I-SEAMORE

D3.2 – PLAN FOR CO-DESIGN AND CO-CREATION PROCESSES IMPLEMENTATION

WP3 I-SEAMORE CO-CREATION & CO-DESIGN PHASES

Integrated surveillance ecosystem for European Authorities responsible for Maritime Operations leveraged by reliable and enhanced aerial support

Co-funded by the European Union

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Abstract	This deliverable aims to provide with a methodological framework to conduct collaborative processes of designing (co-design) and creating (co-creation) technologic solutions, to answer maritime surveillance' needs.

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EXECUTIVE SUMMARY

Deliverable 3.2 aims to outline a framework for collaborative processes to design (co-design) and create (co-create) technological solutions for maritime surveillance, which entangles the involvement of multiple stakeholders: **end-users**, **technical** and **research partners**. The fundamental importance of these processes is to generate impactful technology for end-users.

The methodological framework outlined in the present document comprises 5 phases:

- **Phase 1:** Mapping the end-users' needs, identifying challenges and resources regarding maritime surveillance operations.
- **Phase 2:** Collaboratively identify technological solutions that meet the identified needs and elicit, while prioritizing their requirements.
- **Phase3:** Validation of the elicited requirements.
- **Phase 4:** Technology development and adaptation of I-SEAMORE services and tools.
- **Phase 5:** Integration, testing and validation of the technology developed.

This framework provides guidance on how to plan and execute a collaborative process for identifying, creating, designing, developing, and validating technology that serves the needs of key stakeholders in the field of maritime surveillance.

Furthermore, the process of outlining this framework benefited from the multidisciplinary collaboration between T3.2 'Setup of Co-Design & Co-Creation Processes from Technological & Societal Perspectives' and T3.3 'Definition of Use Cases, Design of Operational Concepts and Elicitation of User Requirements & KPIs', which led to the implementation of cost-effective collaborative activities (e.g., collaborative workshops) which accounted as a trialing of initial phases of the framework. Also, the collaboration between partners (in collaborative activities) and between end-users and technical partners are the stepping-stones of the collaborative development of technology for maritime surveillance.

Finally, to guarantee the uptake of the frameworks and their adaptability to each task of the project, the consortium should promote training and consultancy to task leaders and partners.

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HCD	Human Centered Design
IDF	Interaction Designing Foundation
UCD	User Centered Design

1 INTRODUCTION

The present document aims to **deliver the results of Task 3.2 Setup of Co-Design & Co-Creation Processes from Technological & Societal Perspectives** [M1-M6; Lead: INOV and Partners: ATOS, ISIG, PUD, TS and VTX]. It had the goal to **establish a framework and related methodology** to enable open cooperation between technology organisations, maritime security practitioners, civil society representatives and other relevant stakeholders in co-designing and co-creating new solutions for effective maritime and border security, with real impact for end-users. Task 3.2. aimed at the creation of a collaborative framework, by defining guidelines and procedures for the establishment of an open and multidisciplinary innovation ecosystem centred on the stakeholders aiming at:

1) facilitating the generation of ideas, best practices, and knowledge sharing.

2) introducing new scientific and technological concepts for maritime security.

3) promote joint experimentation; and

4) enhance the innovation capabilities of the end-users and involved stakeholders.

This task was accomplished along with T3.3 (Phases 1 and 2 of the framework), which already consisted as a pre-test of initial phases of the framework.

1.1 Purpose of the document

This document aims to provide a framework to enable open cooperation between technology providers and maritime security practitioners in co-designing and co-creating solutions for effective maritime and border security. Specifically, this deliverable reports the results from T3.2 (Setup of Co-Design & Co-Creation Processes from Technological & Societal Perspectives).

Therefore, a methodological framework is provided to: (1) identify end-users needs for what concerns their duties in maritime surveillance; (2) support the creation and design of technological solutions that can be provided by technical partners to meet such needs.

Moreover, such framework is relevant for the implementation of the activities within T2.4 – Monitoring and Evaluation/Validation Framework, ultimately supporting the assessment of maturity level of the solutions developed by the project, by using a feedback mechanism, enhancing the engagement of stakeholders and end-users. This will be pursued by adopting a participatory approach and by applying the collaborative methodology developed within T3.2.

1.2 Structure of the document

The present document is organized into 5 main sections:

- **Chapter 1** aims to present the purpose and structure of the document.
- **Chapter 2** aims to introduce the theoretical background that underpins the creations of the co-creation and co-designing methodological framework.
- **Chapter 3** presents the methodological framework itself and the collaborative processes are outlined and described.
- **Chapter 4** presents a methodological toolbox that ought to facilitate the implementation of the frameworks by the consortium.

- **Chapter 5** provides with a conclusion and futures steps.

2 THEORETICAL BACKGROUND

The necessity to create (technological) solutions that fit intended audiences' needs has called for bringing into the centre of development processes the end-user of a specific solution or process [1]. Over the past two decades, user-centered design (UCD), also known as Human-Centered Design (HCD)[1], is an approach largely rooted in human-computer interaction, industrial design, and cognitive psychology. UCD is an approach to product development that grounds the process in information about the people who will ultimately use the product [2]. Although UCD borrows concepts from other disciplines (e.g., participatory research), it bundles them into a set of procedures intended to make solutions more effective [1]. Usability (i.e., the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use) is the principal outcome of UCD approach. UCD can be applied not only to the creation and improvement of software and physical products, but also to design to solve social necessities, such as designing services (e.g., health) [3] [4].

UCD is not a method itself, it is a field that makes use of quantitative, qualitative, and mixed methods approaches to align solutions with end-users need [1]. This field is in its sense collaborative because it involves end-users and other important stakeholders in designing solutions. Nevertheless, the concept of collaborative creation is also important for the present project.

Below we present the concepts of collaborative creation and collaborative designing, that are embedded within a user/human-centered paradigm of technology development. These concepts are fundamental for the I-SEAMORE ecosystem by underpinning the proposed methodological framework.

2.1 Collaborative creation and design

Collaborative creation (co-creation) and collaborative design (co-design) are two conceptual approaches to innovation, that build on the active involvement of identified stakeholders having been useful within design and innovation processes [5][6][7][8]. Co-creation and co-design rely on the active involvement of stakeholders, to ensure a stronger ownership and effectiveness of (potential) solutions.

The different traditions from which co-creation and co-design stem have strong repercussions on their aims. Thus, while the production and retention of value is a central aspect of co-creation, the relations between the designers and those who would benefit from the design are at the centre of co-design [9].

These two processes are usually applied in many fields: marketing, healthcare, urban planning, engineering, design, among several others, to promote innovative thinking. Although co-design and co-creation are often used interchangeably, they constitute two different processes, providing different assets for the process of the identification and development of new technologies. Notably, the two processes can be defined as follows:

- **Co-creation** has been used with different aims depending on the context in which it has been adopted. The term has been used to create value and enhance engagement, collective intelligence, and creativity; it has been understood as the coproduction of knowledge, originally developed within business studies and marketing [5].
- **Co-design** is influenced by UCD tradition, which advocates for centring each phase of the design process on the users and their needs, involving other people who may be directly or indirectly affected by the outcome of a project. Usually, these people are referred to as stakeholders. In innovation processes, co-design has also been considered valuable because it can support the faster and more effective adoption of solutions [5]. Co-design aims for better design based on a richer, deeper

understanding of what users know, want and need. During co-design, active collaboration occurs between researchers, designers, developers, and users are "experts of their experiences"; it involves more than participants saying what they want, it involves jointly exploring and articulating needs and jointly identifying possible solutions [10].

Creative collaboration plays an increasingly important role in solving complex interface problems [11]. The combination of different skills in a design team extends the solution space and increases the amount of available cognitive and creative resources to find an optimal solution [9]. It unfolds along different stages, from understanding and sharing experiences to prototyping [12].

From the literature review several important principles can be pointed, serving the development of the methodological framework in the following chapter (Chapter 3) and the operationalization of the methodology into activities (in Chapter 4). We end the conceptual Chapter of the D3.2. by presenting key principles that scholars have pointed to be followed within co-creation and co-designing processes. These principles translate into facilitators of successful collaborative processes.

2.1.1 Strategic principles and ways of performing collaborative processes

In the present section, we revised on core principles and strategies/activities that were helpful in grounding the methodological framework for I-SEAMORE', and the proposed activities to be performed by the consortium.

In collaborative processes, great effort should be devoted to structuring collaboration, which is underlined in the assumption that end-users and stakeholders are experts in their own experiences and that is critical to bring in peoples' expertise, to ensure that the final solutions respond to end-users needs [5]. To that end, some principals are fundamental when undergoing a collaborative process such as recruiting diverse stakeholders that are valued as equals (regarding knowledge, experience and expertise;[12][13]).

It is necessary to acknowledge end-users and stakeholders' expertise because the process is anchored on their experience and needs, and collaborative processes must draw up their active role in creating value [15]. Therefore, also drawing upon UCD literature, a clearer conceptualization of users and user needs should involve more explicit articulation of user types and incorporation of user perspectives across intervention development phases [1]. Meaning that defining target end-users and their needs will lead to the identification and prioritization of problems to be solved, based on the perspectives of those whom the problems affect [14].

To address end-users needs a stage approach can be used. For instance, at an early level of the project to be cost-effective, involving only lead end-users in a formative information phase, through **exploratory interviews**. Although, this is a cost-effective method of mapping needs and potentially innovative solutions, this is limited in scalability [1]. **Observational field visits** can also be conducted, to observe the settings in which an innovation will be used to gather information about the everyday activities, environments, interactions, objects, and users in that setting [14]. Therefore, in following phases the use of **collaborative workshops** is a wide used and effective strategy to explore and identify solutions, prototyping and testing [5] [14]. However, there is the need to use creative techniques to make users' experiences available for discussion, namely by including the use of visual materials, storyboards, collages that depict their experience or understanding regarding problems and solutions that an innovation process will seek to address [14]. Less abstract and more "visible" elements should be created, during the co-design process, because it encourages a more focused engagement, discussion, and testing of hypotheses [10]. They allow people to experience a solution or situation that did not previously existed and facilitates the consideration of multiple, potentially overlapping, perspectives or solutions [15]. In similar stages to identify end-users needs, **focus groups** can be used about end-users/stakeholders' perspectives (which are more structured, less informal, and less flexible than collaborative workshops) that consist of structured, moderated group discussions that are designed to gather information about the preferences, experiences, and priorities [14].

When solutions have been identified, a more iterative and non-linear approach can be used (e.g., design thinking; [16]). For instances, it is important to undergo ranking and prioritization of solutions to be developed, according to different profiles of use (e.g., develop personas, scenarios or use cases) to be uptake in prototyping phases with prototypes that represents an innovation and use the prototype to quickly obtain feedback from potential users [14]. Engaging in cycles of rapid prototyping (the process of testing an idea as quickly and inexpensively as possible; [17]) ought to be done by building a simple prototype (e.g., illustration, mock-up, storyboard) that represents an innovation and use the prototype to quickly obtain feedback. Then engaging in iterative development, through the progressive refinement of an innovation through a cyclical that creates and tests solutions to address those problems and needs [14]. In these iterative phases, ideas and solutions are continually tested and evaluated with end-users/stakeholders, changes and adaptations are a natural part of the process, testing new possibilities and insights as they emerge [12][13].

Overall, along every stages openness and participation are highly prised in collaborative processes' literature because they foster the new knowledge to be produced through the shared goals and vision, by gathering different perspectives on the subject and on what to accomplish within the collaborative process, by finding common ground and collaboratively create a consensus on what to accomplish (end-goal) and how to do it (the process) [12][13].

To conclude, a collaborative process to the purposes of technological development benefits from a stage-approach (with more static phases and more non-linear ones), as presented in design thinking processes that consists of iterative non-linear processes that goes from understanding users need and problems, to solution identification, prototyping and testing [16]. For the I-SEAMORE project we aimed to navigate the often-scattered literature and channel its multidisciplinary knowledge into a customized methodological framework that is presented in the next chapter.

