucidates how the labor market and education systems across Europe must be aligned and working closely to technological and market developments to prevent major societal disruptions (e.g., job loss, uncovered new employment due to unprepared workforce).

Furthermore, people living on islands see AIRSHIP as a great opportunity for those who do not want to be on board anymore but want to stay still connected to the sea and use their knowledge to benefit. Old captains, people with young children, could in this way maintain their qualifications and continue working while going home each evening. It also enables working part-time or with flexible schedules, which today is impossible for those who work onboard in the sector. The need for employees with interdisciplinary knowledge might potentially mean that these jobs will result in higher incomes.

As cargo transport vessel, AIRHSIP was seen by consumers as a great addition to the current transportation options, if it is not noisy and does not change their habits. Consumers had more interest in it provided it would solve also passenger transport problems. The possibility of having their perishable goods sooner rather than later was largely accepted as a good solution, provided it was affordable. The question of affordability was raised on several occasions, especially considering the fluctuations in certain products in the EU/outside EU market and the divergence in purchasing power rates across European countries and regions. There was also interest in safety from several angles – e.g. would autonomous vessel be able to make right decisions while on waters, could

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it navigate without harming other vessels and leisure yachts, would it be safe enough in case of cyber-attack, etc. Provided the safety of the operation of AIRSHIP is demonstrated and the AIRSHIP itself is proven to be useful, consumers saw it as two possible versions – if it is expensive, it will become a niche transport mode, like water planes and helicopters. Provided it is affordable, it could be one of the main delivery vessels of the future. It was seen also as possible means to create new transport and logistics chains. To summarize – prove it is safe, affordable and useful, does not disturb the residents, and it will have enough public acceptance for operation.

The key performance indicators identified during the first year of project AIRSHIP about social impact were defined in greater detail during the social impact assessment. Initial key performance indicators viewed the impact mainly from the viewpoint of maritime and aviation industry and concentrated on the operator viewpoint. On the contrary, this study has indicated the need to redefine the indicators as AIRSHIP has influence on the local communities and their wellbeing, as well on planetary wellbeing more broadly. While AIRSHIP has been planned as commercial cargo transport vessel, its use as disaster recovery vessel was well identified during the empirical study as well as its possibility of adding additional transport routes and corridors and hence enhancing the chance of remote locations in participating in world markets. The findings of the research have confirmed that the business cases indicated during the second year of project AIRSHIP were seen as useful by the participants of the empirical study.

Lastly, it should be noted that the research presented in the respective reports needs to be continued on environmental aspects of AIRSHIP. Many of the respondents of the survey indicated the need to showcase that AIRSHIP indeed is a net zero vessel in real life, not only on paper, highlighting how transparency and citizen communication are essential for conveying environmental compliance to the public. It was mentioned that AIRSHIP would need to use green energy in addition to the electric engines and batteries to demonstrate a true net zero vessel. However, as this study has been mainly qualitative and concentrated mainly on Estonian environment, compared with Spanish and Portuguese findings, it could be extended to other regions, and these might provide different results. Moreover, the changes in the regulations at international, European, and national/regional levels are ongoing – the MASS Code is under development; the AI regulations exist for now only in European Union and there are few countries which have regulations for testing or using the fully autonomous or remotely operated vessels. There is, therefore, a need to conduct thorough research once the first results of actual use of AIRSHIP are obtained, as this study is purely based on perceptions of people after a short introduction into AIRSHIP and its capabilities. The actual situations, after people have seen AIRSHIP in action, will need to be studied separately and can provide quite different results. Finally, this study presents groundbreaking research on an unprecedented degree, both regarding the fields of study involved and the geographical domain. Further research within and outside of the AIRSHIP project should continue to uptake these results to expand knowledge in these research lines.

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Annex A – Literature review article list

Author	Year	Name	type
A. Laakso et al.	2025	A risk assessment of an autonomous navigation system for a maritime autonomous surface ship	journal article
Y. Mori	2025	An analysis of challenges and impacts of different trends/factors on the implementation of onboard training: perspectives from maritime education and training …	journal article
C. Han et al.	2025	Beyond Navigational Situation Awareness: Developing and evaluating situation awareness support system for remote engine room monitoring at the future shore …	journal article
L.S. Lops et al.	2025	Essential Competencies in Maritime and Port Logistics: A Study on the Current Needs of the Sector	journal article
S. Karakas	2025	Exploring the key enablers of robotic process automation in the maritime industry: S. Karakas	journal article
L. Chen	2025	Frontiers | MAV-ISR: from maritime gray zone competition to norm formation	journal article
K.M. Lynch	2025	Investigating decision-making in human-machine teams for the operation of Maritime Autonomous Surface Ships	doctoral thesis
A.R. Moraiu et al.	2025	Investigating educational solutions in the field of autonomous shipping at Finnish Universities	journal article
S. Hasan	2025	Legal Challenges in Enforcing the Duty to Render Assistance at Sea: Implications for Maritime Autonomous Surface Ships (MASS)	journal article
C.N.U. Klinic	2025	Maritime Autonomous Surface Ship's Remote Operation Centers: Multidimensional Analysis for Safe and Sustainable Operations	journal article
C. Capos et al.	2025	Maritime Stakeholders' Insights on Maritime Education and Training in the Autonomous Shipping Era. A Small-Scale Study in Spain	journal article
D.H.M. Stapleton	2025	MASS Regulation in Nordic and Baltic Sea Countries: A Comparative Analysis	journal article
E. McMahon	2025	Navigating the future: licensed deck officers' perceptions of, performance with, and acceptance of Maritime Autonomous Surface Ships (MASS)	doctoral thesis
B. Baldvinsson	2025	Navigator Responses to Safety Challenges in Autonomous Maritime Systems	master thesis
C. Correa-Jullian et al.	2025	Operational safety hazard identification methodology for automated driving systems fleets	conference paper
R. Saha	2025	Perceived impacts of higher levels of automation within the European inland waterway transport: a socio-technical system evaluation	licenciate thesis
R. Song et al.	2025	Safety and efficiency of human-MASS interactions: towards an integrated framework	journal article

