Position Paper on offer and request in robotic and sensors

D4.1.2

WP4 – Creation and establishment of innovation ecosystem model for underwater robotics and sensors

Project References

Call for proposal 2019 Strategic – InnovaMare
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Work package: WP4 – Creation and establishment of innovation ecosystem model for underwater robotics and sensors
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Deliverable title: Position Paper on offer and request in robotic and sensors
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Deliverable description: D.4.1.2 Position paper on offer and request in robotic and sensors – position paper is conducting of research analysis on gaps and opportunities in services and skills for business and SRIs.PP5 and PP11, M11.
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Contents

INTRODUCTION

The purpose of this deliverable is to present a bottom-up analysis of needs for services, technologies and offers provided by the companies belonging to the private sector, and the scientific-research community. This analysis provides an overview of the gaps and opportunities in services and skills, and the potential ecosystem of demand/request of technologies (in the fields of robotics and sensors) in the area of Italy - Croatia programme. The dataset collected through the questionnaires and interviews presents the baseline to structure the "marketplace" service that will be active in the MAiROS web platform and to identify the potential areas of intervention of the DIH, as well as its full range of services.

The deliverable is structured as follows:

- Chapter 1 - OBJECTIVES presents the overall project and Work Package objectives and the expected results.
- Chapter 2 – METHODOLOGY provides a description of the methodology used for the sending, collecting and reviewing the questionnaires, and conducting the interviews.
- Chapter 3 - QUANTITATIVE ANALYSIS gives an overview and deepening of the collected results and outlines the first categorization in terms of country, type of questionnaires, categories of stakeholders etc.
- Chapter 4 - QUALITATIVE ANALYSIS consists of two subchapters: TECHNOLOGY ASSESSMENT (of offers and needs per country, per type of actor and in general) and TECHNOLOGY MATCHING (between offers and needs, investigating whether the collected offers answer all the collected needs).
- Chapter 5 – STATE OF THE ART IN UNDERWATER ROBOTICS consists of two subchapters: STATE OF THE ART (desk research and reference to existing documents and projects) and INNOVAMARE POSITIONING analysis (Adriatic Sea compared to global and EU scenarios).
- Chapter 6 - SERVICES TO BE DEVELOPED FOR THE DIGITAL INNOVATION HUB presents the spillovers of the activity in the perspective of creating a Digital Innovation Hub
- Final chapter, CONCLUSIONS, summarizes the most important results and findings of the entire Deliverable.

CHAPTER 1 - Objectives

InnovaMare project objective is to enhance framework conditions for innovation on cross-border level by setting up strategical & operational level capacity that consist of mix of policy instruments & innovation players as a frame for development of innovative technologies for sustainability of Adriatic Sea. It will improve the performance of the Programme area in the field of innovation by establishing & developing mechanisms as jointly developed and implemented cross-border model of innovation ecosystem in area of underwater robotics & sensors. It will be central point for boosting innovation in monitoring & surveillance sector which contributes to a better exploitation of the existing potential & strengthen innovation relationships between SMEs & research centres operating in Programme area. InnovaMare project aims to enhance collaboration on technology transfer by creation of innovative network for underwater robotics & sensors based on request & offers from private & scientific research.

The main result of InnovaMare project is improved performance of the Programme area in the field of innovation by developing and implementing mechanisms which contribute to a better exploitation of the existing potential for cross-border patent application and strengthen innovation relationships between SMEs and SRI. The enhancement of framework conditions for innovation on cross border level in area of underwater robotics and sensors is using already existing knowledge and expertise and bringing integration elements on cross-border level for innovation and transfer of technology. Through established innovation ecosystem model in underwater robotics and sensors the project will integrate quadruple helix stakeholders, innovation policies, transfer of knowledge, human skills development, collaboration tools, demand driven approach. Based on this as a showcase of integration and technology transfer success the project partners will jointly develop and pilot eco-innovative tools for sustainability of Adriatic Sea.

The activity 4.1 includes the engagement of all partners through different activities, one of which is a bottom-up analysis of private sector needs for services, technologies and offers from scientific-research community. This analysis will provide a first clear overview of the potential ecosystem of demand/request of technologies (in the fields of robotics and sensors) in the area of Italy - Croatia programme. The dataset collected through the questionnaire (D 4.1.1) is the baseline to structure the “marketplace” service that will be active in the MAiROS web platform and to identify the potential areas of intervention of the Digital Innovation Hub, as well as its full range of services.

The objective of this Position Paper was to aggregate outcomes of the questionnaires collection for stakeholders, a precise and easy tool applied in order to gather technological requests and offers from stakeholders. The minimum goal of 50 interviews in Italy and Croatia has been met. 72 questionnaires were collected in total, and **52** of these were validated, since they provided sufficient information to classify and to analyze them. In particular, 29 questionnaires were submitted by Italian stakeholders and 23 questionnaires were submitted by Croatian stakeholders, which presents a good balance. However, some of

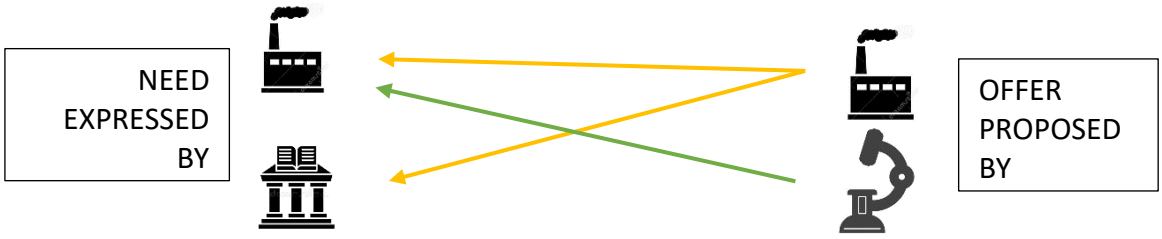
the stakeholders submitted both offers and requests, which are often present in the same questionnaire. As a result, Italian questionnaires are comprised of 20 offers and 12 requests, whereas Croatian questionnaires are comprised of 19 offers and 12 requests. With the help of questions in the interviews, the needs from stakeholders were clarified and a total number of offers and requests of **63** has been considered for evaluation in this deliverable.

CHAPTER 2 - Methodology

In first instance a classification of stakeholders that could have a need for a technological solution and could answer that need was defined. We consider that we move in the context of facilitating a marketplace of needs and offer of technological solutions, thus we give priority to needs and offers for ready-to-implement solutions or at higher levels of development (TRL).

			
	Private sector	**Scientific-research community (public)**	**Public administration**
	Companies, private research centres, consortia of private actors	*Universities, national research bodies*	*Municipalities, agencies for environmental protection/defence*
Is the type of actor likely to express a technological need?	✓	**NO**	✓ (pub. procurements)
Is the type of actor likely to propose a technological offer?	✓	✓	**NO**

Connections between who can express a need and who can propose a technological offer:



We asked TECHNOLOGICAL NEEDS to private sector and public administration and TECHNOLOGICAL OFFERS to scientific-research community and private sector. Despite this initial assessment of reference target actors, after the collection of questionnaires the most relevant outcome is that technology requests came also from scientific and research stakeholders.

Process and timeline

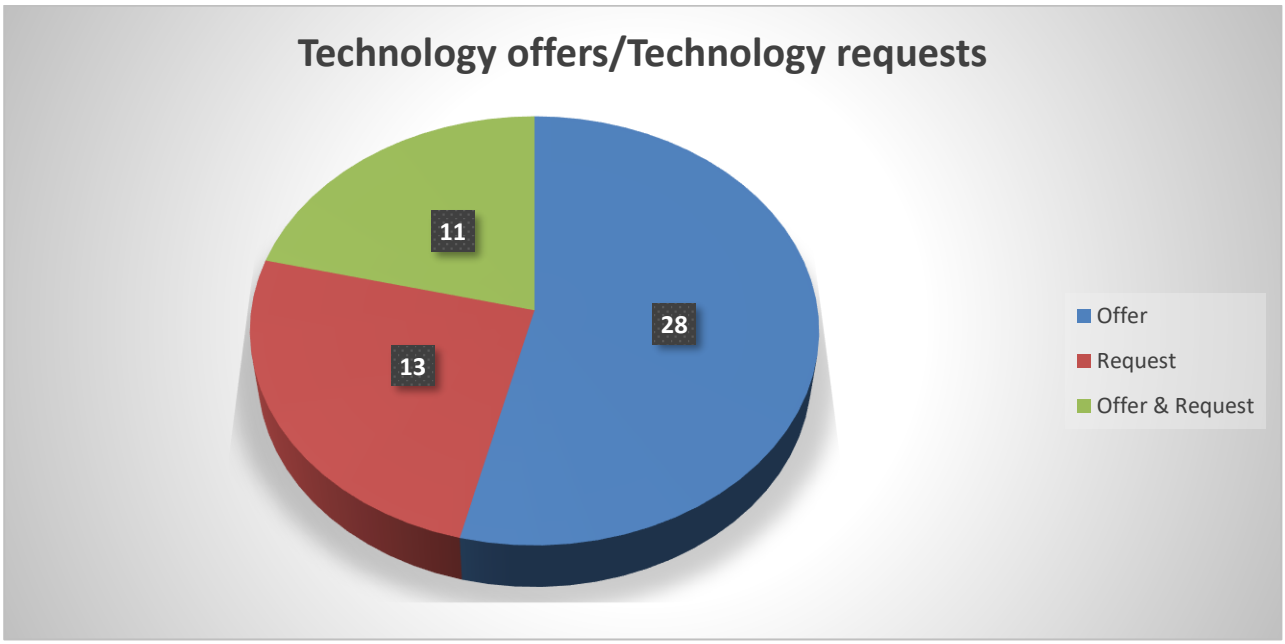
Considering the points before mentioned, we proceeded with the following process:

InnovaMare Partner	***Interviewee***
1. Identify a **list of potential interviewees balancing needs/requests**, as suggested in "*Actions requested to InnovaMare partners for D4.1.1 implementation*"	
2. **Spread the questionnaire** (mailing), with a general introduction related to why we are preforming it (mention the marketplace that will be available on MaIROS platform). **Tailored calls to interviewees** will follow in order to better introduce the project. A **trial questionnaire** will be given as example to help and make more understandable the contents that should be provided. The questionnaire can be filled in through Survey Monkey.	Receive the general invitation to fill in the questionnaire. [*Some potential interviewees*] receive a call by InnovaMare partner presenting the initiative and the process.
	Read the example of the questionnaire. Fill in as many questionnaires as the number of needs/offers you'd like to express. To complete the questionnaire, use Survey Monkey (https://it.surveymonkey.com/r/YCQPFJY) *[Only in case you receive a pre-filled questionnaire from a project partner, complete it and send it back via e-mail.]*
3. Reception of the questionnaires: every questionnaire will be sent by mareFVG to the responsible project partner in order to **verify the contents and (if needed) proceed with the interview** to deepen the contents.	
4. **(if needed) Perform the direct interview (virtually of face-to-face)** focusing on improving the open text questions of the questionnaire and to solve potential doubts. Moreover, remember to present the online marketplace and the overall action of InnovaMare.	
5. **Send back the completed questionnaires** to mareFVG that will collect all them in an Excel file. This will serve to upload the contents in the "marketplace" tool and to perform the analysis for drafting the Position Paper. Marketplace tool will give the opportunity to post a technological need/offer anytime.	

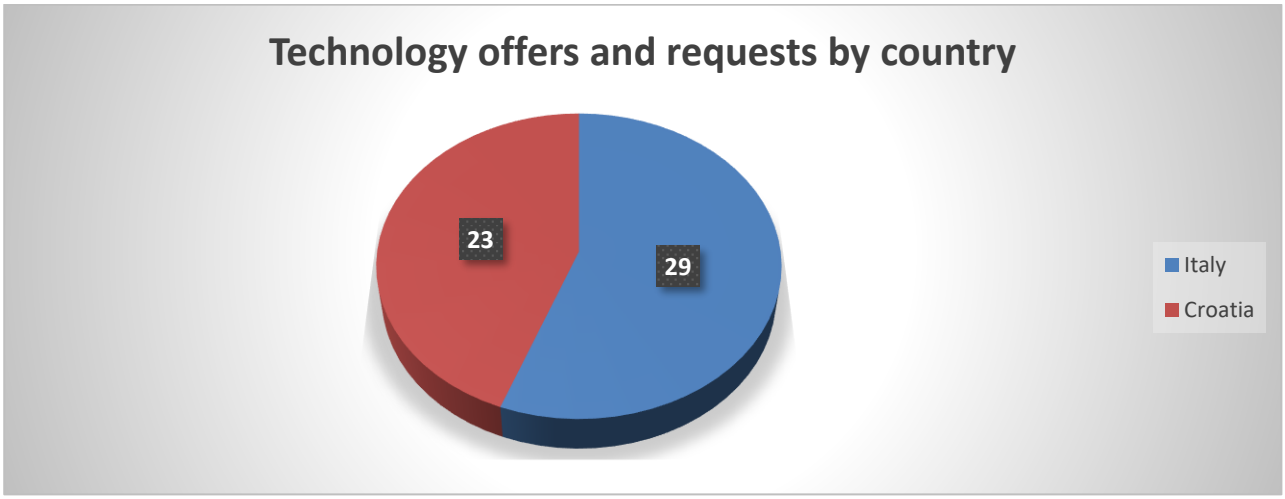
CHAPTER 3 – Quantitative analysis

The data was collected via questionnaires and interviews from stakeholders. Several stakeholders have provided multiple questionnaires, submitted by the various key personnel, with different technological offers and technological requests.

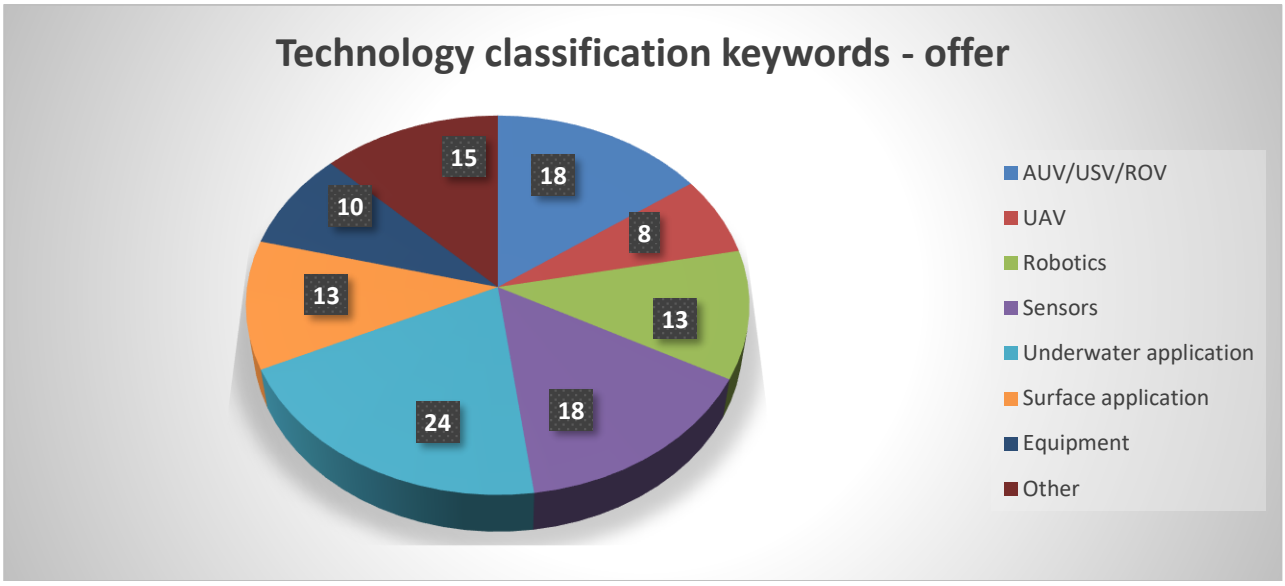
In total, 40 stakeholders have provided 52 validated questionnaires and interviews. Out of 52 validated questionnaires and interviews, 28 were related to technological offers, 13 were related to technological requests, and 11 were related to both technological offers and technological requests, as shown in the following figure.



Validated questionnaires and interviews relating to technology offers and technology request were distributed almost equally between Italy and Croatia, as shown in the following figure:



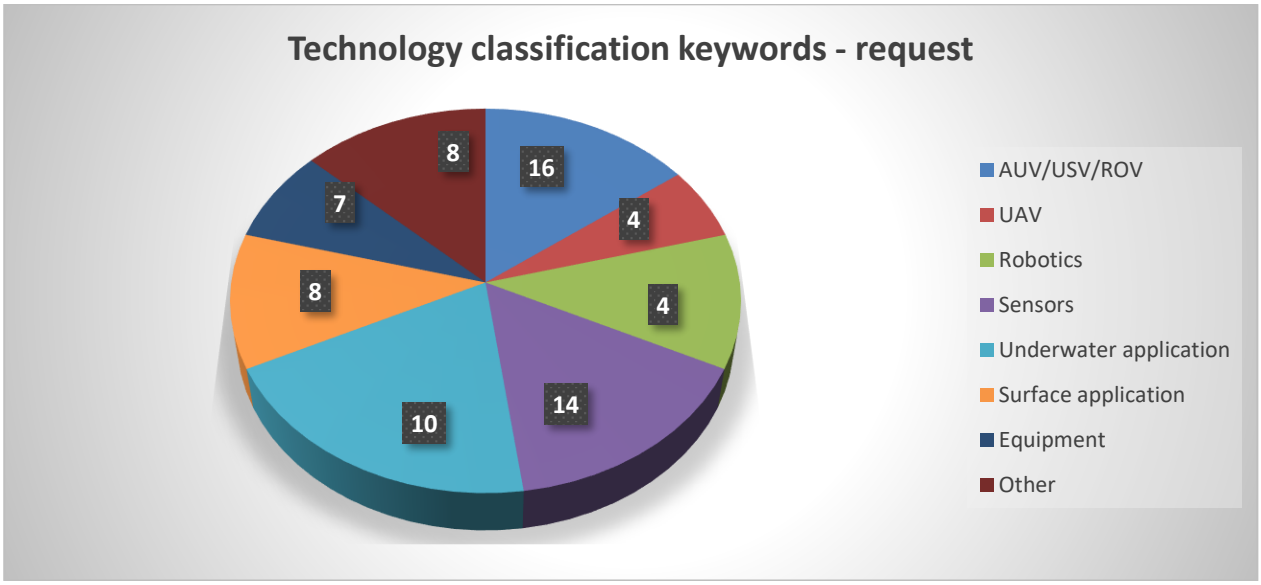
The stakeholders were asked to choose among the several proposed keywords in order to classify the technology solutions they are offering or requesting. In order to better categorize their solutions, it was possible to add two more keywords in the field "other". The answers for technology offers are grouped as follows:



Under the category “other”, the stakeholders have specified the following keywords related to technology offers:

- Scientific research, consulting services
- Business consulting
- Satellite imagery
- Software
- Hybrid marine propulsion system
- Maritime fuel cells
- Underwater noise, citizen science
- Underwater communication, underwater localization
- Underwater Perception
- ITC software solutions
- Physical models, numerical simulations
- Underwater communications, wireless communications
- Underwater cables
- Custom software for Mobile Robotics, system integration for mobile robotics
- Machine learning
- Multibeam echosounder