3 COLLABORATIVE FRAMEWORK FOR MARITIME SURVEILLANCE

This methodological framework ought to enable the integration of collaborative creation and design process to support the development of new technological solutions for maritime security needs. The collaborative initiatives will involve key entities on maritime surveillance, ultimately aiming to generate real impact for the end-users. Accordingly, the specific goals of the methodological framework are to:

(1) support the identification of end-users needs, in line with their concerns, their roles and functions in maritime surveillance;

(2) support the creation and design of technological solutions for maritime surveillance in a collaborative manner.

The framework outlined in the present document is similar to a design thinking approach, that is a 5-stage iterative and non-linear process (presented in more depth in Chapter 4 concerning the methodological toolbox). Thus, for the I-SEAMORE project we aimed to develop a specific methodological framework, that comprises the following 5 phases (Figure 1: Co-creation and co-design process proposed for i-seamore):

Phase 1: Mapping the end-users' needs, identifying challenges and resources regarding maritime surveillance operations.

Phase 2: Collaboratively identify technological solutions that meet the identified needs and elicit, while prioritizing their requirements.

Phase 3: Validation of the elicited requirements.

Phase 4: Technology development and adaptation of I-SEAMORE services and tools.

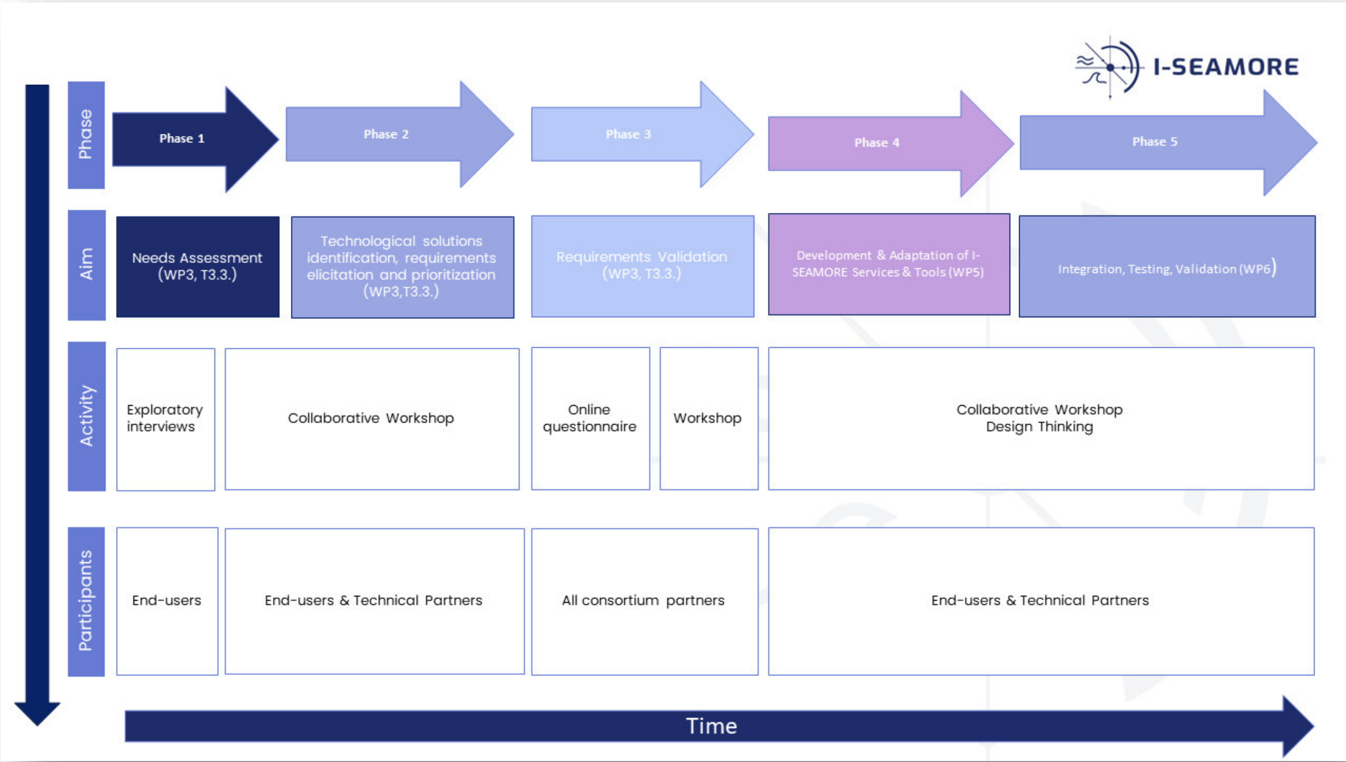
Phase 5: Integration, testing and validation of the technology developed.

This framework was already being implemented along T3.3 (Phases 1, 2 and 3 of the framework). The results of T3.3, that consists of phases 1, 2 and 3 of the proposed methodological framework, can be found in a dedicated report in APPENDIX A to D3.2.pdf (APPENDIX A).

Below we provide an overview of the methodology proposed within the development of the task 3.2, as well as describing the application to the I-SEAMORE consortium for the purposes of the project. Although phases 1, 2 and 3 were already implemented, providing their results is outside of the scope of the present deliverable.

Furthermore, in Figure 1: Co-creation and co-design process proposed for i-seamore, for each phase it is presented its aim, the proposed activities to operationalize such aim and whom should be involved.

FIGURE 1: CO-CREATION AND CO-DESIGN PROCESS PROPOSED FOR I-SEAMORE



3.1 Phase 1 – needs assessment

Phase 1 pertains to the initial phase of T3.3 [M1 to M4, led by INOV], and its aim is to map the **end-users' needs, challenges, and resources** regarding maritime surveillance. This phase should entangle two types of activities: (1) **exploratory semi-structured interviews** with each end-user involved in the project, and then in an (2) **in-person collaborative workshop** with the involvement of end-users and technical partners. The choosing of these activities is framed in section 2.1.1 of the deliverable. In chapter 4, these activities are described aiming at the illustration of its implementation in T3.3.

3.2 Phase 2 – technological solutions identification, requirements elicitation and prioritization

Phase 2 is also part of T3.3 [M3 to M5, led by INOV]. The aim of phase 2 is twofold: (1) **collaboratively identify technological solutions that meet the previously identified needs in phase 1**; and (2) **elicit and prioritize** (based on their importance and urgency) **the requirements of the identified technological solutions** to be taken up in the I-SEAMORE Ecosystem. This phase is also able to assist T3.3 in the **Elicitation of User Requirements & KPIs**, through the involvement of end-users and technical partners in the **in-person collaborative workshop** (held in Lisbon on 31st March 2023, which results can be found in APPENDIX A). After considering the user solution needs, the subsequent stage aimed at defining end-users' requirements. This involved breaking down the needs into precise requirements that could be effectively tackled through a technological solution. The requirements were formulated to adhere to the *SMART* criteria, ensuring they were specific, measurable, achievable, relevant, and time bound.

Once the requirements have been identified, they should be prioritized based on their importance and impact on end-users. This can be done simply by going through the list of requirements and the participants in the collaborative workshop discuss, looking for a consensus on *high*, *medium,* or *low* priority (see Appendix A).

3.3 Phase 3 – requirements validation

Phase 3 [T3.3, led by INOV, M5 to M6] aiming at the **Definition of Use Cases, Design of Operational Concepts and Elicitation of User Requirements & KPIs** with end-users and technical partners, through an **online questionnaire** followed by an **online workshop** to conclude the requirement validation phase with all consortium partners.

3.4 Phase 4 – development and adaptation of I-SEAMORE services and tools

The aim of phase 4 is to assist the accomplishment of tasks T5.1 [M7-M15, led by TS], T5.2 [M7-M18, led by TNO] and T5.3 [M8-M23, led by ATOS] (WP5, M7 to M23, led by ATOS) – to **develop and adapt I-SEAMORE services and tool**. Through T5.1, T5.2 and T5.3 the consortium should schedule 3 to 4 **collaborative workshops** with end-users, technical partners, and research team to go through all the necessary steps to accomplish the WP objectives and activities, adopting a **design think methodology**, from M7 to M23 (July 2023 – November 2024). Phase 4 should be organised according to the objectives of WP5, as described in the Grant Agreement (pp84):

> *WP5 aims at delivering all software-based components and modules to be used during integration and test activities (WP6) as well as in the final demonstrations (WP7). Therefore, it has the following objectives: 1) to develop the I- SEAMORE Interoperability layer and to define the data model to be adopted within the proposed Ecosystem; 2) to setup the I-SEAMORE Orchestration Platform; deploying and testing applications 3) to develop and/or adapt the set of I- SEAMORE tools and services (C4I, UxVs Mission Planner, Visual Analytics and M&S Tools, and Debrief Module); and 4) to develop and enhance the capabilities of I-SEAMORE data fusion modules (L0 to L3 for multiple types of data).*

Within the present phase it is suggested the collaboration between Tasks 5.1, 5.2 and 5.3 in organising the collaborative workshops (with end-users and technical partners) to foster the usefulness of the technological solutions and the project efficiency. Indeed, each of these tasks will be more effective if prepared jointly, whenever concerning its collaborative nature by bringing together end-users and technical partners. Design thinking activities should be organised according to the phases of project execution, namely:

Task 5.1 [M7-M15] lead by TS: aims to develop I-SEAMORE interoperability layer.

Task 5.2 [M7-M18] lead by TNO: aims to ensure the full operability of I-SEAMORE Orchestration Platform by deploying preliminary demos to test the interoperability mechanisms.

Task 5.3, and its sub-tasks [M8-M23] led by ATOS: will aim to develop and adapt I-SEAMORE services and tools.

3.5 Phase 5 – integration, testing and validation

This last phase, aiming at the integration, testing and validation is suitable to assist the execution of WP6 [M12-M28 led by TNO], through tasks 6.1 to 6.5, according to the Description of Action, WP6 aims at (Pp. 86, Grant Agreement):

> *WP6 includes all the integration, testing and validation activities foreseen for the I-SEAMORE Ecosystem and its components. Thus, WP6 main objectives are:1) integrating the different components of I-SEAMORE and to test and verify the system, and therefore provide WP7 with a qualified Ecosystem; 2) end-users to perform a validation of all development work and respective functional results; 3) to host integration, testing and preliminary deployment of the complete I-SEAMORE Ecosystem at MPT's OEC; and 4) the technical verification and validation of the developed components taking into account the requirements and KPIs defined in WP2.*

Given the requirement for WP6 to integrate components, conduct testing, verifications, and validation with end-users, it would be advantageous to arrange **collaborative workshops** that focus on a "test" phase within a **design thinking** approach. To this end, the interdependence between Tasks 6.1, 6.2, 6.3, 6.4 and 6.5 (along with T2.4/WP2 and T3.3/WP3) is described as follows (Pp. 86, Grant Agreement):

> *(…) four main cycles are expected (M12-13, M17-18, M22-23 and M27-28) – the two initial ones will be targeting the preliminary testing of functionalities from standalone components as well as some aspects of the developed interoperability layer (WP4, WP5) – this will allow to timely identify any potential capability gaps or interoperability errors; the latter two, will be focused on testing the integration results (T6.2, T6.3) and the preliminary deployment of the Ecosystem (T6.4). Alongside the testing activities, the end- user entities will perform two cycles of validation activities (at M18 and M28), making use of the monitoring and evaluation framework from T2.4, to ensure that all components are ready to move to the final demonstrations (WP7) and meet the requirements and KPIs initially established and updated within T3.3.*

Therefore, the collaborative methodological framework suggests the incorporation of the iterative testing phase of the design thinking approach, which will be elaborated upon in the subsequent chapter.