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M. Rosic et al.	2025	Semantic Interoperability of Multi-Agent Systems in Autonomous Maritime Domains	journal article
C. Han et al.	2025	Situation awareness information requirement for marine engine room monitoring at the future shore control center	journal article
M. Belabyad et al.	2025	Skills and competencies for operating maritime autonomous surface ships (MASS): a systematic review and bibliometric analysis	journal article
M.T. O'Malley	2025	Supporting the Navy Through Model-Based Systems Engineering: The Development of a Human Factors and Ergonomics Framework for Unmanned Surface Vehicles	master thesis
M. Belabyad et al.	2025	The human element in autonomous shipping: a study on skills and competency requirements	journal article
H.M. Eldabe	2025	The Negative Impact of Complacency on the Seafarer's Attitude and Behaviors	journal article
S. Odegard	2025	The Road to Autonomy: what are the current status of the development project and what are the future prospects	master thesis
A.F. Rachmannullah et al.	2025	The role of perceived knowledge in public intention to use autonomous ferry: an extension of theory planned behaviour	journal article
T. Yuzui et al.	2025	Toward a hybrid approach for the risk analysis of maritime autonomous surface ships: a systematic review	journal article
A. Umeda, E. Shimizu	2024	A Framework for Requirements Management to Develop Safety Management and Operation of Maritime Autonomous Surface Ships	journal article
A. Öster	2024	A Holistic Anomaly Detection System: Improving Safety in Maritime Engine Rooms by Utilizing Methods Mimicking Human Perception	master thesis
X. Li, K.F. Yuen	2024	A human factor analysis of remote-control failure for maritime autonomous surface ships	journal article
X. Li et al.	2024	A human-centred review on maritime autonomous surfaces ships: impacts, responses, and future directions	journal article
J.M. Kim	2024	A study on the prioritization of competencies for remote operator of Maritime Autonomous Surface Ship (MASS): An Analytic Hierarchy Process (AHP) …	journal article
N. Perumal	2024	A study to examine vessel traffic services in the context of maritime autonomous surface ships: Strait of Malacca as a case study	master thesis
S. Hasan	2024	An insight on the role and response of International Maritime Organization and classification societies in regulating maritime autonomous surface ships	journal article
T.C. Ho, H.S. Lee	2024	Analysis of Key Factors and Correlations Influencing the Adoption of Autonomous Ships by Shipping Companies—A Study Integrating Revised DEMATEL …	journal article
H. Lee et al.	2024	Analysis of major issues in the field of Maritime Autonomous Surface Ships using text mining: focusing on S. Korea news data	journal article

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R. Robertson	2024	Autonomous Ships and Salvage	master thesis
I.M. Ramli et al.	2024	Blue economy initiatives in South-East Asia: challenges and opportunities	report
T. Mestrovic et al.	2024	Challenges for the education and training of seafarers in the context of autonomous shipping: Bibliometric analysis and systematic literature review	journal article
D. Rutledal	2024	Designing for Situational Awareness in Remote Operator Centers for Autonomous Ships.	doctoral thesis
T.O. Olajide	2024	Digitalization effects on women seafarers in the era of maritime autonomous surface ship (MASS)	master thesis
A.S. Alamousch et al.	2024	Drivers, opportunities, and barriers, for adoption of Maritime Autonomous Surface Ships (MASS)	journal article
L. Yiteng	2024	Exploring industry acceptance of maritime autonomous surface ships: A grounded theory approach	journal article
J.D. Palbar Misas et al.	2024	Future of maritime autonomy: cybersecurity, trust and mariner's situational awareness	journal article
A. Kataria et al.	2024	Future Shipping Operations and Transitioning Maritime Higher Education: An Activity System perspective	conference paper
X. Yuan, B. Yu	2024	IMO Legal Regulation of Maritime Autonomous Surface Ships: Progress, Trends and China's Response	book chapter
D.R. Sharma	2024	Integration of Human, Technology, Organization, and Innovation Elements in Safety Management to Meet Challenges of Advanced Maritime Technology including ...	journal article
C.A. Udeh et al.	2024	International Journal of Management and Organizational Research	journal article
H. Zhang et al.	2024	Introduction: Charting the Course on the Autonomous Ocean	book chapter
A.A. De Silva-Luceneio	2024	Maritime autonomous surface ships (MASS): a study on the awareness, acceptance, and preparation of the Philippine maritime industry	master thesis
A. Pletschke	2024	Maritime Autonomy and Diversity: Exploring the Role of Technology and Working Practices	master thesis
S. Sekularac-Ivosevic et al.	2024	Maritime Society 5.0: Embracing Newly Emerged Skills and Career Pathways	conference paper
A.L. Ölcer et al.	2024	MASS and Decarbonisation Policy: Exploring the Nexus Between Maritime Autonomous Surface Ships and Decarbonisation Efforts	journal article
K. Wrobel, M. Gil	2024	MASS and Humans Interlinked: Errors, Skills, Training, and Job Market	book chapter
M. Poornikoo	2024	Modeling Perspective on Human-Automation Interaction (HAI): Levels and Trust in Automation	doctoral thesis
L.C. Nguyen	2024	Navigating the Digital Horizon in the Maritime Industry: A Case Study of Vietnam	book chapter
Y. Nemoto	2024	Navigation safety of Maritime Autonomous Surface Ships	journal article