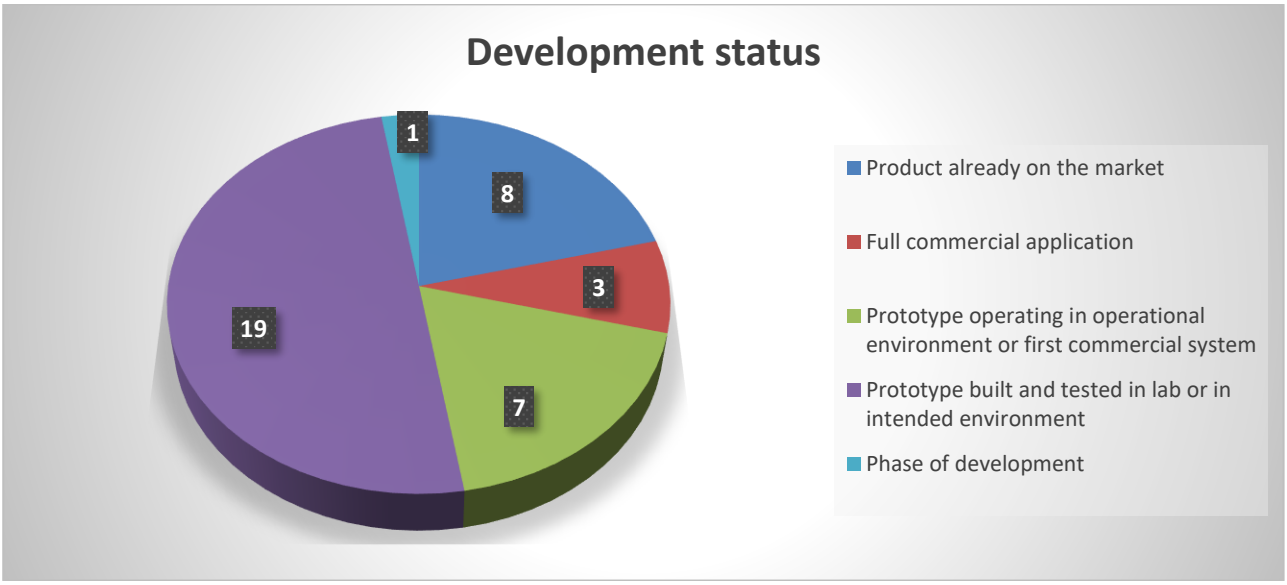
The answers for technology requests are grouped as follows:



Under the category “other”, the stakeholders have specified the following keywords related to technology requests:

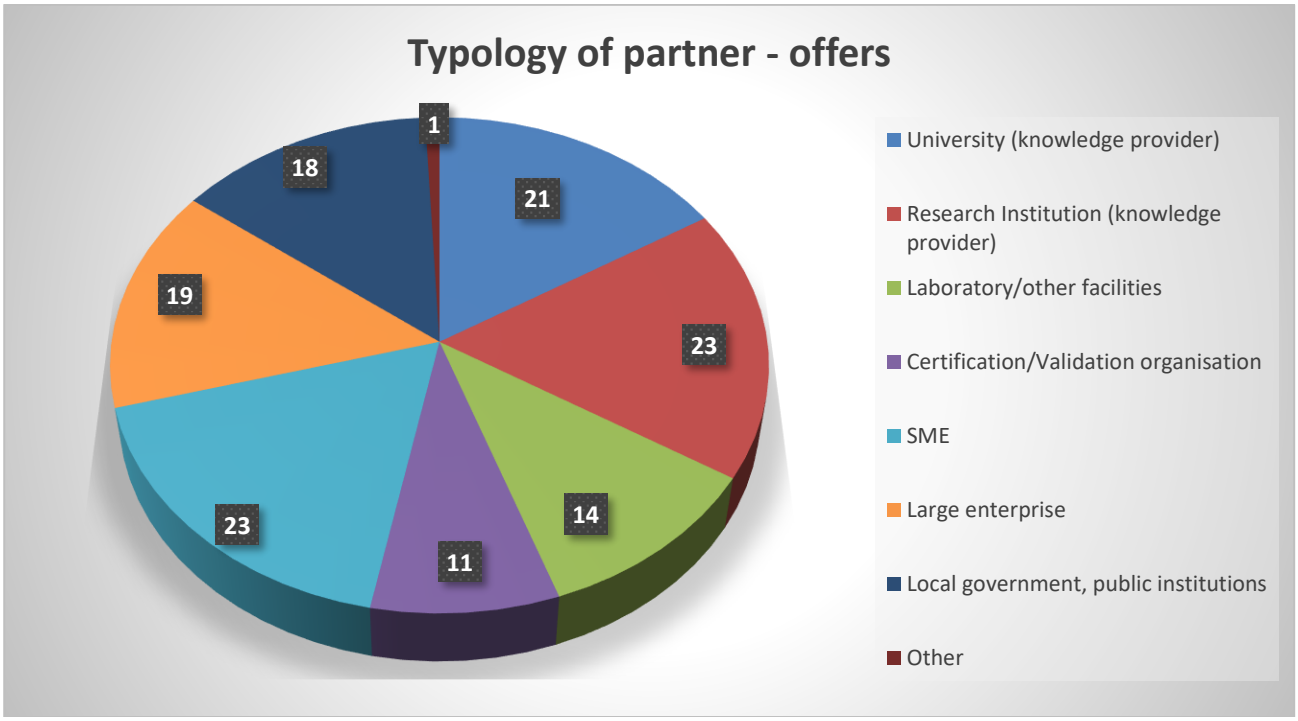
- Underwater archeology, seafloor mapping, landscape reconstruction
- Business consulting
- Satellite imagery
- Sound velocity profiler – Multibeam echosounder survey
- Drifter Buoy
- Gliders AUV
- Underwater communication, underwater localization
  Buoy with sensors and IT tool

the results have shown that 38 solutions have expressed the stages of development, as shown in the following figure:

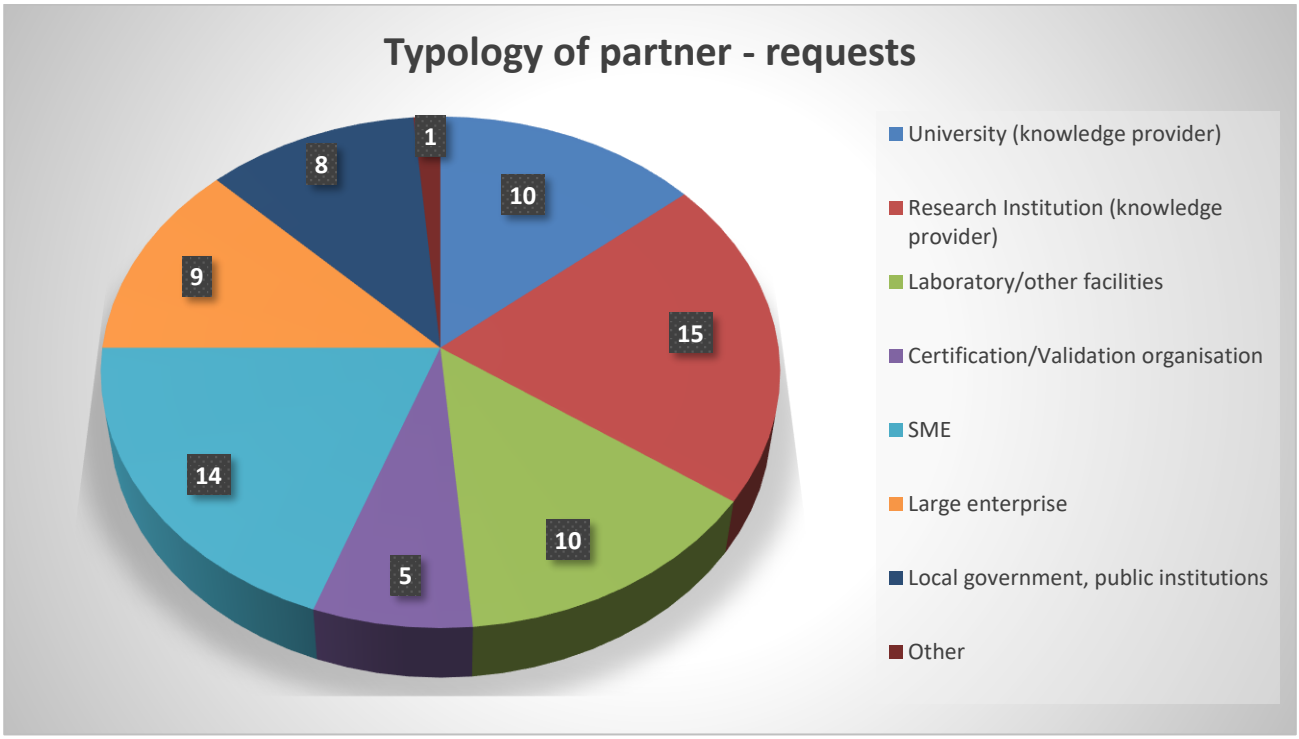


Of all offered technological solutions, only one is patent protected at the European level. Eight solutions have received recognized awards (Seal of Excellence, medals, etc).