4 METHODOLOGICAL TOOLBOX FOR IMPLEMENTING A CO-CRATION AND CO-DESIGN PROCESS

The final goal of T3.2 is to foster the capacity, within the consortium, to adopt a collaborative process during the project. Thus, this chapter aims to provide an array of methods that can be used within the aims of a collaborative creation and design process for I-SEAMORE.

4.1 Exploratory interviews

During phase 1 of the framework, the objective was to map and identity the end-users' needs regarding their responsibilities for maritime surveillance exploration. To accomplish this, semi-structured interviews were conducted. Participants were all from partner organizations of the project. The data was gathered through online interviews, with the participants providing their verbal consent. Two interviewers were involved in the process: one researcher asked the questions while the other ensured adherence to the interview script. The information collected during these interviews underwent a thematic analysis to identify response patterns, that aligned with the predetermined objectives of the interview.

The interview' script was organized into 4 goals:

(1) Identify overall procedures, namely regarding safety/security, systems used.

Questions: *Can you share with us your experience regarding maritime surveillance? Which data do you get and how? Do you use any devices, like drones to assist you? How it is like when visibility is low, like when there is fog?*

(2) Identify needs and challenges.

Questions: *Can you elaborate on which kind of needs you have been experiencing regarding maritime surveillance and which kind of challenges have you been facing? Which kind of data do you think you need?; Regarding visual analytics tasks, which are the needs that need to be met by technology?; Regarding drones operation, what needs to be improved? Regarding data collection and analysis?*

(3) Identify resources and capabilities provided by I-SEAMORE Ecosystem.

Questions: *Which kind of resources and capabilities would be able to assist you in facing the previous identified needs and challenges? Would it be useful to have the possibility to plan a drone flight when you get an alert?; Regarding simulation models, which solutions are important to consider?*

(4) Use-cases needs and challenges.

Questions: *Regarding smuggling of drugs*: *please elaborate on challenges and resources needed.; regarding Irregular migration*: *please elaborate on challenges and resources needed.*

4.2 Collaborative workshop

A collaborative workshop is a potent tool to achieve consensus, foster engagement, and driving innovation in a short period of time [18]. By bringing together stakeholders, including end-users and technological partners, from diverse backgrounds and perspectives, it enables effective communication, enhanced collaboration, and problem-solving.

Thus, the methodological framework proposes the implementation of collaborative workshops for Phase 1 - Needs and assessment and Phase 2 - Technological solutions Identification, requirements elicitation and prioritization 2. For Phase 4 - Development and adaptation of I-SEAMORE services and tools and Phase 5 -

Integration, testing and validation, partners can also organise collaborative workshops to perform design-thinking activities, that will be expanded in the subsequent section.

As mentioned in the section **Strategic principles and ways of performing collaborative processes,** in a collaborative workshop, participants are considered experts in their own experiences, which they bring to the 'table'. When organizing a collaborative workshop, it is important to:

To ensure a successful collaborative workshop, it is crucial to:

- Foster a safe and enthusiastic atmosphere that encourages fruitful outcomes from the activities.
- Encourage active participation, where participants are motivated to engage in discussions, share their ideas and perspectives, and collaborate in developing solutions that address the needs of all stakeholders.

Within this framework, the collaborative workshop designed for phase 1 (needs assessment) and phase 2 (solutions identification and requirements elicitation) incorporated brainstorming sessions, group discussions, breakout sessions, and interactive exercises. For phase 1 and 2 participants are end-users and technical partners: AEAT, PUD, ATOS, Vortex, TS, CS Group, RBP, MPT, U BF and TNL. More details can be found in APPENDIX A. However, several ideation tools can be utilised such as Brainstorming (see [19]), Brainwriting (see [20]), or rapid prototyping (see [17]) depending on the goals to be accomplished.

Below, we provide additional tools and strategies to be used for phase 1 and 2 collaborative workshops. Regarding collaborative workshops for phase 4 and 5 (since they are underpinned in a design thinking approach) they are described in the subsequent section.

4.2.1 Needs assessment

When conducting a collaborative workshop to identify the specific needs, challenges, and resources of end-users regarding maritime surveillance, the participants can be divided into two sub-groups. The division of the groups should ensure a certain level of heterogeneity by including a mix of end-users and technical partners. An example of instructions for this phase is provided in Figure 2. For the needs assessment groups activity participants are given A4 paper sheets and pens and asked to work alone for 10 minutes to identify (1) needs; (2) challenges; (3) resources for maritime surveillance – using their experience. Afterwards, participants work together to compile, organize and map (1) needs; (2) challenges; (3) resources for maritime surveillance (Figure 3). For this last step, participants are instructed to be 'as visual as possible' and to prepare to present their conclusions in a plenary session with all participants (Figure 4). During the conclusion of the presentation phase, the participants should actively engage by posing questions and contributing to the discussion, thus enhancing its depth and breadth. The research team's moderators should motivate the discussion by inquiring, seek clarifications, and stimulate the conversation. Ultimately, this would play a crucial role in the collaborative process of identifying the needs to be addressed in subsequent stages, such as solution identification, prioritization, and requirement elicitation.

FIGURE 2: INSTRUCTIONS FOR THE NEEDS ASSESSMENT PHASE

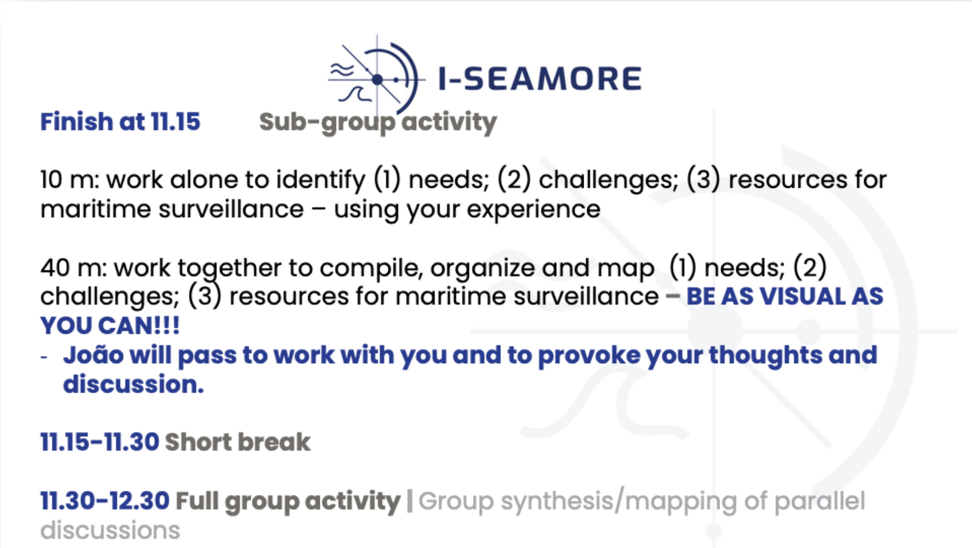
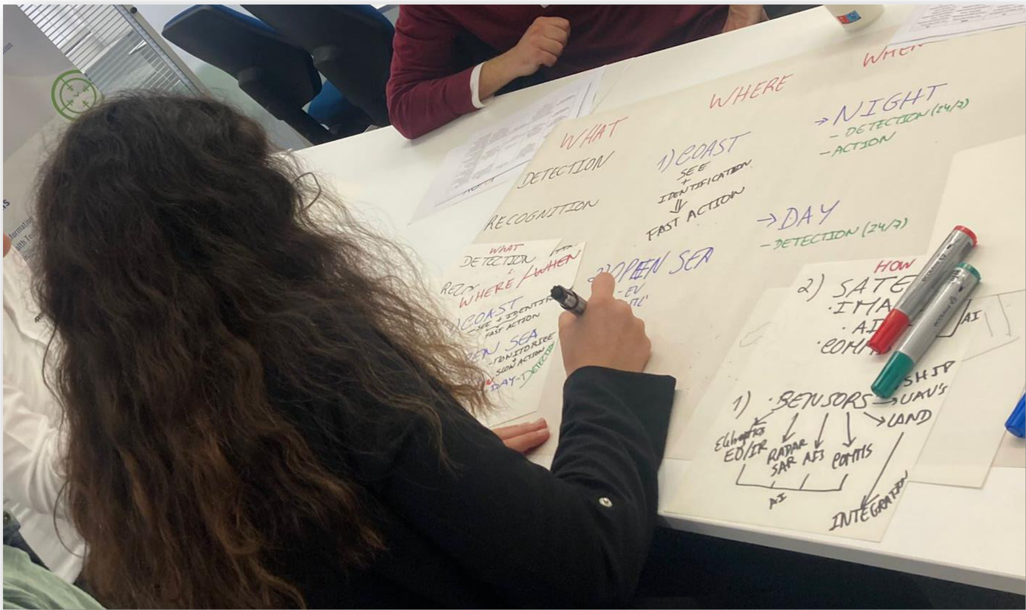


FIGURE 3: CAPTION OF GROUP ACTIVITY DURING NEEDS ASSESSMENT PHASE



4.2.2 Identifying solutions and elicit requirements

Building upon the previously identified needs, a similar activity can be conducted to engage end-users and technical partners in collaboratively identifying and prioritizing solutions.

First, participants were divided into two sub-groups. The division of the groups should ensure a certain level of heterogeneity by including a mix of end-users and technical partners. They then collaborated to:

- Brainstorm technological solutions for maritime surveillance.
- Align those solutions with the previously identified needs.
- Specify requirements for the solutions.
- Identify priorities among the proposed solutions.

Participants were encouraged to adopt a visual approach and to prepare to present their conclusions during a plenary session involving all participants. The involvement of technological partners played a significant role throughout the process.

These activities aimed to capture key points and ideas from each discussion, to organize and categorize them, and to identify patterns and connections. The synthesis of these discussions helped to generate a comprehensive understanding of collective insights, perspectives, and ideas. This process facilitated the identification of areas of consensus, as well as areas of divergence or disagreement, informing decision-making, problem-solving, and action planning. Special attention was given to the specification of requirements (within the scope of D3.3) and the identification of priorities. Multiple moderators were present to stimulate discussions and assist the sub-groups in deepening their conversations.

The data collection to assess needs yielded the identification of common themes, patterns, and areas of concern. These findings played a crucial role in determining the key issues that require attention within the I-SEAMORE Ecosystem. Written notes and relevant materials were collected during the session to accurately capture the outcomes of the workshop. Based on this information, a comprehensive summary report was developed, outlining the workshop's key findings, recommendations, and action items (APPENDIX A to D3.2.pdf). Notably, no recording was conducted to ensure confidentiality, and no materials were stored in online formats.