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C. Asan	2024	NEW ERA STANDING ON BEYOND THE HORIZON FOR MARITIME TRANSPORTATION: INDUSTRY 5.0 (MARITIME 5.0)	conference paper
I. Kurt, M. Aymelek	2024	Operational adaptation of ports with maritime autonomous surface ships	journal article
N. Setchell	2024	Planning Not to Fail	conference paper
N. Voroniuk	2024	Relevance of international legal and national standards of safety of navigation and the role of classification societies in the context of modern challenges and …	journal article
M.A. Musa	2024	Smart autonomous transport: Land and water	book chapter
H.K. Hardini et al.	2024	Social Mindset Restructuring: A Critical Requirement for Implementing Maritime Autonomy	conference paper
G.W. Kamwendo	2023	Interrogating the state of application of technology within the Malawi Maritime Force as maritime expression: a task-technology fit approach	master thesis
T. Kuntasa, T.C. Lim	2023	A conceptual model of autonomous ship remote operators' competency	journal article
H. UĞURLU	2023	Application of combined SWOT and AHP (A'WOT): A case study for maritime autonomous surface ships	journal article
I. Yurika	2023	Attacks on commercial maritime autonomous surface ships at sea	journal article
G. Theotokatos et al.	2023	Autonomous shipping—an analysis of the maritime stakeholder perspectives	journal article
B. Stepien	2023	Can a ship be its own captain? Safe manning of autonomous and uncrewed vessels	journal article
E. Veitch	2023	Designing for Land-based Control of Autonomous Vessels	doctoral thesis
K. Fjortolf et al.	2023	Development of a human reliability assessment framework addressing specific needs and requirements of maritime operations	Report
T. Erdal	2023	Digital transformation in the maritime industry. The increasing implementation of autonomy and need for competence reskilling	master thesis
K. Makkawan et al.	2023	Exploring Competencies for Thai Navigation Officers in Digital Age	journal article
R. Kari	2023	Exploring EEG Based Stress in Remote Ship Operations as Foundation of Customized Training	doctoral thesis
Q. Chen	2023	From concept to practicality: Unmanned vessel research in China	journal article
B.E. Maghoromi	2023	Impact of emerging technologies on maritime education and training: a phenomenological study	master thesis
J. Earthy	2023	Industrial and regulatory progress	book chapter
S.C. Narayanan	2023	Key factors impacting women seafarers' participation in the evolving workplace: A qualitative exploration	journal article
R. Saha	2023	Mapping competence requirements for future shore control center operators	journal article

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L. Chen	2023	Maritime rights, obligations, and liabilities of intelligent ships from the perspective of risk distribution	journal article
Y. Liu et al.	2023	On the determination and rank for the environmental risk aspects for ship navigating in the Arctic based on big Earth data	journal article
T. Porathe	2023	Overview of recent research	journal article
E.A.E. Mohamed	2023	Technological Innovations in the Maritime Sector: A Comprehensive Analysis of Intelligence Knowledge and Industry Dynamics for Graduates Adaptation.	journal article
K.M. Lynch et al.	2023	The application of a system-based risk management framework and social network analysis to the Maritime Autonomous Surface Ship system: Who are the decision …	journal article
R. Saha et al.	2023	The shift toward autonomous European inland waterway shipping: Identifying the gaps in the emerging socio-technical system	journal article
H. Fahmiasari	2023	The State of Autonomous Shipping in Indonesia	report
A.A. Elnoury, S. Farag	2023	The Impact of Inadequate Maritime Conventions on Implementing Autonomous Ship Technology.	journal article
M. Saager et al.	2023	Towards Modelling Cooperation in Future Maritime Remote-Control Center	journal article
H. Namazi et al.	2023	Trustworthiness Evaluation Framework for Digital Ship Navigators in Bridge Simulator Environments	conference paper
A. Bilic	2023	WHO WANTS TO STAY ON BOARD? INDUSTRY 4.0 AND MARITIME EDUCATION AND TRAINING	conference paper
A. Stegani, L. Apicella	2022	A new educational model for Marine 4.0 technologies	conference paper
V. Samani	2022	A preliminary analysis of the impact of autonomous maritime surface ships in marine technology education	master thesis
Q. Zhang	2022	A study on legal issues of unmanned ship maritime regulation	master thesis
M. Ji	2022	A study on the legal status and responsibilities of the master in autonomous vessels: the case of general remote operators	master thesis
D. Polemis	2022	A theoretical analysis of contemporary vessel navigational systems: assessing the future role of the human element for unmanned vessels	journal article
Y.J. Park et al.	2022	Analyzing the factors influencing the intention to adopt autonomous ships using the TOE framework and DOI theory	journal article
A. Pastra et al.	2022	Building a trust ecosystem for remote inspection technologies in ship hull inspections	journal article
C. Dragomir et al.	2022	Charisma of Safety in Maritime.	journal article
S.I. Ahn	2022	Development of a human reliability assessment framework addressing specific needs and requirements of maritime operations	doctoral thesis