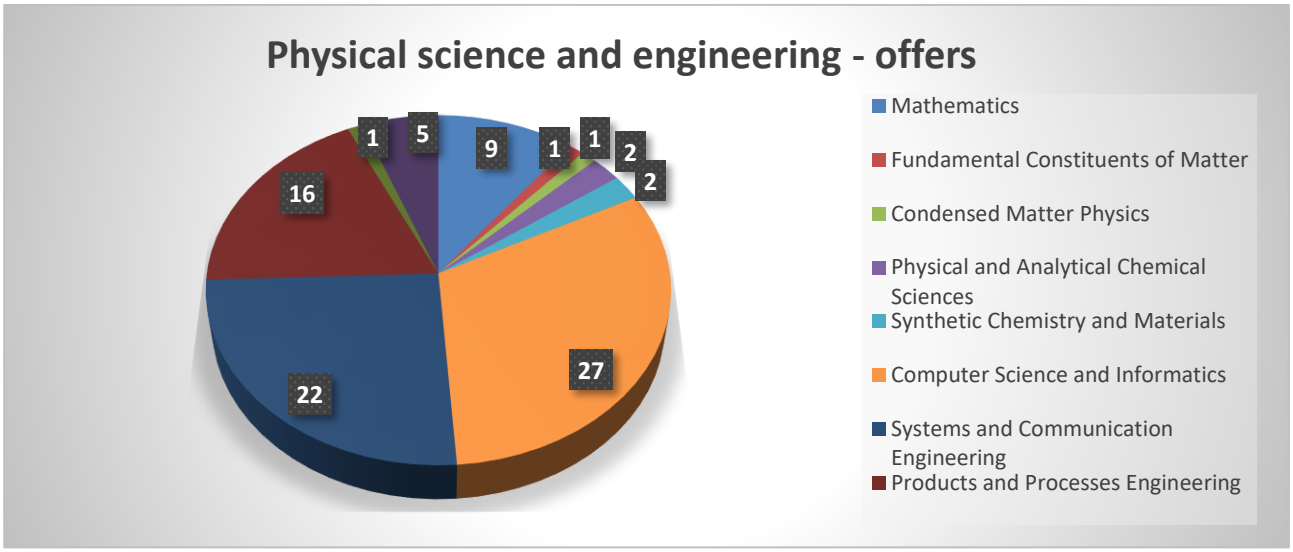
Regarding the partner search (typology of desired partner), the answers from stakeholders with technological offers are shown in the following figure, according to the individual technology offers.



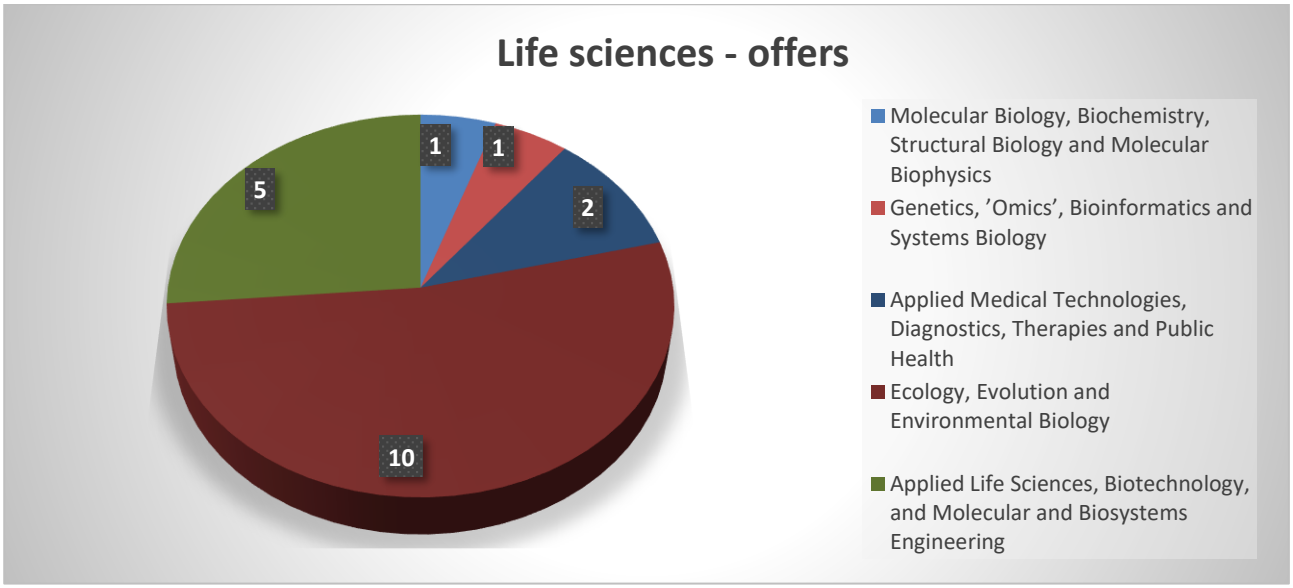
Regarding the partner search (typology of desired partner), the answers from stakeholders with technological requests are shown in the following figure, according to the individual technology requests.



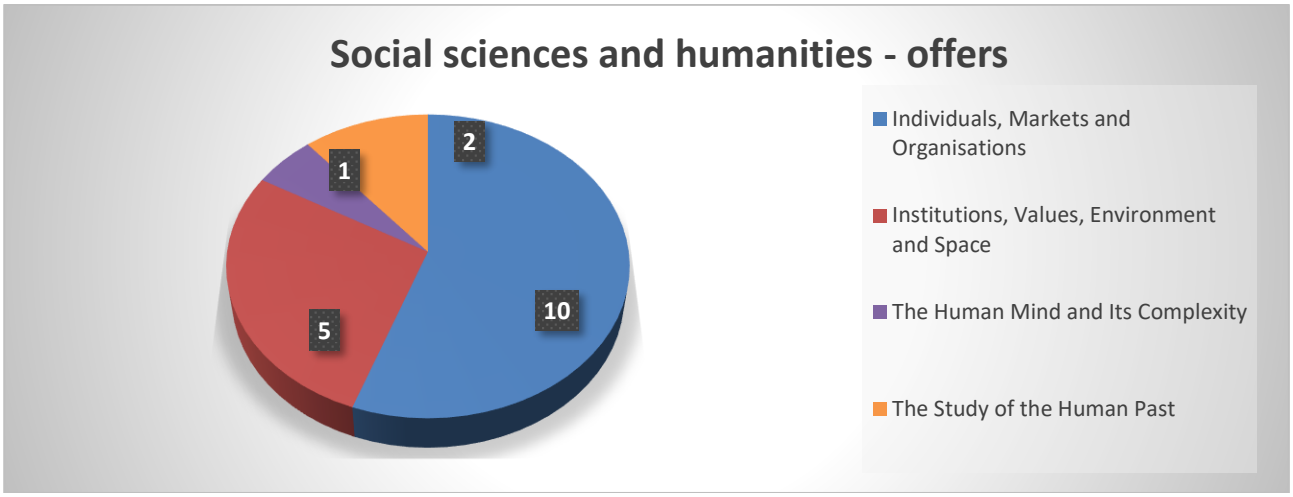
Competences in the scientific domains of PHYSICAL SCIENCES AND ENGINEERING of stakeholders with technology offers are presented in the following figure, according to the individual technology offers.



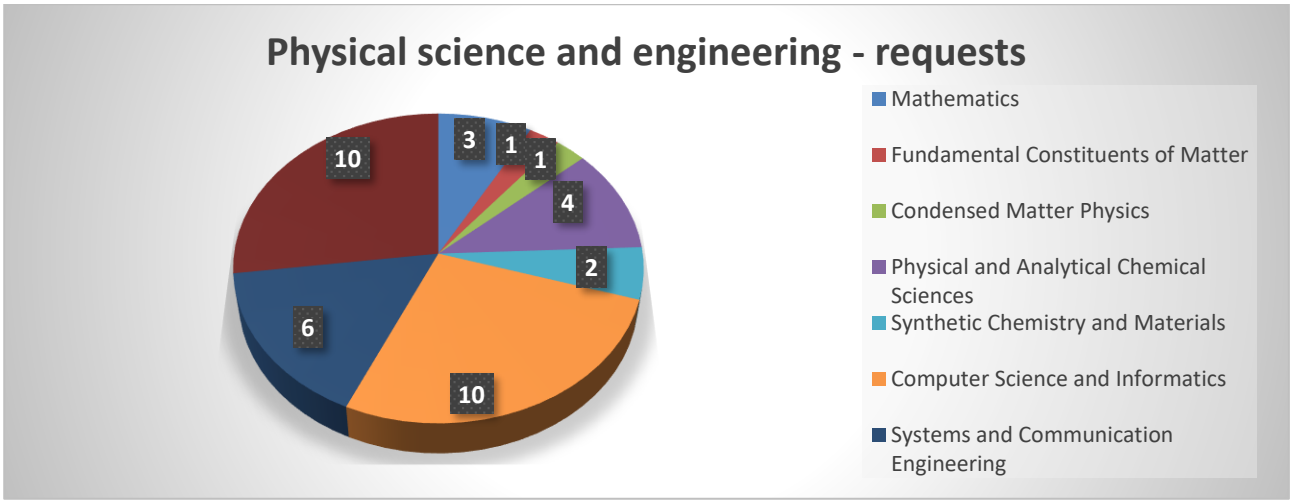
Competences in the scientific domains of LIFE SCIENCES of stakeholders with technology offers are presented in the following figure, according to the individual technology offers.



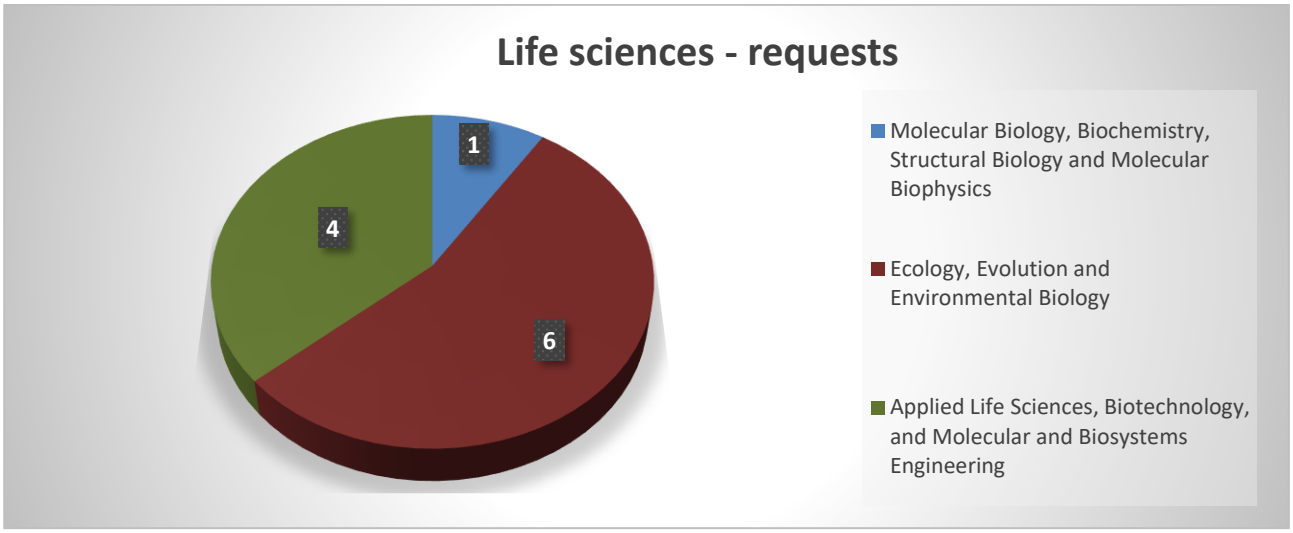
Competences in the scientific domains of SOCIAL SCIENCES and HUMANITIES of stakeholders with technology offers are presented in the following figure, according to the individual technology offers.