By conducting a qualitative analysis of the discussions and written materials, generated during the collaborative workshop, a systematic approach was taken to present the identified solutions that align with the needs and challenges. The group discussions culminated in a visual representation of the identified needs and solutions, as illustrated in 'Figure 3: Caption of group activity during needs assessment phase'

FIGURE 4: INSTRUCTIONS FOR THE SOLUTION IDENTIFICATION AND REQUIREMENTS ELICITATION PHASE

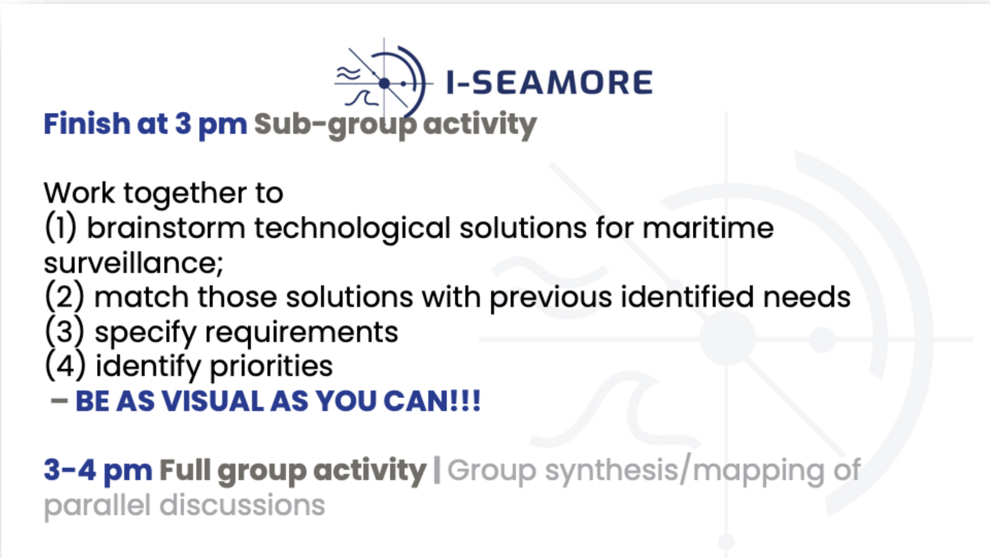
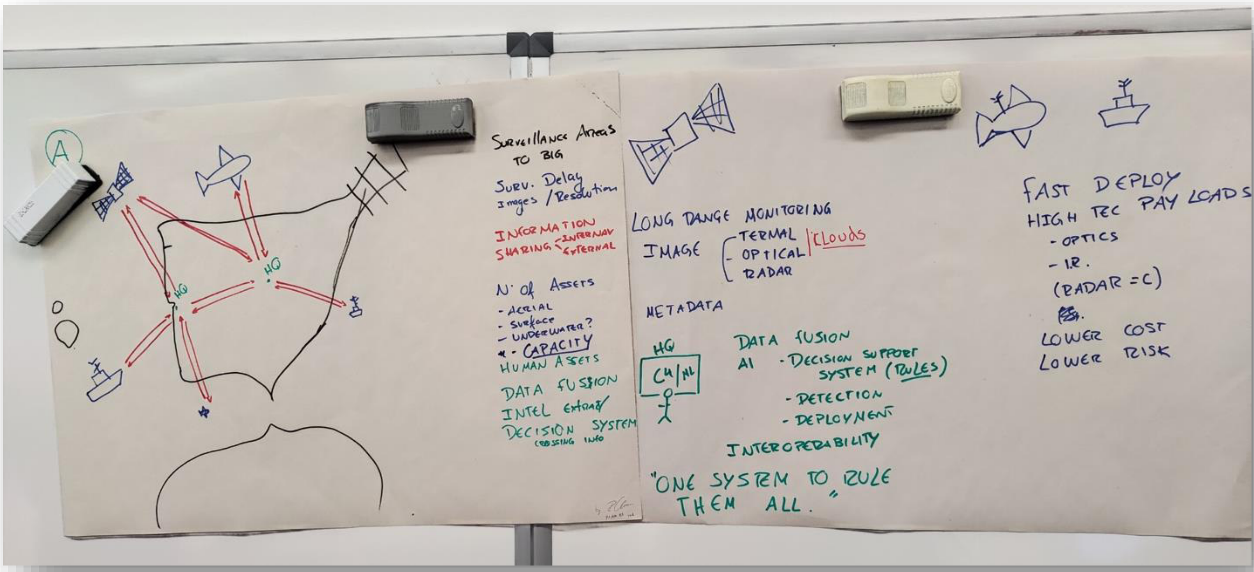


FIGURE 5: VISUAL REPRESENTATION OF THE GROUPS DISCUSSIONS



4.3 Design thinking

The proposed methodological framework suggests the implementation of design thinking activities during phases 4 and 5 to achieve the following objectives:

- Phase 4: Development and adaptation of I-SEAMORE services and tools.
- Phase 5: Integration, testing, and validation.

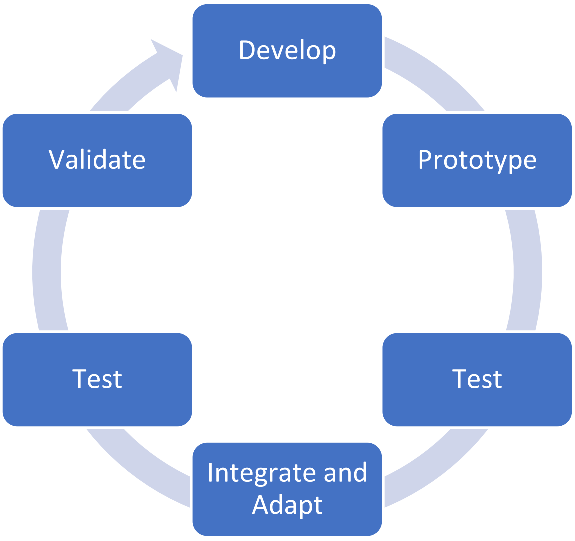
Design thinking methodologies enhance team performance during the development phase of technological innovation processes. They prioritize a human-centered approach, interactive collaboration, and active participation [21]. Typically articulated as a multistep, iterative process involving initial exploration and articulation of user needs, development of prototypes, and revision of designs in response to data collection, with each iteration resulting in a new, more usable, and often innovative solution [1].

Therefore, incorporating design thinking into phases 4 and 5 of the framework aligns perfectly with the collaborative spirit of the I-SEAMORE project.

By utilizing a design thinking approach in phases 4 and 5, it is assumed that the process of gathering information on needs and requirements has already been accomplished during phases 1 to 3. Consequently, partners should focus on prototyping, testing with end-users, gathering their feedback, and making appropriate adjustments to the technology. This iterative process can be facilitated through collaborative workshop sessions, as described earlier.

As showed in 'Figure 6: Visual representation of design thinking approach to phases 4 and 5 of the framework' in phase 4 and 5 activities will be related to develop, prototype, test, integrate and adapt feedback to test again and validate improvements. Prototyping, and rapid iterations based on evaluation of each successive prototype, that can be done during collaborative workshops, is a way of collecting data and feedback at all stages of the development cycle [22]. It is especially helpful to mock up important interactions that will be crucial to success or workflow ease [1]. Prototyping is iterative and involves the sequence of developing a prototype, reviewing that prototype with users, and then refining it based on their feedback.

FIGURE 6: VISUAL REPRESENTATION OF DESIGN THINKING APPROACH TO PHASES 4 AND 5 OF THE FRAMEWORK



5 CONCLUSIONS

The present deliverable (D3.2.) aimed to present a methodological framework for collaborative processes to co-design and co-create technological solutions for maritime surveillance. Indeed, D3.2 is the output of Task 3.2. **Setup of Co-Design & Co-Creation Processes from Technological & Societal Perspectives** [M1-M6; Lead: INOV and Partners: Atos, ISIG, PUD, TS and VTX]. The methodology proposed shall ensure that end-users needs are to be met, due to its human-centric potential by having outlined a framework that is user/human centered, along 5 phases:

- Phase 1: Mapping the end-users' needs, identifying challenges and resources regarding maritime surveillance operations.
- Phase 2: Collaboratively identify technological solutions that meet the identified needs and elicit, while prioritizing their requirements.
- Phase3: Validation of the elicited requirements.
- Phase 4: Technology development and adaptation of I-SEAMORE services and tools.
- Phase 5: Integration, testing and validation of the technology developed.

The outlined framework benefited from the collaboration between T3.2 and T3.3, specifically in preparing and conducting the exploratory interviews and the collaborative workshop, which allowed an implementation of the initial phases of the framework. The exercise of bringing together different tasks within the consortium showed itself to be a positive opportunity that increased its efficiency and cost-effectiveness in accomplishing tasks' goals. This benefit was verified in the effective collaboration process between end-users and technical partners during the definitions of technological requirements. In this, it was extremely efficient doing an in-person collaborative workshop (as performed in T3.3). This allowed us to overcome barriers regarding different representations/perceptions of the daily experience of maritime surveillance. This cooperation should be generalized in other stages of the project, as suggested in the methodological framework.

The cooperation between these two tasks was also beneficial because it allowed the framework to be designed within a multidisciplinary team, from social sciences to technological sciences. The collaboration between team members/partners from different disciplines, was challenging regarding the need to share representations about maritime surveillance. However, this multidisciplinary collaboration enhanced flexibility and adaptability inside the consortium to analyze the maritime surveillance experience form different perspectives.

Below we provide a brief prescription regarding the implementation and generalization of the framework as a working plan, that should be flexible enough to account to changes in the project.

5.1 Implementing the plan and future steps

This framework will assist the development of new solutions for maritime security with real impact for the end-users. To guarantee such impact, the conduction of collaborative activities along the plan should always strive for a clear and structure of collaboration [5], namely:

- What to accomplish (aims and outputs).
- How to do it (the process and activities).

- Who will be involved (entity/person role) and limits for each stakeholder.

Also, recruitment of participants should account for diversity, regarding knowledge, experience, and expertise [12][13]. A great deal of effort must be put in understanding and mapping end-users needs [14], because they are the base onto to develop the technology.

To guarantee the uptake of the frameworks and its adaptability to each task of the project, the consortium should promote training and consultancy to task leaders and partners.

Furthermore, future steps could lead to the conduction of usability tests, with end-users interacting with an innovation (or multiple versions of the innovation) to examine how they perform specific tasks with the innovation, while collecting data on usability and desirability from the user.

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APPENDIX A

The results of T3.3., that consists of phases 1, 2 and 3 of the proposed methodological framework are included in D3.2 as Appendix A - Report on collaborative workshop at INOV

I-SEAMORE

Report on Collaborative Workshop at Inov

(31.03.2023)

WP.3 - I-SEAMORE CO-CREATION & CO-DESIGN PHASES

Integrated surveillance ecosystem for European Authorities responsible for Maritime Operations leveraged by reliable and enhanced aerial support.

Co-funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under the Grant Agreement 101073911.

Table of Contents

Co-funded by the European Union

1. INTRODUCTION

The present document aims to report the procedures, outputs, and outcomes of the face-to-face collaborative workshop held in Lisbon (31.03.2023) with the projects' end-users and technological partners, under Tasks 3.2 & 3.3, aiming at:

- Mapping the end-users' needs, challenges, and resources regarding maritime surveillance;
- Collaboratively identify and/or create solutions/requirements to be taken up in the I-Seamore Ecosystem;
- Prioritize the identified needs and challenges based on their importance and urgency.

This workshop and its' aims are part of the co-creation and co-design process that will be reported in D3.2. (Plan for Co-Design and Co-Creation Processes Implementation) – see Figure 1.