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F. Asplund, P. Ulfvengren	2022	Engineer-centred design factors and methodological approach for maritime autonomy emergency response systems	journal article
J. Onwuamadike	2022	Exploring Potential Job Profiles in MASS Operations: a description of tasks, skills, and experience.	master thesis
A. Sharma, T. Kim	2022	Exploring technical and non-technical competencies of navigators for autonomous shipping	journal article
M. Yorulmaz, K. Karabulut	2022	Factors Influencing the Utilization of Smart Ships in Maritime Transportation	journal article
A.S. Hoem et al.	2022	Human-centred risk assessment for a land-based control interface for an autonomous vessel	journal article
A.N. Okonkwo	2022	Impact of big data analytics on the privacy rights of seafarers	master thesis
K. Boguslawski et al.	2022	Implications of autonomous shipping for maritime education and training: the cadet's perspective	journal article
M. Shahbaksh et al.	2022	Industrial revolutions and transition of the maritime industry: The case of Seafarer's role in autonomous shipping	journal article
D. Mandrioli	2022	Maritime Autonomous Surface Ships and International Law	doctoral thesis
T. Yamada, N. Kajita	2022	Necessity of New Framework to Support Social Implementation of Maritime Autonomous Surface Ships	journal article
I. Kurt, M. Aymelek	2022	Operational and economic advantages of autonomous ships and their perceived impacts on port operations	journal article
R. Weber et al.	2022	Operationalizing COLREGs in SMART ship navigation: Understanding the limitations of algorithm-based decision support systems in traffic situations	journal article
L. Zhu	2022	Policy-oriented analysis on the navigational rights of unmanned merchant ships	journal article
D. Mandrioli	2022	The use of MASS in the context of International Law of the Sea	doctoral thesis
K.A. Alyward	2022	Towards an understanding of the consequences of technology-driven decision support for maritime navigation	doctoral thesis
D. Black	2022	Uncrewed Vessel Port Entry	master thesis
T. Kim et al.	2022	Unlocking long-term safety, environmental and economic values of Maritime Autonomous Surface Ships (MASS)	book chapter
L. Han, W. Xia	2021	Autonomous Ships in China: Policies and Regulations	journal article
M. Tarkowski et al.	2021	Connectivity benefits of small zero-emission autonomous ferries in urban mobility—case of the coastal city of gdańsk (Poland)	journal article
Y. Ichimura	2021	Evaluating the impacts of digitalization on ship operation: examining how to enhance maritime safety	master thesis
C. Han et al.	2021	Future directions for human-centered transparent systems for engine room monitoring in shore control centers	journal article
P. Cinco	2021	Investigation of the preparedness of maritime education and training institutions (ME aining institutions (METIs) of	master thesis

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		seafar TIs) of seafarer's top supplying countries op supplying countries in the introduction of the maritime autonomous surface ship (MASS)	
G. Kavallieratos	2021	Security of the Cyber Enabled Ship	doctoral thesis
A. Bakdi et al.	2021	Testbed scenario design exploiting traffic big data for autonomous ship trials under multiple conflicts with collision/grounding risks and spatio-temporal dependencies	journal article
K. Tam	2021	The potential mental health effects of remote control in an autonomous maritime world	journal article
T. Crichton, K. Jones	2021	The potential mental health effects of remote control in an autonomous maritime world	journal article
K. Aboul-Dahab	2021	The Readiness of the maritime education for the autonomous shipping operations	journal article
M.D.D. Maharani	2021	Uncertainty of Sustainability of Marine and Fishery MSMEs in Coastal Areas and the presence of Maritime Autonomous Surface Ships in the Era of Society 5.0	journal article
V.N. Gutsuljak	2021	Прозелитные нормы в российском и международном морском праве	journal article
L.A.L. Wennersberg et al.	2020	A framework for description of autonomous ship systems and operations	conference paper
M. Zhang et al.	2020	A probabilistic model of human error assessment for autonomous cargo ships focusing on human–autonomy collaboration	journal article
K. Aylward	2020	Automated functions: Their potential for impact upon maritime sociotechnical systems	journal article
V. Goltsev	2020	Automatization of the maritime transport versus job availability	bachelor thesis
M. Kim et al.	2020	Autonomous shipping and its impact on regulations, technologies, and industries	journal article
B. Pundars	2020	Autonomous Shipping in changing the structures-Future implications on Maritime Education and Training	master thesis
Y.Gu et al.	2020	Autonomous vessels: state of the art and potential opportunities in logistics	journal article
I. Salihoglu et al.	2020	değerlendirildiği, 400 stajyer kapasitesiyle Piri Reis Üniversitesi gemisinin örnek uygulama olarak gösterildiği (bkz. sayfa 20) eğitim gemisinde köprüüstü ve …	report
C. Karatug	2020	DETERMINATION OF NEW TECHNOLOGIES AND FUTURE SKILLS OF SEAFARERS TOWARDS SMART SHIPPING	conference paper
S. Jo, E. D'Agostini	2020	Disrupting technologies in the shipping industry: How will MASS development affect the maritime workforce in Korea	journal article
V.S. Manhas	2020	Human factors and autonomous ship operation: a comparative analysis of the maritime and aviation industries	master thesis
S. Wan	2020	Identification and challenge of human factors under the trend of MASS development	master thesis