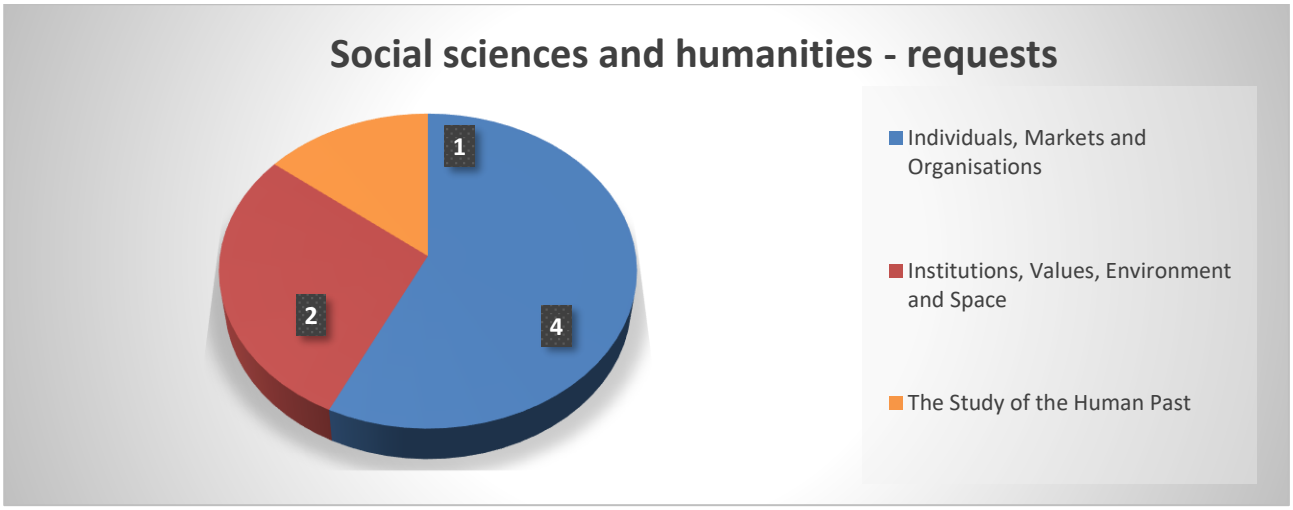
Competences in the scientific domains of PHYSICAL SCIENCES AND ENGINEERING of stakeholders with technology requests are presented in the following figure, according to the individual technology requests.



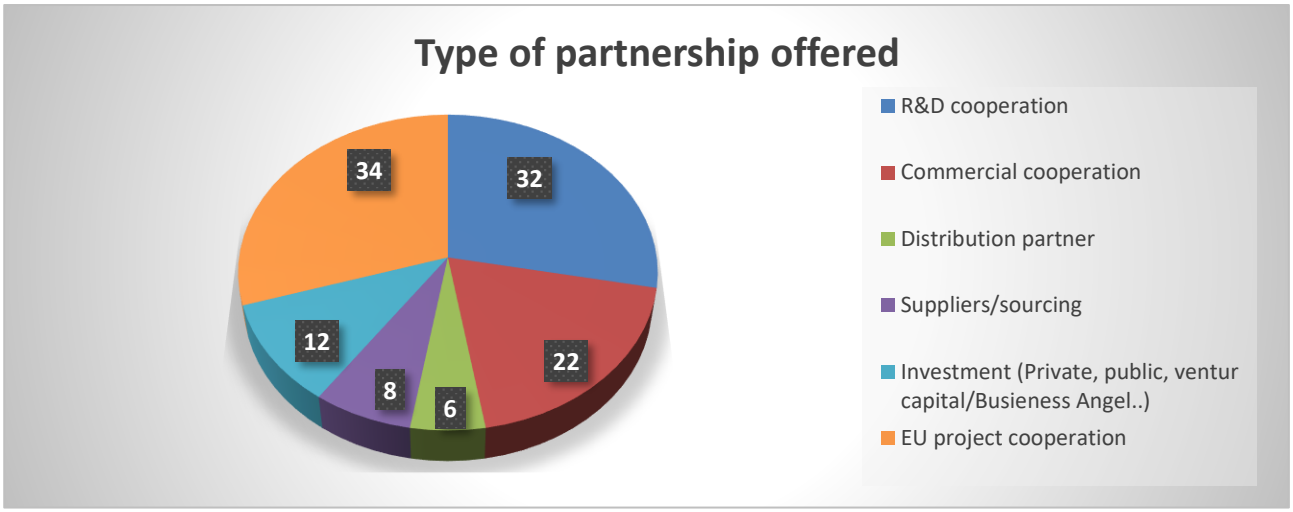
Competences in the scientific domains of LIFE SCIENCES of stakeholders with technology requests are presented in the following figure, according to the individual technology requests.



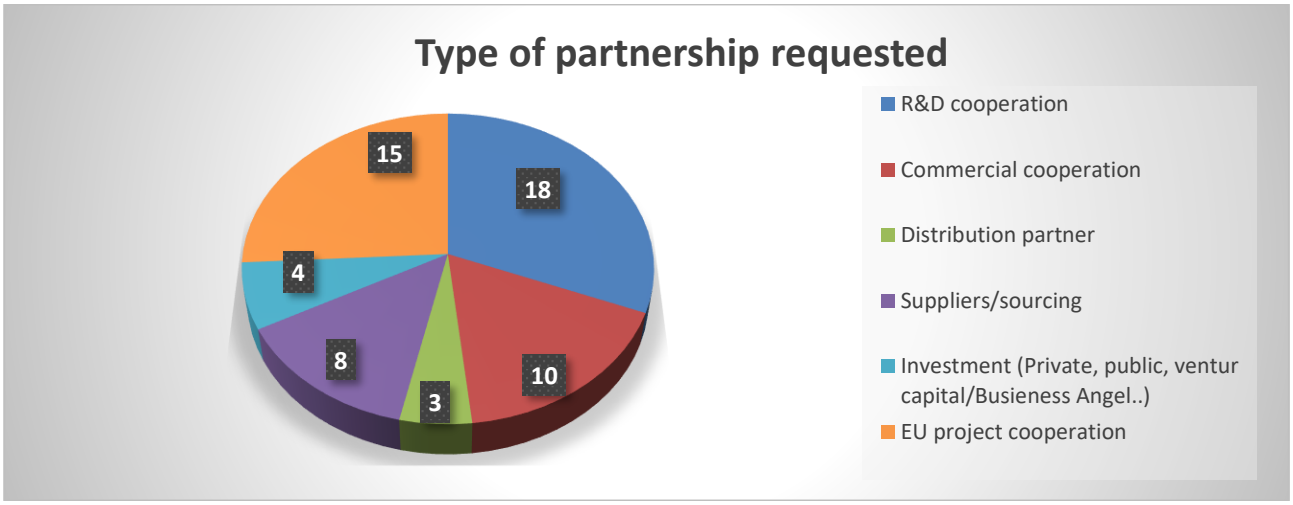
Competences in the scientific domains of SOCIAL SCIENCES and HUMANITIES of stakeholders with technology requests are presented in the following figure, according to the individual technology requests.



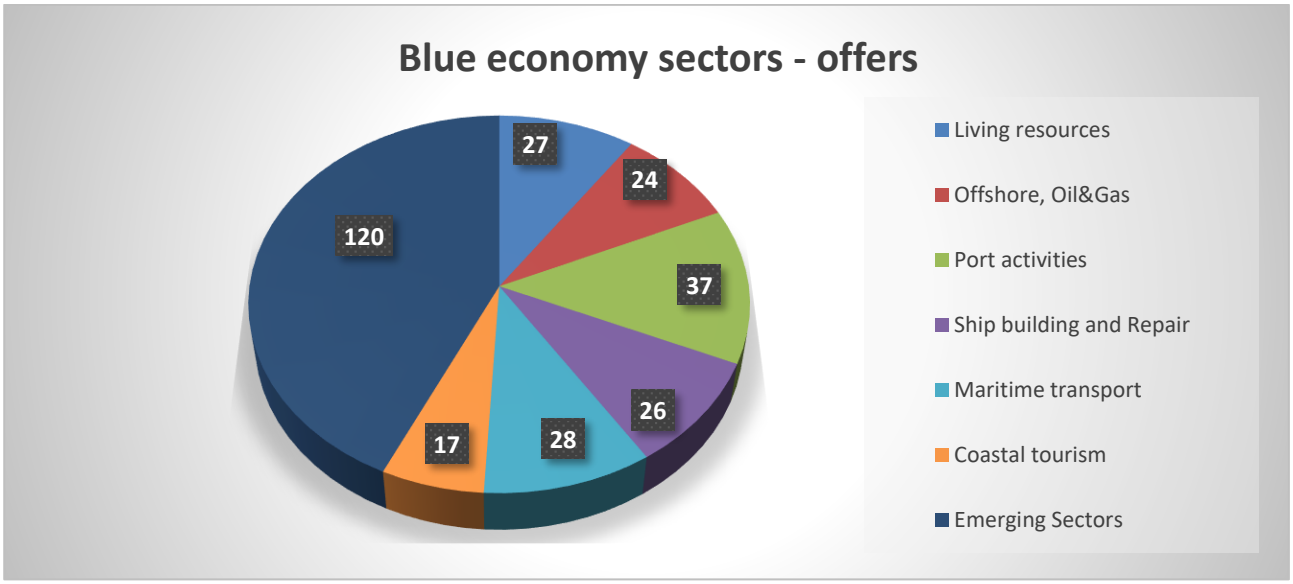
Type of partnership offered is shown in the following figure, according to the individual technology offers.