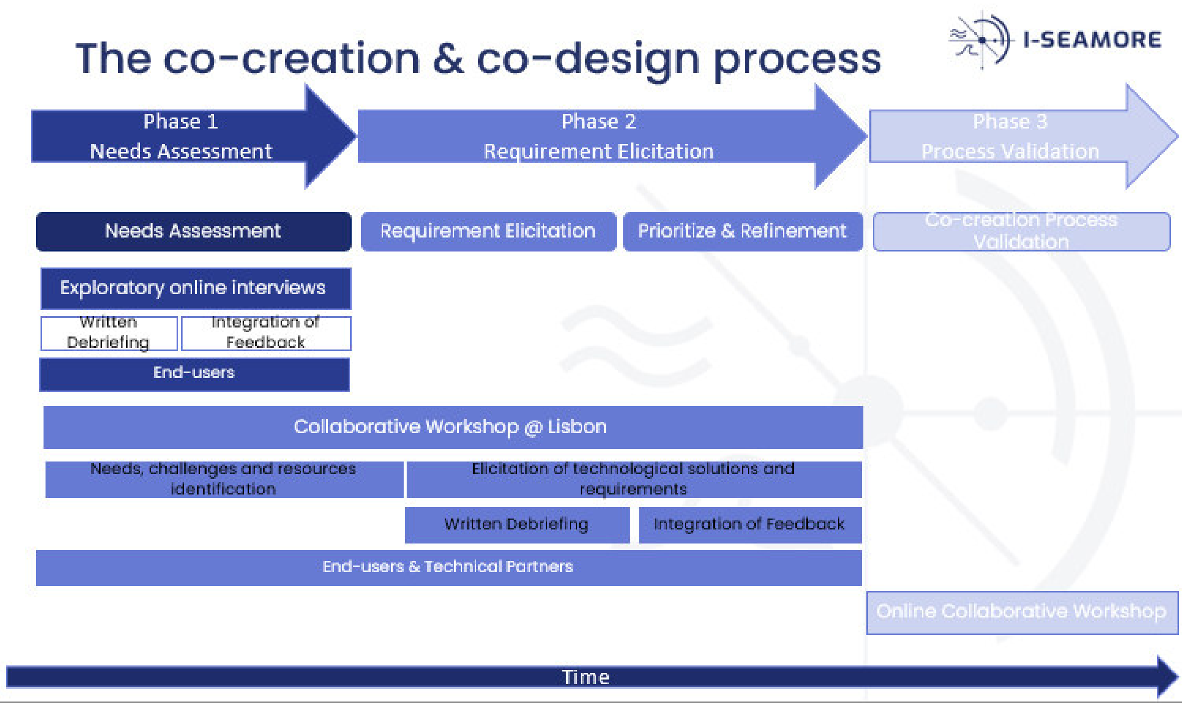

Figure 1. Outline of the co-creation and co-design process for maritime surveillance

The present report is organized into four main sections:

Section 1: the procedures involved in the conceptualization and operationalization, of the collaborative workshop are reported.

Section 2: identification of end-users' needs in their Maritime surveillance activity.

Section 3: technological solutions for maritime are presented as the results of the work done by INOV team from the data collected in the collaborative workshop.

Section 4: requisites are presented, which are a consequence of a refinement made by INOV team from the previous technological solutions identified. End-users also defined requisites priorities.

Finally, some elements are presented as appendix at the end of the document.

2. COLLABORATIVE WORKSHOP: A PROCESS TO IDENTIFY NEEDS FOR MARITIME SURVEILLANCE.

This section includes the description of the procedures involved in preparing and conducting the collaborative workshop and its results regarding needs and solutions for maritime surveillance.

Collaborative workshop is a powerful tool for achieving a variety of goals, including building consensus, promoting engagement, and fostering innovation. Bringing together stakeholders (end-users and technological partners) from different backgrounds and perspectives in this workshop allowed for better communication, enhanced collaboration, and problem-solving.

The major achievements of the workshop include:

Building consensus: We provided a forum for discussion and debate, where stakeholders reached a shared understanding of the problem and potential solutions.

Promoting engagement: By involving stakeholders in the problem-solving process, the workshop helped build buy-in and commitment to the proposed solution.

Fostering innovation: By bringing together stakeholders with diverse backgrounds and perspectives, the workshop allowed creative thinking and new ideas to emerge.

Encouraging learning: The workshop allowed stakeholders to learn from each other. By sharing their knowledge and experiences, stakeholders better understood the problem and potential solutions.

Overall, this collaborative workshop was a valuable tool for achieving a variety of goals related to problem-solving, decision-making, and innovation.

2.1 METHODOLOGY

The above-mentioned aims were sought through a collaborative workshop, consisting of a group meeting with end-users and technical project partners in which activities were developed with the aim of analyzing problems, debating ideas, generating solutions, making decisions and/or creating plans. These activities consisted of (sub)group discussions, resulting in visual synthesis of the discussions held. Data was collected through written notes and material resulting from the discussions carried out.

2.2 WHY A COLLABORATIVE WORKSHOP IS A USEFUL METHODOLOGY?

In a collaborative workshop, participants are considered experts in their own experiences, which they bring to the 'table'. It is important to create a safe and enthusiastic atmosphere so that the activities lead to fruitful results. Participants were encouraged to actively engage in discussions, share their ideas and perspectives, and work together to develop solutions that meet the needs of all stakeholders. The workshop used a variety of activities, such as brainstorming sessions, group discussions, breakout sessions, and interactive exercises. This process was done by capturing the key points and ideas from each discussion, organizing and categorizing them, and identifying patterns and connections between them. The process was performed to synthesize and map out the discussions. The goal of group synthesis/mapping was to generate a comprehensive understanding of the collective insights, perspectives, and ideas that emerge from the group discussions. This can help identify areas of consensus, as well as areas of divergence or disagreement, and can inform decision-making, problem-solving, and action planning. Special emphasis was dedicated to the specification of requirements and the identification of priorities. Also, several moderators were present aiming to instigate the discussions, helping the (sub)group to deepen the discussion.

2.3 HOW WERE NEEDS ASSESSED?

A comprehensive needs assessment was conducted to identify the specific needs, challenges, and resources of end-users regarding maritime surveillance. First, participants were divided into two sub-groups (Appendix A). For both groups, the research team aimed to achieve a certain heterogeneity between end-users and technical partners. Then, participants were given A4 paper sheets and pens (Figure 2) and were asked to work alone for 10 minutes alone to identify (1) needs; (2) challenges; (3) resources for maritime surveillance – using their experience. Afterwards, participants work together to compile, organize and map (1) needs; (2) challenges; (3) resources for maritime surveillance (Figure 3). For this last step, participants were instructed to be 'as visual as possible' and to prepare to present their conclusions in a plenary session with all participants (Figure 4). At the end of the presentation period, participants ask questions and enrich the discussion. Also, moderators from the research team were present making questions, searching for clarifications and instigating the discussion which was also an important part of the collaborative process of identifying needs to be met in the following steps – solution identification, prioritization and requirement elicitation.

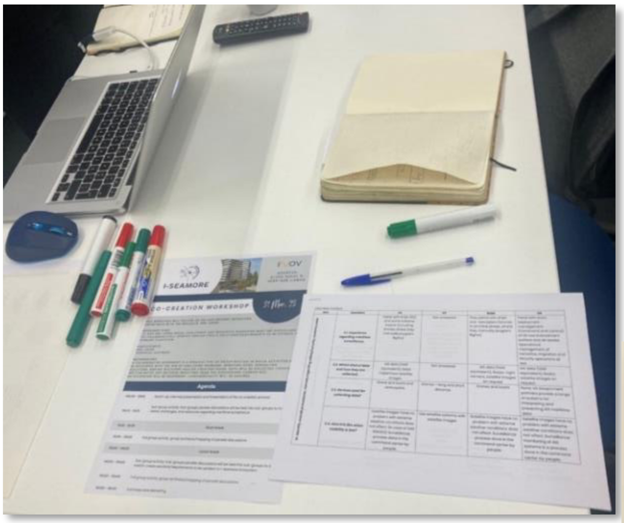

Figure 2. List of material provided for each participant.

Figure 3. Sub-group activity

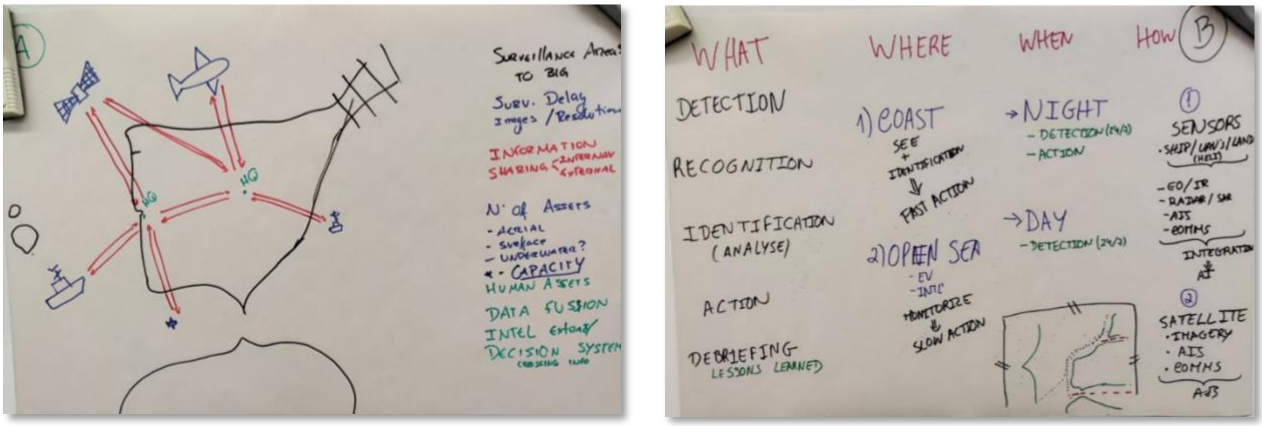

Figure 4. Visual outputs of sub-group discussion

2.4 HOW WERE SOLUTIONS IDENTIFIED?

Drawing upon the previously identified needs, end-users and technical partners were engaged in a similar activity as previously described for needs assessment, to identify solutions to be prioritized collaboratively.

First, participants were divided into two sub-groups (Appendix A). Then, participants work together to (1) brainstorm technological solutions for maritime surveillance; (2) match those solutions with previous identified needs (3) specify requirements and (4) identify priorities. Once again, participants had to be 'as visual as possible' and prepare to present their conclusions in a plenary session with all participants (Figures 5 and 6). In this process, technological partners played an important role.

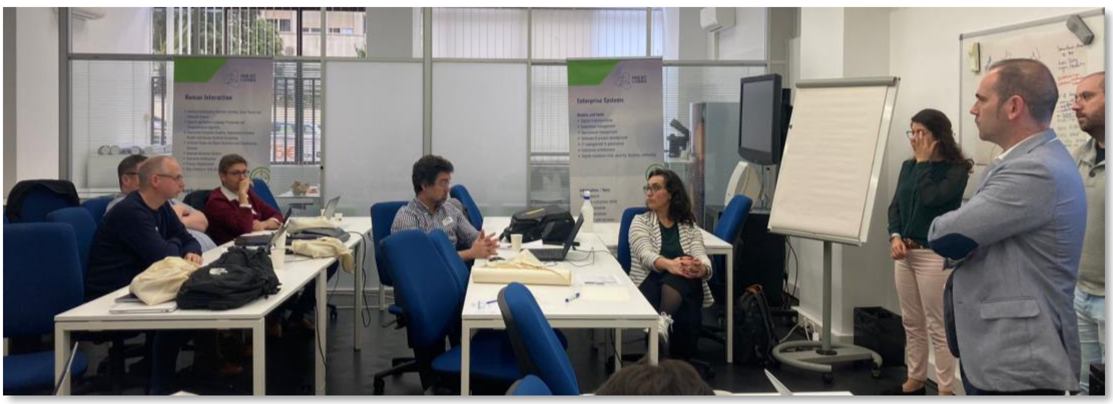

Figure 5. Results presentation and discussion in plenary.

Figure 6. Plenary discussion

2.5 DATA

Data collected from the needs assessment led to identifying common themes, patterns, and areas of concern. This helps to identify key issues that need to be addressed in the I-Seamore Ecosystem. Done in this report and it is material to D3.3. Written notes and other materials were collected during the session to ensure that the workshop outcomes were accurately captured. This information was used to develop a summary report outlining the key findings, recommendations, and action items from the workshop. No recording was performed. Confidentiality was ensured; no materials were stored in online formats, and written outputs will be part of D3.2, and D3.3.

3. RESULTS: SOLUTIONS IDENTIFIED

Through a qualitative analysis of the discussions and written materials produced during the collaborative workshop, we present a systematization of the solutions identified that match the needs and challenges outlined above. The group discussions led to a visual presentation of the solutions (Figures 7 and 8). This section aims to identify patterns, themes, and meanings that emerge from the data and information collected in the workshop. Accordingly, after identifying needs and challenges regarding maritime surveillance, user requirements can be specified to match the needs and preferences of end-users. The work done during the workshop was important to make user requirements specific, measurable, and achievable. After the process of solutions identification and the step of specifying the technological requisites, the team prioritized the user requirements based on their importance and feasibility. This will help the research team to determine which requirements to focus on first.