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E.E.Y. Abdelraouf, H. Eisayad	2020	Implementing the Safety Culture Improves the Autonomous Ships Prosperity	journal article
D. Zhang et al.	2020	Prediction Model of Human Error Probability in Autonomous Cargo Ships	conference paper
K. Aylward, et al.	2020	Preventing unruly technologies in maritime navigation: A systems approach	book chapter
K. MacKinnon, M. Lundh	2020	Preventing Unruly Technologies in Maritime Navigation: A Systems Approach	book chapter
C. Xu	2020	Study on the applicability of STCW Convention to MASS and updating ETO's standard of competence	master thesis
S. Lindsay	2020	Sufficiency of existing legal frameworks for addressing maritime security challenges surrounding autonomous vessels	journal article
I. Yoon	2020	Technology assessment on the astonomous ships: key findings and recommendations	conference paper
R. Dremliuga et al.	2020	The development of the legal framework for autonomous shipping: Lessons learned from a regulation for a driverless car	journal article
T. Relling et al.	2019	A socio-technical perspective on the future Vessel Traffic Services	journal article
N. Shipping	2019	AUTONOMOUS SHIPS: A NEW PARADIGM FOR NORWEGIAN SHIPPING	report
P. Vidan et al.	2019	Autonomous systems & ships-training and education on maritime faculties	conference paper
D. Metlay et al.	2019	Autonomous Transportation Technologies: Society and Individuals in the Loop	report
R. Fiedler et al.	2019	Autonomous vehicles' impact on port infrastructure requirements	report
M. Sason	2019	Competitiveness of Autonomous Ship and Norwegian Maritime Shipping Industry	master thesis
A. Amro et al.	2019	Connect and protect: Requirements for maritime autonomous surface ship in urban passenger transportation	conference paper
F.M. Chan	2019	Female engineer officers: breaking the glass ceiling	master thesis
M. Lutzhoff, et al.	2019	Human-centred maritime autonomy-An ethnography of the future	conference paper
T. Kim et al.	2019	Impact of automation technology on gender parity in maritime industry	journal article
V. Sencla et al.	2019	Industry 4.0: autonomous shipping and new challenges for maritime education and training	journal article
P. Zampella	2019	Maritime and air law facing unmanned vehicle technology	doctoral thesis
A.L. Wennersberg et al.	2019	Project type: IA Innovation Action Start of the project: 01/06/2019 Duration: 54 months	report
V. Jokiranta	2019	The Shipmaster in Remote & Autonomous Operations	master thesis
D.A. Pandeagua	2019	The significance of marine autonomous surface ships: prospects to the Philippine maritime industry	master thesis
Z. Pietrzykowski et al.	2018	Autonomous ship–Responsibility issues	book chapter

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B. Quinisio	2018	Development of a strategy for management of autonomous ships by coastal states	master thesis
L.O. Dreyer	2018	Identified challenges in the safety management of merchant maritime autonomous surface ships.	master thesis
J.C. Chong	2018	Impact of maritime autonomous surface ships (MASS) on VTS operations	master thesis
United Nations	2018	Reflecting on the past, exploring the future	report
C.A. Thieme et al.	2017	A risk model for autonomous marine systems and operation focusing on human–autonomy collaboration	journal article
K. Chen	2017	Research on safety management of Maritime Autonomous Surface Ships	master thesis

Annex B – Survey introduction

Dear participant,

We, researchers from Estonian Maritime Academy, Kristin Kerem and Carina Hartšenko, are kindly inviting you to participate in the study on social and environmental aspects of the unmanned ground effect maritime vehicle AIRSHIP within a European Union Horizon program financed project "Autonomous Flying Ships for Inter-Island and Inland Waters Transport".

The aim of our project is to analyse the social and environmental aspects of a new type of **vehicle that is being developed during the project** – unmanned maritime vessel that moves close to the water surface in flying mode.