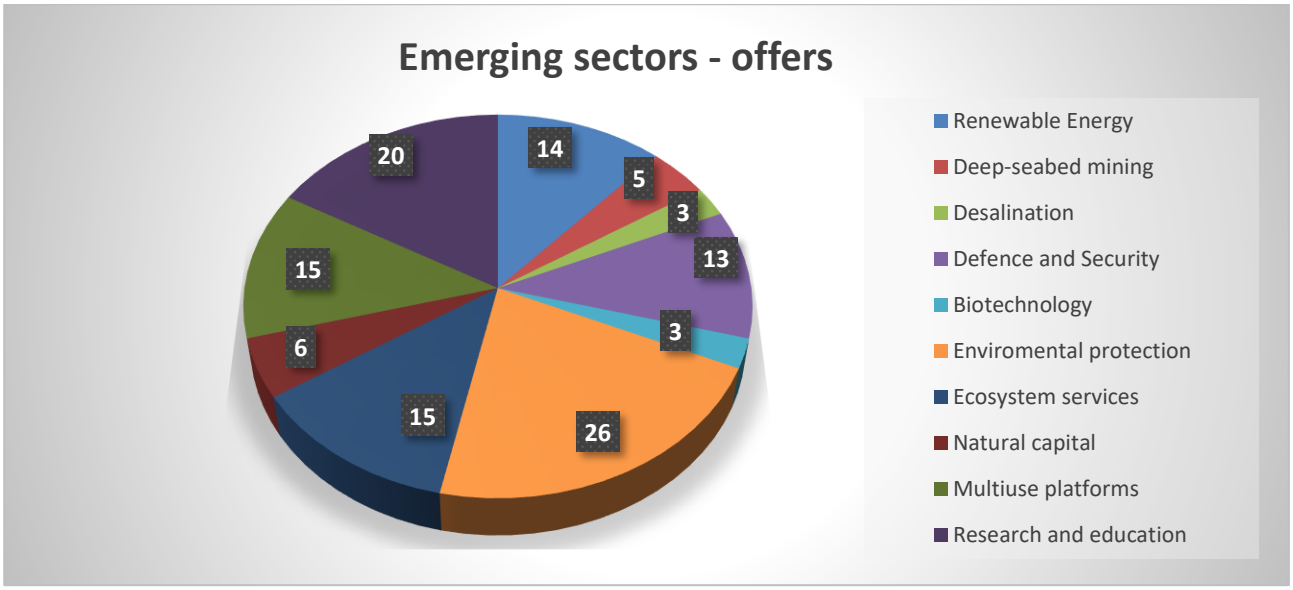
Type of partnership requested is shown in the following figure, according to the individual technology requests.



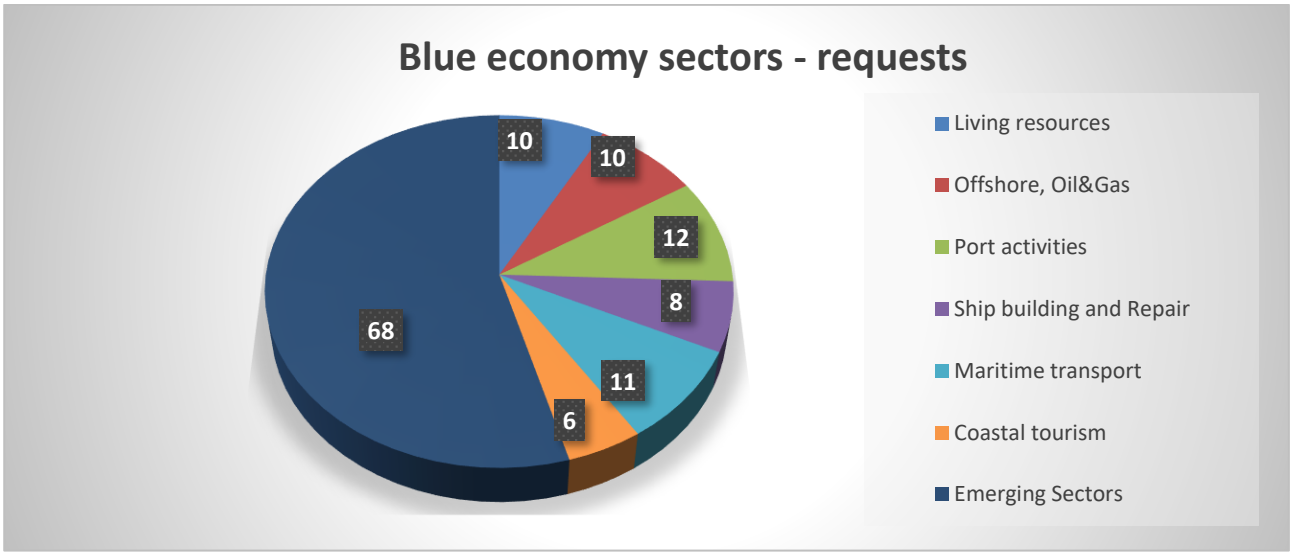
The blue economy sectors in which the stakeholders would like to disseminate their offers are shown in the following figure.



The emerging sectors in which the stakeholders would like to disseminate their offers are shown in the following figure.



The blue economy sectors in which the stakeholders would like to disseminate their requests are shown in the following figure.



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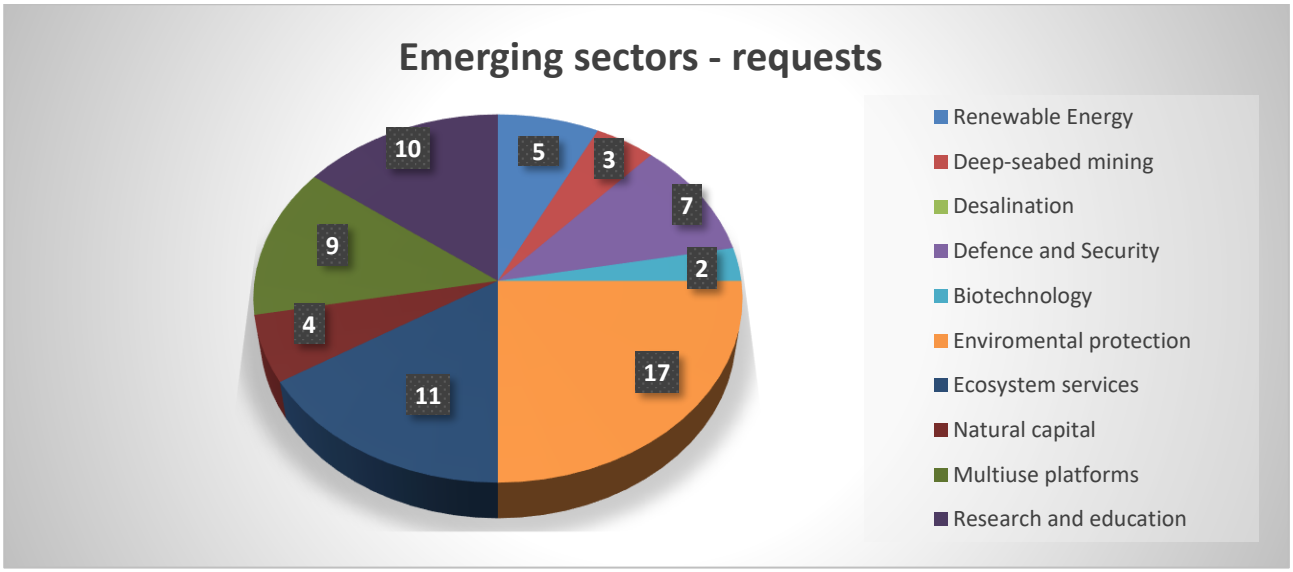


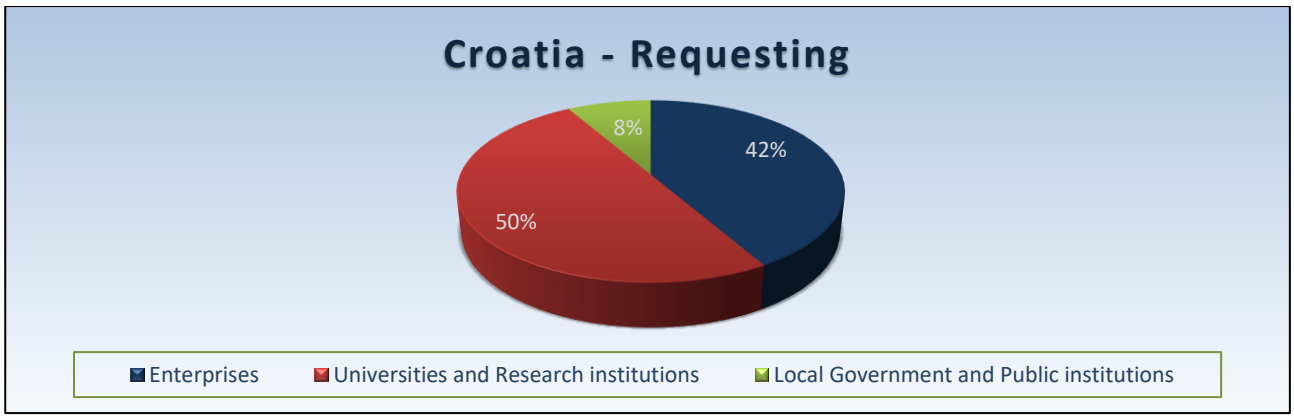
CHAPTER 4 – Qualitative analysis

Section 1 – Technology Assessment

In this section the open-ended responses of the questionnaires were analyzed and the technology offers and technology requests were categorized into specific categories in line with the analysis. Technology assessment was carried out for countries (Italy and Croatia) and for type of organization (enterprises, universities and research institutions, local government and public institutions).
In the first step of the analysis, the offers and the requests were evaluated for countries and for type of organization at the same time. The results are shown in the following figures.