In the afternoon session, the solutions identified are presented as key points and developed. They (end-users) identify that the surveillance area is too big. The process could involve different entities based on the distance to coast. Considering the diversity of topics, we organize them in the following topics identified in sections 3.1 to 3.6. This organization was performed based on partners' outputs and INOV analysis.

3.1 MARITIME SURVEILLANCE – WHAT, WHEN, WHERE, HOW

An excellent dynamic between end-users and technical partners was established. Technical partners had the possibility to show the potential of their technology in drones, satellites, data integration, sensors, and end-users identified their problems in the maritime surveillance process.

Maritime surveillance is the process of monitoring and observing activities on the seas, oceans, and other bodies of water. This is an important task to ensure the safety and security of maritime transportation and prevent illegal activities such as piracy, smuggling, and human trafficking. The general process description of how a maritime surveillance is based on:

- Planning: Before any surveillance operation begins, a team of experts develop a plan based on the specific objectives and requirements of the mission. This plan includes the type of equipment to be used, the area to be covered, and the duration of the operation.
- Gathering Information: The next step is to gather information about the area to be monitored, including its geography, weather conditions, and potential risks. This information helps determine the best way to approach the mission and ensure the safety of the surveillance team.
- Equipment Preparation: Once the plan is in place and information has been gathered, the team begin to prepare their equipment. This may include radar systems, cameras, drones, or other technology necessary to complete the mission.
- Deployment: The surveillance team then deploys to the designated area and begins monitoring activities on the water. This may involve staying on a boat, operating a drone, or using other means to observe and collect data.
- Data Analysis: As the surveillance mission progresses, the team collects data and analyzes it to identify any potential threats or risks. This analysis helps guide the team's actions and ensure they are able to respond quickly to any incidents that may arise.
- Reporting: Once the mission is complete, the team compiles a report detailing their findings and actions. This report will inform decision-makers and ensure appropriate measures are taken to maintain safety and security on the water.

First, all the end-users described their jobs (**what**): detection, recognition, identification (analysis process), action, and debriefing. These elements are used to identify and assess potential threats or risks on the water. Here is a brief description of each:

- Detection: This is the process of detecting the presence of an object or activity on the water. This involves the use of radar systems, cameras, or other technology to detect objects or movements in the water.
- Recognition: Once an object or activity has been detected, the next step is to recognize what it is. This may involve using visual or other cues to identify whether the object is a vessel, a person, or something else.
- Identification: Finally, once an object has been recognized, the goal is to identify what it is and determine whether it poses a threat or risk. This involves using additional information or technology to identify the vessel or activity and determine its intentions.
- The action and debriefing stages come after the analysis process and involve taking appropriate actions and evaluating the mission's success.
- Action: Once potential threats or risks have been identified, the surveillance team may take action to address them. This involves contacting law enforcement or other authorities, initiating a search and rescue operation, or taking other measures to ensure the safety and security of the water.
- Debriefing: Finally, after the mission is complete, the team conducts a debriefing to evaluate the operation's success and identify improvement areas. This may involve analyzing the data collected during the mission, reviewing the team's actions and decisions, and identifying opportunities for future training or development.

Where - Maritime surveillance can take place in various locations, depending on the specific goals and objectives of the mission. Here are two examples of where maritime surveillance may be conducted:

- Near the coast: One common location for maritime surveillance is near the coast, where the goal may be to quickly identify and intercept potential threats or risks. This could include identifying and tracking vessels that may be involved in smuggling, piracy, or other illegal activities. In these situations, the surveillance team may need to take fast and decisive action to prevent or address these threats, working closely with local authorities and law enforcement as needed.

- Open sea: Another location where maritime surveillance may be conducted is in the open sea, where the goal may be to monitor and track vessels over a longer period of time. For example, in the case of illegal migration or drug smuggling, surveillance teams may need to track vessels as they move across the water, identifying patterns or changes in behavior that may indicate the presence of a threat. This may involve the use of advanced tracking technologies and careful analysis and coordination between different agencies and organizations involved in the mission.

When. Maritime surveillance may be conducted at any time, depending on the specific goals and objectives of the mission. Here are two examples of when maritime surveillance may be necessary:

- Nighttime surveillance: In some cases, maritime surveillance may need to be conducted at night, particularly when there is a need for detection and action. For example, piracy and smuggling operations often occur under the cover of darkness, and surveillance teams may need to monitor the waterways 24/7 to detect and respond to potential threats. This may involve the use of advanced detection technologies, such as night vision cameras or radar systems, as well as highly trained personnel who can identify and respond to potential threats quickly and effectively.
- Continuous surveillance: In other cases, maritime surveillance may need to be conducted continuously, 24/7/7 days a week. This may be necessary when monitoring ongoing activities such as illegal fishing, migration, or drug trafficking. Continuous surveillance may involve a combination of remote

monitoring technologies and on-site personnel, who can monitor and respond to potential threats as they arise.

How. The methods used for maritime surveillance will depend on the specific goals and objectives of the mission, as well as the available resources and technologies. Here are two examples of how maritime surveillance may be conducted:

- **Near the coast**: In this scenario, maritime surveillance involves the use of various sensors, including EO/IR (electro-optical/infrared), radar, SAR (synthetic aperture radar), AIS (automatic identification system), and COMMS (communications). By integrating data from these sensors, surveillance teams can obtain a more comprehensive view of the waterways, identifying potential threats and risks quickly and accurately. For example, radar and AIS can be used to detect and track vessels, while EO/IR and SAR can provide additional data on the size and type of vessel and any activities taking place on board. COMMS can also be used to communicate with other vessels or authorities in real-time, coordinating responses to potential threats as they arise.
- **Open sea**: In this scenario, maritime surveillance involves using satellite images, AIS, COMMS, and AFS (automated fishing vessel systems). By analyzing satellite images, surveillance teams can detect and track vessels over large areas, identifying potential threats and risks from a distance. AIS and COMMS can be used to communicate with vessels and authorities in real-time, coordinating responses to potential threats or emergencies. AFS can also be used to monitor fishing activity and detect potential illegal fishing operations.

By establishing a clear understanding of the requirements and capabilities, technical partners and end-users worked together to create/design an effective maritime surveillance system that meets the needs of all stakeholders.

Figure 7, and 8, show the output of group activity work towards end-users' identification of solutions that match their needs. These solutions were based on afternoon activity, where technological partners guide end-users identified problems (morning activity) to these identified solutions, which were represented visually in Figures 7 and 8. This was the basis for INOV team to identify project requisites.

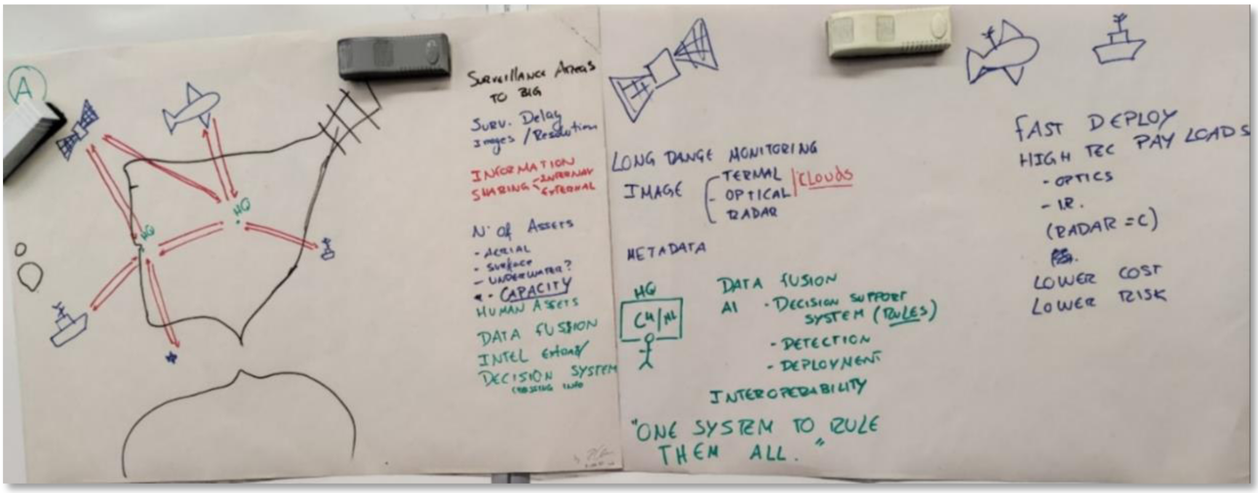

Figure 7. Major outputs for solution needed identification phase, by group A.

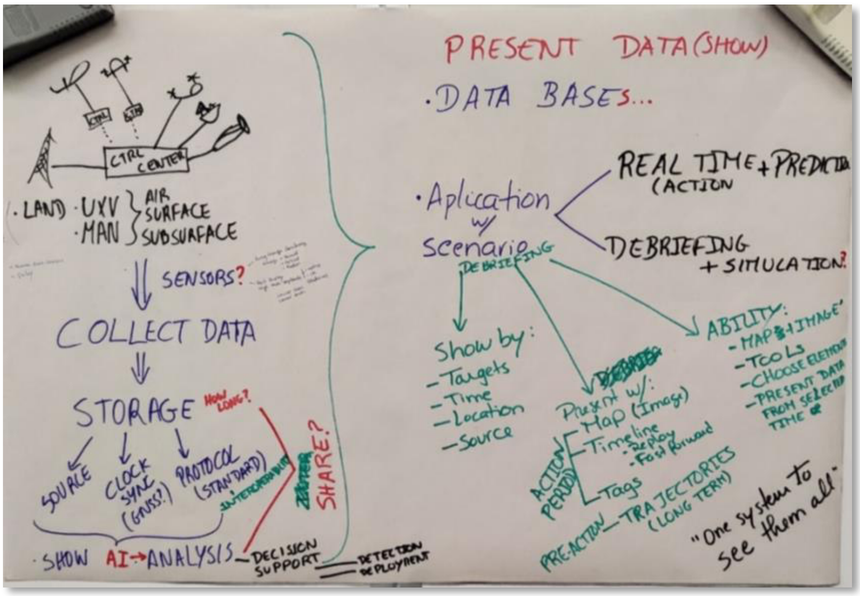

Figure 8. Major outputs for solution needed identification phase, by group B.

Group A and B, working process towards solutions needed in Figure 9

Figure 9. Group A and B afternoon session.

INOV Team compiled these results to systematize in requisites described in next the sections. These requisites are proposed (Section 4) and will be discussed until 26th may (Project Validation of user requirements phase).

From the solutions identified, we divided into: Data Sharing, Drones, Technology to Support Surveillance Monitor Processes, AI, Software, and System tools, which are described in the following sub-sections.

3.2 DATA SHARING

Solutions for data sharing were highly stressed. Indeed, effective data sharing is a critical component of maritime surveillance, as it enables stakeholders to quickly identify potential security threats, coordinate responses, and take appropriate action to mitigate risks.

To achieve effective data sharing, stakeholders must establish clear protocols and procedures for data exchange, as well as ensure that data is secure, accurate, and up to date. To implement it, stakeholders must ensure that relevant data is shared between different departments and entities within their organization. This can involve setting up secure data repositories and communication channels, such as shared databases, encrypted messaging platforms, and real-time video feeds, that enable personnel to access and share information quickly and easily.

Externally, stakeholders must establish protocols and procedures for data exchange with external entities, such as other government agencies, international organizations, and private sector partners. This can involve establishing secure data sharing agreements, conducting regular information exchanges, and ensuring that data is properly anonymized and protected from unauthorized access. In addition to establishing protocols and procedures, stakeholders can leverage advanced technology solutions to enhance the effectiveness and efficiency of information sharing. This can include using data analytics and visualization tools to consolidate and analyze large volumes of data from multiple sources, as well as leveraging artificial intelligence and machine learning algorithms to identify patterns and anomalies in data that may indicate potential security threats.