The AIRSHIP vehicle is **fully electric, unmanned (no person onboard)** and capable of **landing on water** without special infrastructure, even in **icy conditions**. These vehicles use the **wing-in-ground effect**, which creates extra lift when flying close to surfaces like water, making them more **energy-efficient**. To operate, it needs **charging stations**, areas at **ports for loading/unloading** goods and **maintenance.** Such vehicles have proven capable of carrying **bigger cargo loads** than traditional aircraft (**up to 1,500 tons**), while also being faster than traditional ships (with speeds between **200-400 km/h** compared to the 14-75 km/h of traditional ships).

To understand what kind of changes this brings in the life of people living in the regions where such vessels could be used, as well as to the lives of seamen, we are investigating the different aspects involved with the use of such vessels. In addition to social aspects, we research its implications on environment – life above and below the seas as well its effect in harbours and neighbouring areas.

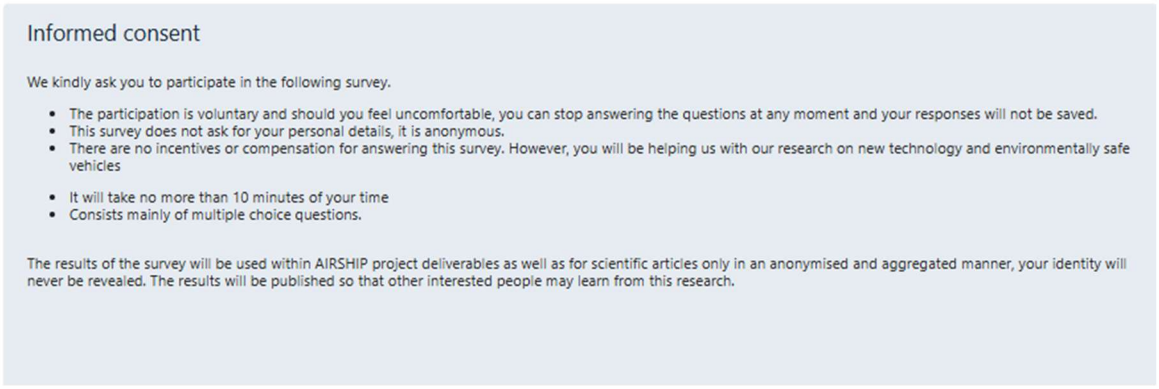
Video link to the test flights of the A0-S prototype: https://www.youtube.com/embed/kZTol2WJYHw?feature=oembed&autoplay=0&loop=0&controls=1&mute=0&wmode=opaque&rel=0

Should you have any questions about the research, you are welcome to contact Kristin Kerem at Kristin.kerem@taltech.ee at any moment. By starting this survey you agree to the survey proposal and give your consent for us to use the data for the purposes described above.



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Annex C – Survey informed consent form



Informed consent

We kindly ask you to participate in the following survey.

- The participation is voluntary and should you feel uncomfortable, you can stop answering the questions at any moment and your responses will not be saved.
- This survey does not ask for your personal details, it is anonymous.
- There are no incentives or compensation for answering this survey. However, you will be helping us with our research on new technology and environmentally safe vehicles
- It will take no more than 10 minutes of your time
- Consists mainly of multiple choice questions.

The results of the survey will be used within AIRSHIP project deliverables as well as for scientific articles only in an anonymised and aggregated manner, your identity will never be revealed. The results will be published so that other interested people may learn from this research.

Annex D – Survey questions

1. Your age?
   - Under 18
   - 18–28
   - 29–44
   - 45–60
   - 61–70
   - 71+
2. Your gender?
   - Male
   - Female
   - Other
3. What country do you live in?
   - Estonia
   - Spain
   - Portugal
   - Other (specify)
4. What is your current employment status?
   - Student
   - Student at a maritime academy/college
   - Working in the maritime industry (e.g., Professor, Lecturer, Logistics, Deck Officer..)

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- Working in another industry
- Retired
- Other

5. Where do you live?

- Island
- City
- Countryside
- Other

6. Have you heard of Wing-in-Ground (WIG) effect before?

- Yes
- No

7. AIRSHIP would be effective for…

	Strongly Disagree	Disagree	Agree	Strongly Agree	I do not know
Improving access to goods for faraway or hard-to-reach places					
Making transportation more sustainable for faraway or hard-to-reach places					

8. Who do you think would benefit the most from AIRSHIP for transporting essential goods to hard-to-reach places like islands? (Select all that apply)

- Elderly populations
- Persons with disabilities
- Isolated communities
- Emergency response teams
- Healthcare facilities
- Other (please specify):

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9. Which challenging environments could benefit the most from AIRSHIP as a safer alternative to traditional transport methods? (Select all that apply)

- Disaster zones needing quick and safe delivery of supplies
- Remote islands with limited transport options
- Areas with poor infrastructure
- Regions with extreme weather where traditional transport is unsafe
- Hard-to-reach areas with harsh environments
- Other (please specify):

10. Do you think AIRSHIP could provide an effective alternative to traditional transport methods in disaster-hit areas? (Select all that apply)

- Yes, they could improve the speed of delivering emergency supplies.
- Yes, they could operate in areas with limited infrastructure.
- Yes, they can operate continuously without risking human lives.
- Yes, they enable remote inspection of disaster zones.
- No, they are not an effective alternative
- Other (please specify):