Overall, data sharing is fundamental for effective maritime surveillance, and requires close collaboration and coordination between stakeholders, along with the use of advanced technology solutions to maximize the speed, accuracy, and effectiveness of data exchange across different entities and authorities.

3.3 DRONES

Drones can be an effective and cost-efficient solution for maritime surveillance, as they provide a fast and flexible way to monitor vessels and activities at sea. However, there are several challenges associated with using drones for maritime surveillance, including weather conditions and limited range.

Wind is a major factor that can affect drone operations in maritime surveillance, as it can cause instability and make it difficult to maintain a stable flight. To address this challenge, stakeholders can use drones with advanced stabilization systems and weather sensors, which can help compensate for wind and other environmental factors. Additionally, they can use advanced flight planning and control software to optimize drone flight paths and minimize exposure to wind and other adverse conditions.

Another challenge associated with using drones for maritime surveillance is limited range. Drones typically have a maximum range of around 100km, which can limit their effectiveness in monitoring large areas of the ocean. To address this challenge, stakeholders can use a combination of drones and other surveillance technologies, such as satellites or unmanned surface vessels (USVs), which can provide complementary coverage and extend the range of surveillance operations.

In terms of cost, drones can be a cost-effective solution compared to other surveillance technologies, such as manned aircraft or ships. However, the cost of drones can vary depending on their capabilities, payloads, and other factors. To maximize cost-effectiveness, stakeholders can use drones with modular payloads and multi-mission capabilities, which can be adapted to different surveillance tasks and environments.

Overall, drones can be an effective and efficient solution for maritime surveillance, but they require careful planning and management to overcome challenges related to weather conditions and range limitations. By using advanced technology and integrating drones with other surveillance systems, stakeholders can improve the speed, accuracy, and effectiveness of maritime surveillance while minimizing costs and risks

Drone can process information reduce the amount of data to be transmitted.

Drones can process information onboard to reduce the amount of data that needs to be transmitted in maritime surveillance operations. By using advanced computing systems and algorithms, drones can analyze the data they collect in real-time and identify relevant information that needs to be transmitted back to a control center.

For example, drones equipped with advanced imaging systems can capture high-resolution images of vessels or other targets, and then use onboard image processing algorithms to identify key features, such as vessel type, size, and direction of travel.

This information can then be transmitted back to a control center in a compressed format, reducing the amount of data that needs to be transmitted and improving overall data transmission efficiency.

Similarly, drones equipped with environmental sensors can collect data on water temperature, salinity, and other parameters, and then use onboard algorithms to identify relevant trends or anomalies in the data. This information can then be transmitted back to a control center in a compressed format, reducing the amount of data that needs to be transmitted and enabling stakeholders to quickly identify potential environmental threats or other risks.

Overall, the ability of drones to process information onboard and transmit only relevant data back to a control center is a critical component of maritime surveillance operations, as it enables stakeholders to monitor and respond to security threats across a large and complex maritime environment, while minimizing the amount of data that needs to be transmitted and reducing the risk of data overload or communication failures quickly and effectively.

Drones can be a relay to increase data range transmission.

Drones can be used as a relay to increase data range transmission in maritime surveillance operations. By flying at higher altitudes, drones can establish a communication link with assets on the ground or at sea that may be outside of the range of traditional communication systems, such as radio or satellite communications.

Drones equipped with communication relay systems can act as a bridge between remote assets and the command center, transmitting data in real-time from areas that would otherwise be out of reach. For example, drones can relay data from unmanned surface vessels (USVs) or autonomous underwater vehicles (AUVs) that are operating at a distance from the coast or from other assets, such as buoys or sensors.

By acting as a relay, drones can extend the range of data transmission and improve situational awareness for stakeholders involved in maritime surveillance operations. This can include providing real-time updates on vessel movements, environmental conditions, and other relevant data that can help identify potential security threats and facilitate coordinated responses.

Drones mission can be fully programed.

Drones can be programmed to execute specific missions in maritime surveillance operations. This can include pre-defined flight plans and mission objectives, such as monitoring specific areas of interest, tracking vessel movements, or conducting environmental surveys.

Modern drones typically come equipped with sophisticated autopilot systems that allow them to fly pre-programmed routes and execute specific mission tasks without requiring constant input from an operator. These autopilot systems can be customized to include specific flight patterns, altitude settings, and other parameters that are tailored to the needs of the mission.

In addition to pre-programmed missions, drones can also be equipped with advanced sensors and imaging systems that can collect real-time data and transmit it back to a control center for analysis. This can include high-resolution cameras, thermal imaging sensors, and other specialized sensors that can provide detailed information on vessel movements, environmental conditions, and other relevant data points.

Overall, the ability to program drone missions is a critical component of maritime surveillance operations, as it enables stakeholders to monitor and respond to security threats across a large and complex maritime environment, while minimizing the need for human intervention and reducing the risk of human error quickly and effectively.

3.4 TECHNOLOGY TO SUPPORT SURVEILLANCE MONITOR PROCESS

Regarding how to conduct the surveillance, in the case of near-coast surveillance, sensors like EO/IR, Radar, SAR, AIS, and COMMS should be used, and the data should be integrated to provide a comprehensive picture. In the case of open-sea surveillance, satellite images, AIS, COMMS, AFS can be used to gather data and provide a complete overview of the situation.

Satellite images can provide valuable information on the location, movement, and activities of vessels at sea. The images can be obtained from various sources, including government agencies, commercial satellite operators, and private companies.

AIS, or Automatic Identification System, is a tracking system used by vessels to identify and locate other ships in their vicinity. AIS data can be collected by shore-based stations or satellites and can provide information on vessel type, size, speed, and direction.

COMMS, or communications systems, are crucial for maritime surveillance as they enable the exchange of information between vessels, shore-based stations, and other stakeholders. These systems include radio, satellite, and internet-based communication technologies.

AFS, or Automated Financial System, is a technology used to track financial transactions related to maritime activities. AFS can be used to monitor payments, invoices, and contracts, and can help identify potential illegal activities, such as money laundering and fraud.

At open sea, identifying vessel patterns and predicting their position can be critical in maritime surveillance. One technology that can be used to accomplish this is Automatic Identification System (AIS), which is an electronic tracking system that uses VHF (Very High Frequency) radio to exchange real-time information between ships and shore-based stations. AIS can provide valuable information on vessel location, heading, speed, and destination, and can help identify potential safety or security issues.

Another technology that can be used for predicting vessel position is satellite-based tracking systems, such as the Global Positioning System (GPS) and the Global Navigation Satellite System (GNSS). These technologies use a network of satellites to determine the precise location of vessels and can provide real-time data on their movements.

3.5 ARTIFICIAL INTELLIGENCE

In addition to these technologies, machine learning algorithms can be used to analyze large amounts of data and identify patterns in vessel movements. These algorithms can help predict vessel position and detect anomalies in vessel behavior that may indicate potential safety or security risks.

3.6 SOFTWARE AND SYSTEM TOOLS

A **debriefing tool** for maritime surveillance was also discussed. These can be valuable for analyzing and understanding the data collected during surveillance operations. One aspect of such a tool could be the ability to annotate and visualize the data to help identify trends, patterns, and anomalies.

Annotations can be used to add context and insights to the data, such as highlighting specific vessels or areas of interest, marking unusual events or behaviors, or noting significant incidents. These annotations can be linked to specific data points or time periods, allowing analysts to quickly access and review the relevant information.

Visualization tools can also be used to help analysts better understand and interpret the data. These tools can include maps, charts, graphs, and other graphical representations of the data, providing a visual overview of vessel movements, patterns, and behaviors.

Another important feature of a debriefing tool for maritime surveillance is the ability to collaborate and share information with other stakeholders. This can include sharing annotated data, collaborating on analysis, and communicating findings and recommendations.

Overall, a debriefing tool for maritime surveillance that includes annotation and visualization capabilities can help analysts identify important trends and patterns in the data, communicate findings effectively, and ultimately improve the effectiveness of maritime surveillance operations.

4. USER REQUIREMENTS FROM THE SOLUTION NEEDED BY END-USERS.

Based on the user solution needs (Section 2), the next step is to define the user requirements. This involves breaking down the needs into specific requirements that can be addressed through a solution. The requirements should be specific, measurable, achievable, relevant, and time-bound (SMART).

Validate user requirements: Once the user requirements have been defined, they should be validated with the users to ensure they accurately reflect their needs. This can be done through testing, feedback, or other validation methods.

Prioritize user requirements: Once the requirements have been identified, they should be prioritized based on their importance and impact on the user. This can be done through a variety of methods, such as impact mapping or user story mapping.

From the individual interviews and this workshop, major needs can be identified in areas such as AI, Drones, Satellite Data,

Functional requirements were divided into the following topics: AI, Drones, Satellite Data, Data fusion and integration, and System to support. In addition, the previously identified needs (Section 2), we merged with GA requisites, to systematize these needs into requisites. Merging identified needs with proposal requisites can help to ensure that the requirements for a system are well-defined, comprehensive, and aligned with the needs of the stakeholders, while also considering the proposal GA requisites.

4.1 ARTIFICIAL INTELLIGENCE NEEDS

Artificial Intelligence (AI) can transform maritime surveillance operations by enabling more efficient, effective, and comprehensive monitoring of the maritime environment. Bellow, we present the requisites identified as needed:

Requirement id	AI.01
Req. short title	Real-time data analysis
Req. description	AI can be used to analyze substantial amounts of real-time data generated by maritime surveillance systems, such as radar, AIS, and satellite imagery, to provide insights into vessel movements, weather conditions, and other factors that may affect maritime activities. There is a common need of end-users reduce human intervention and create alerts mechanics to avoid human continuous monitor process.
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	AI.02
Req. short title	Object detection and classification
Req. description	AI can be used to detect and classify objects in maritime imagery, such as vessels, buoys, and other maritime infrastructure, to support situational awareness and threat detection. Detection of small boats without AIS is a need from the end-users.
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	AI.03
Req. short title	Anomaly detection
Req. description	AI can be used to identify anomalies in the maritime environment, such as unusual vessel behavior or unusual weather conditions, to support rapid response to emerging situations. This can be applied to reduce human intervention in central command system.
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	AI.04/ DF.01
Req. short title	Integration of multiple data sources
Req. description	AI can be used to integrate multiple data sources, such as radar, AIS, and satellite imagery, to provide a comprehensive view of the maritime environment. This data fusion allows better detection process
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	AI.05
Req. short title	Automation of routine tasks
Req. description	AI can be used to automate routine tasks, such as data processing and analysis, freeing up operators to focus on more complex and high-value tasks. This can be applied to reduce human intervention in central command system.
Source	Use cases, output Co-creation design
Proposed	Proposed
Priority	Medium

Requirement id	AI.06
Req. short title	Enhance situational awareness
Req. description	AI can be used to enhance situational awareness by providing a more complete and up-to-date understanding of the maritime environment, including the location and movements of vessels, weather conditions, and other factors that may affect maritime activities
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	AI.07
Req. short title	Improving decision-making
Req. description	AI can be used to support informed decision-making by providing real-time analysis of large amounts of data

	generated by maritime surveillance systems, to support decision-making in dynamic and rapidly evolving situations
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

The use of AI in this field is still in its initial stages. Still, it has the potential to transform how maritime operations are monitored and managed to support safer, more efficient, and more effective maritime activities. There is a general need for early detection to allow better monitoring processes.