11. What critical supplies could AIRSHIP effectively deliver to disaster-hit areas? (Select all that apply)

- Survival equipment (e.g., rafts)
- Food and water
- Medical aid
- Shelter materials (e.g., tents)
- Communication devices (e.g., radios)
- Other (please specify):

12. How important is it for you to make transportation more sustainable?

Not at all important	Slightly Important	Important	Very Important

13. At which part of the transportation journey should sustainability be prioritized? (Select all that apply)

- Throughout the entire journey (from origin to destination)
- Near the coast (ports and coastal areas)

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- Mid-journey (open ocean or sea)
- Marine protected zones
- Other (please specify):

14. AIRSHIP would be effective for…

	Strongly Disagree	Disagree	Agree	Strongly Agree	I do not know
Reducing air pollution compared to traditional cargo transport methods					
Reducing air pollution compared to traditional cargo transport methods					
Reducing air pollution compared to traditional cargo transport methods					

15. What are the main challenges public spaces face today? (Select all that apply)

- Overcrowding and congestion
- Accessibility issues
- Noise pollution
- Environmental pollution
- Excessive infrastructure
- Other (please specify):
- No issues

16. AIRSHIP would be effective for…

	Strongly Disagree	Disagree	Agree	Strongly Agree	I do not know
Positively influencing coastal public beaches and harbors					
Positively influencing coastal public beaches and harbors					
Positively influencing coastal public beaches and harbors					

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Positively influencing coastal public beaches and harbors					

17. What changes in infrastructure might occur with AIRSHIP transport? *(Optional)*
18. Do you think AIRSHIP can create good connections between mainland and remote islands? (Select all that apply)

- Yes, helping the economy
- Yes, bringing people and communities together
- Yes, helping the environment
- Yes, none of the above

19. How do you think AIRSHIP will impact jobs in the transportation sector?

- They will create jobs
- They will cause job losses
- They will create jobs in some areas but lead to job losses in others
- Nothing will change

20. We would appreciate it if you could share any comments or ideas you may have after completing the survey *(Optional)*

Annex E – Interview questions of different stages

Interview questions of stage 1:

- How much adaptation is necessary in Estonian legislation for the usage of new maritime technologies?
- How should the new regulations be formed? Should Estonia compile these themselves or wait for the international regulations or some other option?
- Which methodology should be used for creating such regulations? Descriptive and normative or risk-based or combined approach?
    - Provided the risk-based method is used, what could be the possible problems?
    - Provided the descriptive method is used, what could be the possible problems?
- IMO has qualified unmanned vessels into 4 categories, from minimal automation to full autonomous ships. Which version do you think will be moving in Estonian waters in 30 years and why?
- The AIRSHIP is combination of ship and aircraft – moving low above the waters autonomously. Today it is agreed that provided such crafts fly lower than 150 meters of height above waters, these correspond

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to maritime rules. What is your opinion, should such crafts correspond to maritime rules on whole; correspond to the maritime navigation rules, but their construction should follow aviation rules; correspond to both, maritime and aviation rules; correspond to the rules of unmanned aerial drones?
- What qualifications should have the remote operator of autonomous AIRSHIP?
- What benefits will the usage of WIG technology give to Estonia as a nation?
- Additional comments or ideas?

Interview questions of stage 2:

First impression of AIRSHIP

If familiar with WIG effect:

How familiar are you with the WIG effect?

Experience with WIG effect in work?

Awareness of similar vessels discussed as transportation mode?

If unfamiliar:

Awareness of similar vessels discussed as transportation mode?

Who would benefit most from using AIRSHIP? Why?

AIRSHIP in disaster response:

If yes:

Ask for elaboration

If no:

Identify main limitations or concerns

Environmental impact:

Will AIRSHIP improve environmental impact?

Which type of pollution would AIRSHIP most effectively reduce and why?

Public space impact:

Could AIRSHIP improve or add challenges to public space?

Challenges for ports:

What challenges might ports face adapting to AIRSHIP technology?

Broader impact:

Potential positive impacts on society, environment, and economy

Employment impact:

Could adoption of AIRSHIP reduce demand for maritime professionals? Why or why not?

Main advantages of AIRSHIP according to participant

Any additional comments or ideas

Interview questions of stage 3:

- After hearing about AIRSHIP, which, in your opinion, are the biggest social aspects, when this vessel is operating (human, environmental, safety,)
- What is your opinion of changes in the workforce such vessels will bring?
- What changes would be required from the educational system to provide workforce equipped with skills for the new technologies?
- What would be the changes of AIRSHIP to local communities? How do you see that they would react? How do you think that the acceptance of local communities can be achieved?
- AIRSHIP is AI guided and therefore independent while in traffic. Which benefits do you see in that? Which problems?
- What would use of such vessel change in the work processes of your administration/port/company (choose the one applicable to the interviewee and his/her workplace)?

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- Is there anything else that comes to your mind when you think of using AIRSHIP?