4.2 DRONES, OR UNMANNED AERIAL VEHICLES

Drones, or Unmanned Aerial Vehicles (UAVs), are increasingly being used in maritime surveillance operations to provide more comprehensive and efficient monitoring of the maritime environment. End-users are interested in this solution because of reduced costs and better and more flexible monitoring processes. The following requisites were identified:

Requirement id	UaV.01
Req. short title	Search and rescue operations
Req. description	Drones can quickly and efficiently search large ocean areas for survivors or debris, reducing response times and increasing the likelihood of a successful rescue.
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	UaV.02
Req. short title	Inspection and maintenance
Req. description	Drones can be used to inspect and maintain maritime infrastructure, such as bridges, offshore platforms, and ships, reducing the need for human operators to work in hazardous environments.

Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	UaV.03
Req. short title	Monitoring of illegal activities
Req. description	Drones can be used to monitor illegal activities in the maritime environment, such as smuggling, illegal fishing, and piracy, providing real-time intelligence that can support rapid response and enforcement operations
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	UaV.04
Req. short title	Maritime domain awareness
Req. description	Drones can be used to provide real-time situational awareness of the maritime environment, including the location and movements of vessels, weather conditions, and other factors that may affect maritime activities.
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	UaV.05
Req. short title	The system shall provide USVs with infrared payloads for nocturne detection.
Req. description	The system that provides Unmanned Surface Vehicles (USVs) with infrared payloads for nocturnal detection is designed to enhance the USVs' ability to detect and track objects or activities during low light conditions, such as at night or in low light environments. The system incorporates infrared payloads that can detect and capture thermal images, enabling the USV to identify and track objects that may not be visible using conventional cameras.

Source	DoA, Use cases
Proposed	Proposed
Priority	High

Requirement id	UaV.06
Req. short title	The system shall enable multi-domain capability for mission management.
Req. description	The system that enables multi-domain capability for mission management is a complex and integrated system that involves multiple subsystems and technologies.
Source	DoA, Use cases
Proposed	Proposed
Priority	High

Requirement id	UaV.07 (to be checked)
Req. short title	The system shall provide UAVs with augmented SIGINT capabilities
Req. description	UAVs with augmented SIGINT capabilities is a complex and integrated system that involves multiple subsystems and technologies
Source	DoA, Use cases
Proposed	Proposed
Priority	High

Requirement id	UaV.08 (to be checked)
Req. short title	The system shall provide UAVs with multiple PTZ for augmented maritime monitoring.
Req. description	the system that provides UAVs with multiple PTZ for augmented maritime monitoring is a sophisticated and integrated system that incorporates multiple subsystems and technologies.
Source	DoA, Use cases
Proposed	Proposed
Priority	High

Requirement id	UaV.09
Req. short title	Debriefing
Req. description	These can be a valuable resource for analyzing and understanding the data collected during surveillance operations. One aspect of such a tool could be the ability to annotate and visualize the data to help identify trends, patterns, and anomalies.
Source	Workshop
Proposed	Proposed
Priority	High

Requirement id	UaV.10
Req. short title	Drones can be a relay to increase data range transmition
Req. description	Drones can be used as a relay to increase data range transmission in maritime surveillance operations. By flying at higher altitudes, drones can establish a communication link with assets on the ground or at sea that may be outside of the range of traditional communication systems, such as radio or satellite communications.
Source	Workshop
Proposed	Proposed
Priority	Medium

4.3 SATELLITE DATA

Satellite information plays a critical role in maritime surveillance systems by providing real-time information about the location and movements of vessels, weather conditions, and other factors that may affect maritime activities. Main advantages are: Remote sensing, Global coverage, Enhanced data collection, Improved safety, Increased efficiency, Integration of satellite information into maritime surveillance systems.

Requirement id	SatData.01
Req. short title	The I-Seamore system shall integrate Copernicus satellite data for maritime surveillance.
Req. description	This is a broad requisite that needs to be divided data acquisition, processing, store and the data analysis (this should be aligned with end-users needs). A web interface or the integration with the existing C2C system.
Source	DoA, Use cases, workshop
Proposed	Proposed
Priority	High

4.4 DATA INTEGRATION AND DATA FUSION

Data fusion involves the combination of data from multiple sources to form a completer and more accurate picture of a situation. In the context of maritime surveillance, data fusion can be performed through the following steps: Data collection, Data pre-processing, Data association, Data fusion algorithms, Data representation, Data analysis, and Data Sharing.

Data fusion technologies are essential for supporting effective maritime surveillance operations, as they allow for the integration of multiple sources of information to provide a comprehensive understanding of maritime activities. It is important to ensure data fusion is performed securely and efficiently, with proper consideration given to data privacy and security concerns.

Requirement id	DF.01
Req. short title	The system shall provide a unified data model for all data gathered from sensors and other sources.
Req. description	
Source	DoA, Use cases, output Co-creation design
Proposed	Proposed
Priority	High

Requirement id	DF.02
Req. short title	Use open standards for data exchange
Req. description	
Source	DoA, Use cases
Proposed	Proposed
Priority	Medium

Requirement id	DF.03
Req. short title	Data integration from new sensors
Req. description	
Source	DoA, Use cases,
Proposed	Proposed
Priority	Medium

4.5 I-SEAMORE SYSTEM

Previous topics are part of I-Seamore System in this section we will cover user and other system interfaces.

Requirement id	ISeamore.01
Req. short title	The system shall integrate radar and AIS data for maritime surveillance.
Req. description	
Source	DoA, Use cases,
Proposed	Proposed
Priority	Medium

Requirement id	ISeamore.02
Req. short title	The system shall perform automatic identification and tracking of vessels.
Req. description	
Source	DoA, Use cases,
Proposed	Proposed
Priority	Medium

Requirement id	ISeamore.03
Req. short title	The system shall develop an adaptor for CISE.
Req. description	The CISE connector for maritime surveillance is a software module that facilitates the exchange of information between different maritime surveillance systems. The connector enables different systems to share data such as vessel positions, trajectories, and identification information in real-time. The connector helps to enhance situational awareness and improve the coordination of maritime surveillance activities across different organizations and countries.
Source	DoA, Use cases,
Proposed	Proposed
Priority	Medium

CISE (Common Information Sharing Environment) and its connector for maritime surveillance. CISE is a European Union (EU) initiative that aims to improve maritime situational awareness and enhance the effectiveness of maritime surveillance in the EU. The CISE system provides a common platform for EU member states and other stakeholders to share information and cooperate on maritime surveillance activities.

Requirement id	ISeamore.04
Req. short title	The system shall set up and configure the orchestration platform in I-SEAMORE Operational Experimentation Centres.
Req. description	
Source	DoA, Use cases,
Proposed	Proposed
Priority	Medium

Requirement id	ISeamore.05
Req. short title	The system shall deploy preliminary demos to test the interoperability mechanisms.
Req. description	
Source	DoA, Use cases,

Proposed	Proposed
Priority	Medium

Requirement id	ISeamore.06
Req. short title	The system shall test and verify the orchestration platform
Req. description	
Source	DoA, Use cases,
Proposed	Proposed
Priority	Medium

Requirement id	ISeamore.07
Req. short title	**Debriefing tool**
Req. description	These can be valuable for analyzing and understanding the data collected during surveillance operations. One aspect of such a tool could be the ability to annotate and visualize the data to help identify trends, patterns, and anomalies
Source	Workshop
Proposed	Proposed
Priority	Medium

Requirement id	ISeamore.08
Req. short title	**Visualization tool**
Req. description	Help analysts better understand and interpret the data. These tools can include maps, charts, graphs, and other graphical representations of the data, providing a visual overview of vessel movements, patterns, and behaviors
Source	Workshop
Proposed	Proposed
Priority	Medium

Requirement id	ISeamore.09
Req. short title	**Annotations tool**
Req. description	Annotations can be used to add context and insights to the data, such as highlighting specific vessels or areas of interest, marking unusual events or behaviors, or noting significant

	incidents. These annotations can be linked to specific data points or time periods, allowing analysts to quickly access and review the relevant information.
Source	Workshop
Proposed	Proposed
Priority	Medium

4.6 PRIORITIZE USER REQUIREMENTS

At the end of the workshop, considering GA and workshop-identified requisites, the end-users and other participants identified priorities in 3 levels, see Figure 10: High, medium, and low. This output is available in the Excel file (requirements_priority.xls) and the from the previous Tables described in sections 4.1 to 4.5.

This is the current status of T3.2 and T3.3. The next steps involve a validation process that will include input from all project stakeholders leading up to the workshop on May 26th.

Figure 10 – Requisites priority process performed after presentations of Group A and B

APPENDIXES

APPENDIX A – PARTICIPANT LIST

For the activities (sub–group discussions) participants were divided into 2 groups – A and B. For both groups, the research team aimed to achieve heterogeneity between end–users and technical partners.

Organisation	Participant Name	Group
INOV	João Ferreira	Organization
INOV	Marta Matos	Organization
INOV	Elisabete Carreira	Organization
AETE	Javier Leon Alcobia	**Group A**
INOV	Paulo Chaves	**Group B**
INOV	Luís Fernandes	**Group A**
Primoco UAV	Jakub Fojtík	**Group B**
ATOS	Jose-Ramon Martinez-Salio	**Group B**
VORTEX-CoLab	João Silva	**Group B**
VORTEX-CoLab	Fernando Alves	**Group A**
TERRASIGNA	Marius Budileanu	**Group A**
CS Group	Damien Gravelat	**Group B**
Coast Guard	Sorin Adrian Olteanu	**Group A**
Marinha Portuguesa	Ana Rita Rodrigues Oliveira	**Group A**
Marinha Portuguesa	Sofia Azevedo Goulão	**Group B**
THALES	Gregor Pavlin	Missing
UKBF	Paul Donnan	**Group A**
UKBF	Alex Mackenzie	**Group B**

APPENDIX B - AGENDA FOR THE WORKSHOP

The following Agenda was created and distributed to all project partners involved in the process.

I-SEAMORE

INOV

ADDRESS:
ALVES REDOL 9,
1000-029 LISBOA

CO-CREATION WORKSHOP

31 Mar. 23

THIS WORKSHOP WILL FOLLOW-UP THE EXPLORATORY INTERVIEWS UNDERTAKEN WITH THE PROJECTS' END-USERS.

WORKSHOP AIMS:
(1) MAP END-USERS NEEDS, CHALLENGES AND RESOURCES REGARDING MARITIME SURVEILLANCE;
(2) COLLABORATIVELY IDENTIFY AND/OR CREATE SOLUTIONS/REQUIREMENTS TO BE UPTAKEN IN I-SEAMORE ECOSYSTEM.

PARTICIPANTS:
END-USERS
TECHNICAL PARTNERS

METHODOLOGY:
A COLLABORATIVE WORKSHOP IS A SPECIFIC TYPE OF GROUP MEETING IN WHICH ACTIVITIES WILL BE DEVELOPED WITH THE AIM OF ANALYZING PROBLEMS, DEBATING IDEAS, GENERATING SOLUTIONS, MAKING DECISIONS AND/OR CREATING PLANS. DATA WILL BE COLLECTED THROUGH WRITTEN NOTES AND MATERIAL RESULTING FROM THE DISCUSSIONS CARRIED OUT.
NO RECORDING WILL BE NECESSARY. CONFIDENTIALITY WILL BE ENSURED.

Agenda

09h30 - 10h15	Warm-up: Informal presentation and Presentation of the co-creation process
10h15 - 11h15	Sub-group activity: Sub-groups parallel discussions will be held into sub-groups to map needs, challenges, and resources regarding maritime surveillance
11h15 - 11h30	**Short break**
11h30 - 12h30	Full group activity: group synthesis/mapping of parallel discussions
12h30 - 14h00	**Lunch break**
14h00 - 15h00	Sub-group activity: Sub-groups parallel discussions will be held into sub-groups to identify and/or create solutions/requirements to be uptaken in I-seamore Ecosystem
15h00 - 16h00	Full group activity: group synthesis/mapping of parallel discussions
16h00 - 16h30	Summary and debriefing