Annex F – List of technology acceptance theories

Name of theory	Short description
Social license to operate (Joyce & Thomson, 2000) (Thomson & Boutilier, 2017) (Stronge, Kannemeyer, & Edwards, 2024)	Defines the need to have ongoing acceptance or approval from society and local community stakeholders for the activities of a certain organization or industry. Views acceptance in two levels, lover level acceptance (having favorable opinions, being satisfied with something and agreeing) and higher-level approval (the willingness to tolerate, agree or acquiesce). The social license depends on the beliefs, perceptions and opinions held by local population and other stakeholders about the project. Depending on the legal system, the approval phase can include issuing official license (civil law systems) and there it can be viewed as a "comprehensive and fully documented process for local stakeholders and others with vested interests to identify their values and beliefs as the participate in the assessment of the environmental impact study and the identification of alternative operating plans for the project". The preconditions for social license are legitimacy and credibility. Its application has been defined in four phases – socializing the concept of SLO within the organization, hearing the views of stakeholders and understanding their expectations, integrating these views and expectations into organization's processes and procedures and reflecting to the society to use the learning opportunities.
FPIC – Free Prior informed Consultation, Free Prior Informed Consent (Thomson & Boutilier, 2017)	Created as part of Performance Standards for Social and Environmental Sustainability for the IFC but has been widely accepted as "an obligation of private sector project proponents to engage with populations affected by the project in a consultative process that is free from intimidation or coercion, prior to any decision made and with relevant and understandable and accessible information and leads to broad community support. It is based on ILO 169 and is directed at governmental bodies, intended for single decisions.
Creating meaningful social impact (Bayley, 2023) (Kah & Akenroye, 2020)	Generally, social impact refers to the effects that actions, policies, or innovations have on people and communities, covering a broad spectrum of areas such as health, education, economic development, and environmental sustainability. While the wording may differ, most definitions focus on the changes in individuals' lives, whether positive or negative, resulting from these actions. In addition, mostly all definitions highlight the importance of recognizing how various factors and decisions impact societal well-being. The social impact aims to improve the well-being of communities and individuals; it is important to recognize that these effects can be both positive and negative. Recognizing both positive and negative social impacts is essential for balanced and sustainable outcomes. It allows stakeholders to make informed decisions by weighing benefits against risks, ensuring that strategies maximize positive outcomes while minimizing harm.
Theory of Planned Behavior (TPB) (Ajzen, 1991)	Core components of Ajzen theory proposes that behavioral intention predicts the actual behavior and is shaped by three key features – personal attitudes, perceived social pressure from the ones considered important and perceived ease or difficulty to perform the behavior. It foresees the need to evaluate its core constructs through the surveys or interviews to find the specific context for your project, then

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Name of theory	Short description
	measure the perceived benefits and moral obligations before considering integrating these into complementary frameworks such as the Technology Acceptance Model (TAM), Protection Motivation Theory (PMT), Norm Activation Model (NAM) and Value-Belief-Norm (VBN) theory.
Social Acceptance Model (SAM) (Wüstenhagen, Wolsink, & Bürer, 2007)	This model was developed to explain the community acceptance of technologies as renewable energy, considering socio-political, community and market acceptance. It views that for something to be socially accepted, it needs to have acceptance on socio-political level, meaning that the technologies and policies connected are accepted by the public, key stakeholders as well as policy makers. Second pillar means that there must be acceptance and trust from the community, and it must have also procedural and distributional justice meaning that benefits are shared as well as having a procedure in place for reaching fair decision through the participation of all relevant stakeholders. Third pillar includes market acceptance from intra-organizational as well as consumer and investor level, shortly – are consumers ready to buy and are investors ready to invest.
RMF – Risk Management Framework (Rasmussen, 1997)	This framework enables the analysis of any issue through six levels – government, regulators, company, management, end users and work environment. Dividing these into three levels – macro, meso and micro – it enables generalizing across the levels and offers a system-oriented approach to understand the deviations in terms of human errors or systematic faults. It promotes risk management cross-disciplinary, to achieve the control structure involving all levels of society for each particular hazard category.
UTAUT – the Unified Theory of Acceptance and Use of Technology (Marikyan & Papagiannidis, 2025)	Includes four main factors – performance expectancy (the technology delivers the results expected), effort expectancy (the ese of use of the system), social influence (social perception of the need to use the software), facilitating conditions (people perception of the usability of the system through the abilities of the organization and its technical capability).
CTAM – Car Technology Acceptance Model (Osswals, Wurhofer, Trösferer, Becck, & Tscheligi, 2012)	Based on UTAUT model, the model has been developed for automotive context, especially for assessing information technology implementation in organizations and cars. The model is intended to support the decision-making processes during the car automation.
MAVA – Multi-Level Model of Automated Vessel Acceptance (Nordhoff, Madigan, Arem, Merat, & Happee, 2021)	Built on different versions of UTAUT models, this is adjusted for the use with the automated vessel acceptance assessment on micro and meso level. It combines UTAUT method with CTAM model.
IAIA regulations for social impact assessment (IAIA, 2025)	IAIA defines the social impacts in eight categories – how the item introduced changes people's way of life, their culture, their community, their political systems, their environment, their health and wellbeing, their personal and property rights, their fears and aspirations.

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Figure 13. EU Flag

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