Italy - Requesting
25%
25%
50%
Enterprises
Universities and Research institutions
Local Government and Public institutions

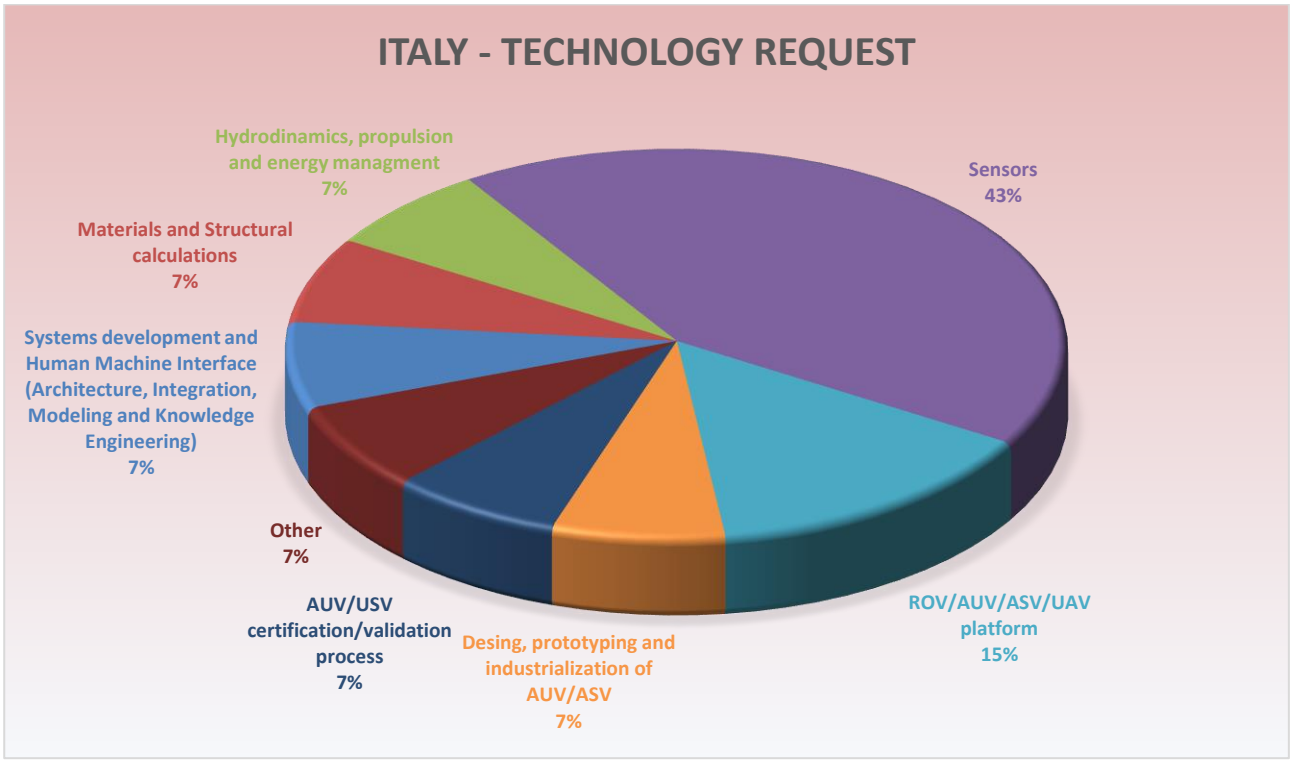

Croatia - Offering
47%
53%
Enterprises
Universities


Croatia - Requesting
8%
42%
50%
Enterprises
Universities and Research institutions
Local Government and Public institutions

As shown in figures, public institutions are more present in demands than in offers, according to the increasing environmental awareness of the national policies. The Italian offers are the only cases of offers by public institutions. They were submitted by Apulian Regional Agency for the Prevention and Protection of the Environment (offering competences in water monitoring and biology), SMACT Competence Center (offering competences in advanced IoT and AI integration) and T2i Trasferimento Tecnologico e Innovazione (offering competences in IoT solutions and in the Human-Machine Interface field). It has to be highlighted that some of the mentioned actors are not properly Public Administration, but they could not be included in the other two categories, thus it has been decided to count their questionnaires as Public Administrations. Most requests and offers are submitted by universities and research centers, for both Italy and Croatia.
The second part of the analysis focused on technology assessment of offers and requests for Italy and for Croatia, as shown in the following figures. In order to categorize them, a number of categories have been defined and the figures show only the populated ones.

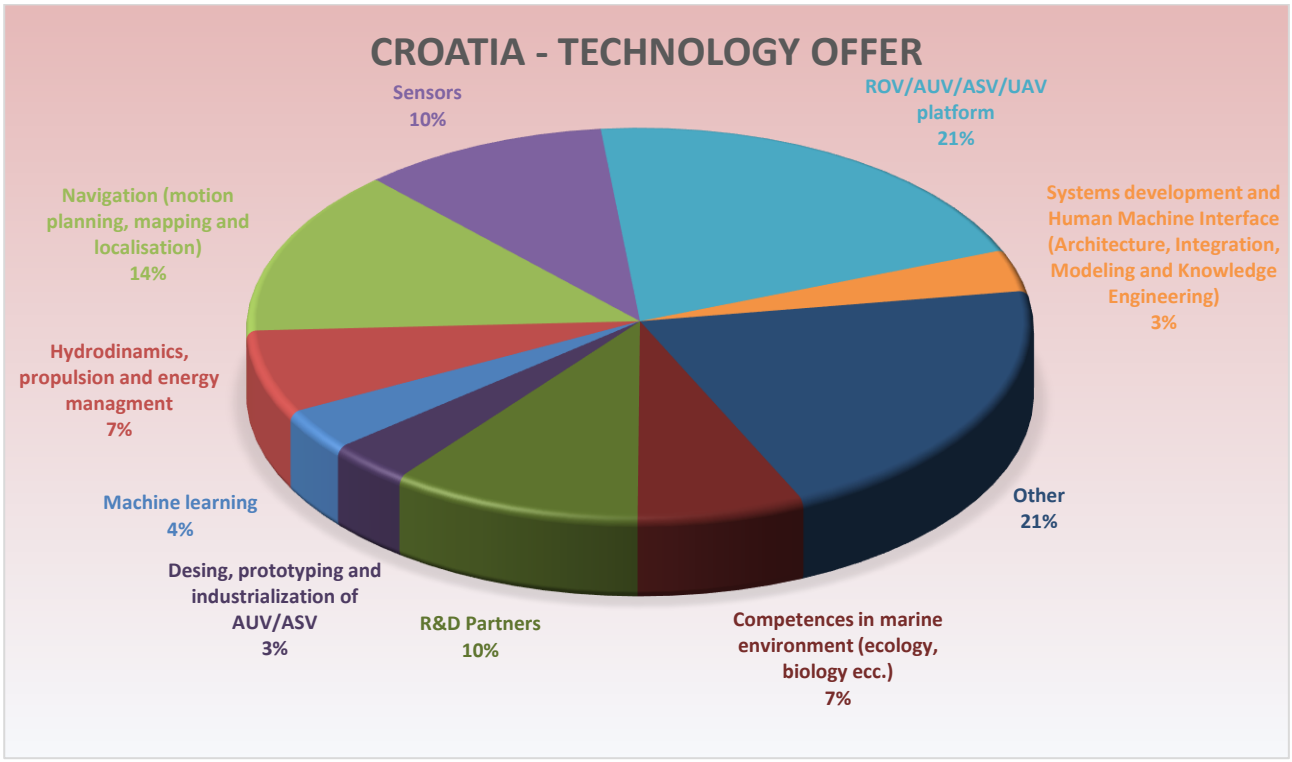
Under the category “other”, Italian stakeholders have specified the following keywords related to technology offers:

- Sea monitoring full infrastructure
- Underwater noise monitoring full system
- 2D and 3D physical and numerical models of marine and environmental hydraulics



Under the category “other”, Italian stakeholders have specified the following keywords related to technology requests:

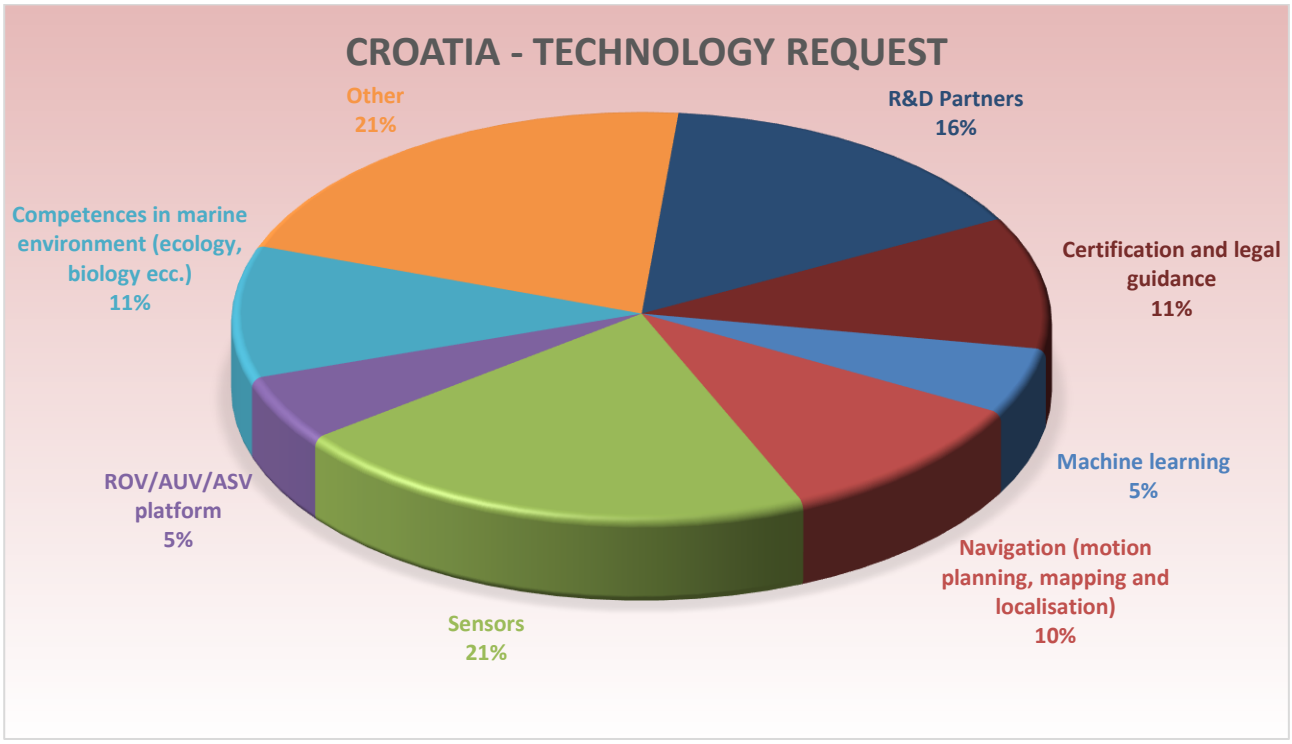
- Infrastructure inspections and perimeter surveillance



Under the category "other", Croatian stakeholders have specified the following keywords related to technology offers:

- Satellite imagery
- Software solution for automated process of fish biometrics
- IoT device with cloud applications
- Underwater device with acoustic beacon
- Low-cost portable environmental lab with IoT functionalities
- Photogrammetry

The category "R&D partners" includes all those open-ended responses in which the organizations did not specify a specific technology, but they have expressed their willingness or their need to perform scientific research in the multidisciplinary field of maritime studies. This category is present both in the offers and requests, and has the same meaning in all the following parts of the analysis.

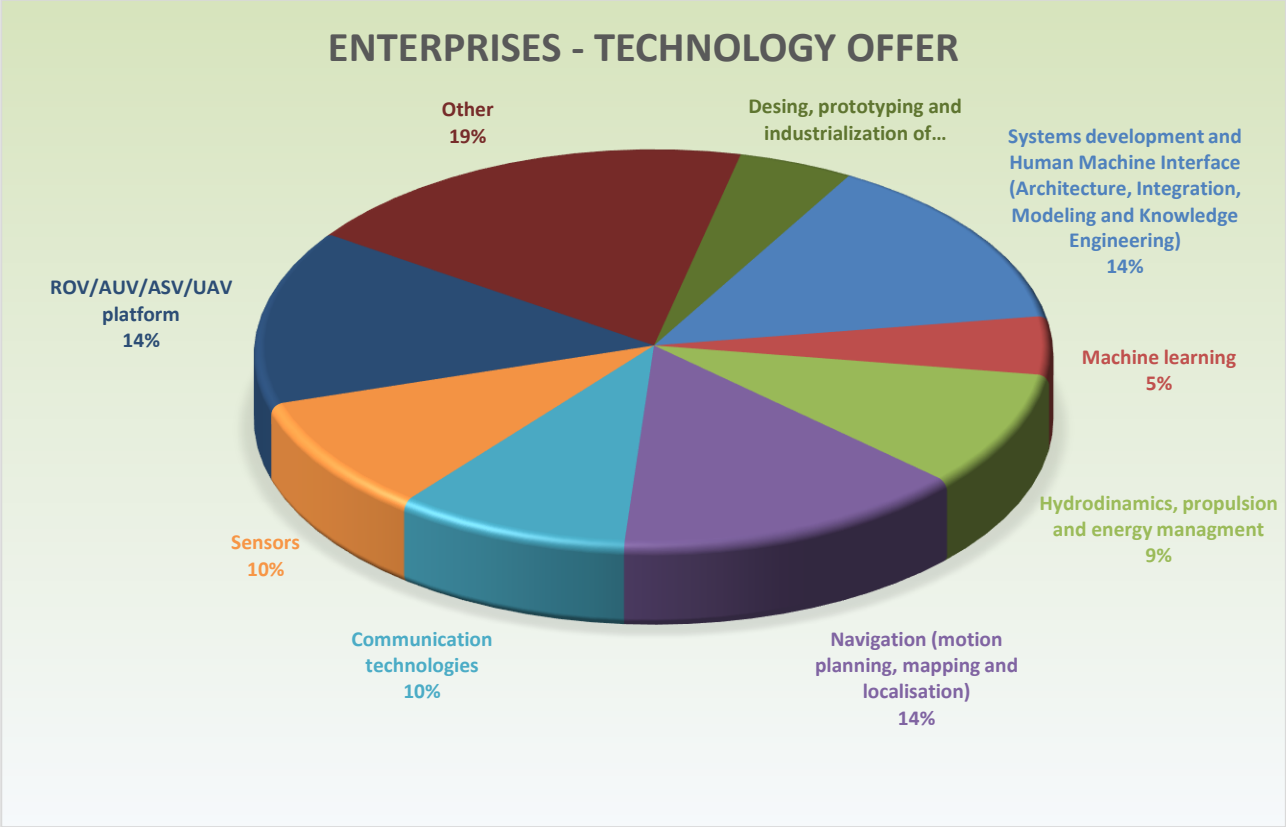


Under “other”, Croatian stakeholders have specified the following keywords related to technology requests:

- Laboratory analysis for water quality
- Buoy with sensors and IT tool
- Commercial partner in Italy
- Potential end-users and implementation partners

In general, offers are concentrated in systems development and HMI, navigation, ROV/AUV/USV platforms, whereas requests focus on sensors and certification.
In particular, the figures show a strong demand for sensors in Italy (to detect hydrocarbon leaks in water, to take the temperature and to take the salinity of sea surface, to detect microplastic and other tasks). Many of the Croatian offers consist in complete ROV/AUV/ASV/UAV platforms, both for specific tasks, such as human diver assistance or to capture microplastics, both for different tasks, thanks to the possibility to exchange payloads (sonars, cameras, chemical sensors, navigation systems etc.).

Offers and requests have been classified per type of organization (enterprises, universities, local government and public institutions) in the last phase of the analysis. The following figures show the results.



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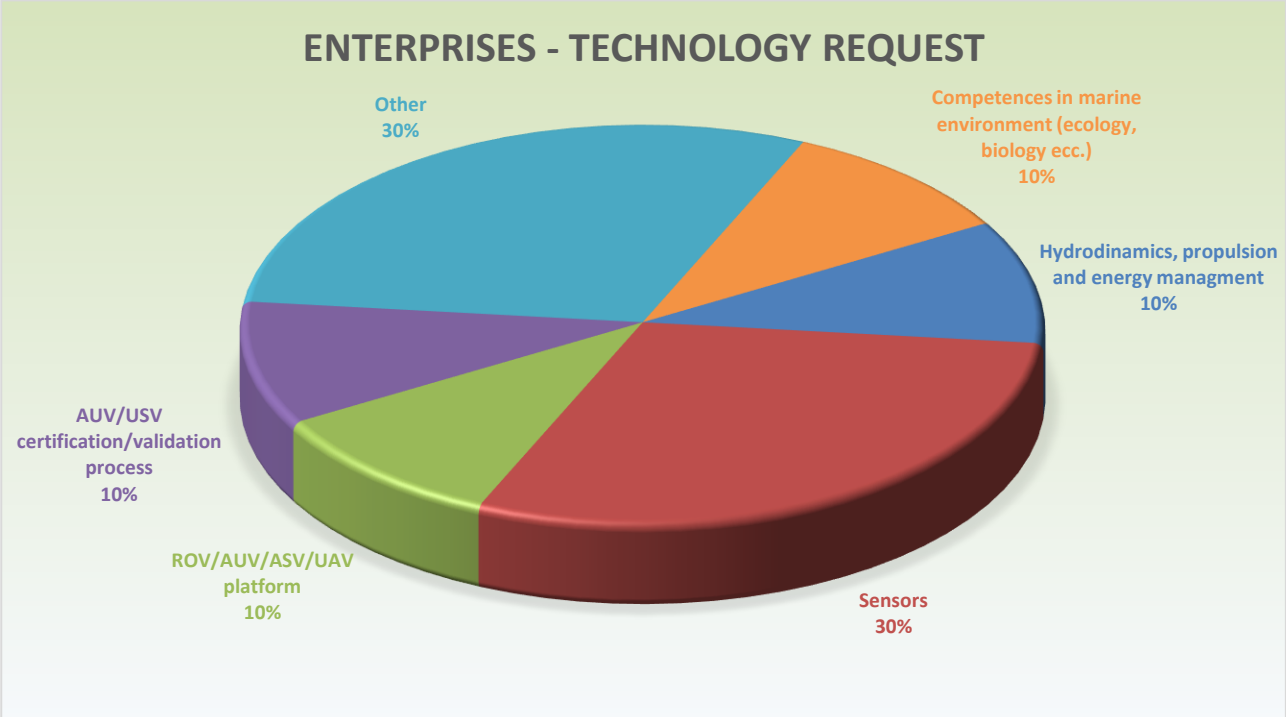
- IoT device with cloud applications
- Photogrammetry



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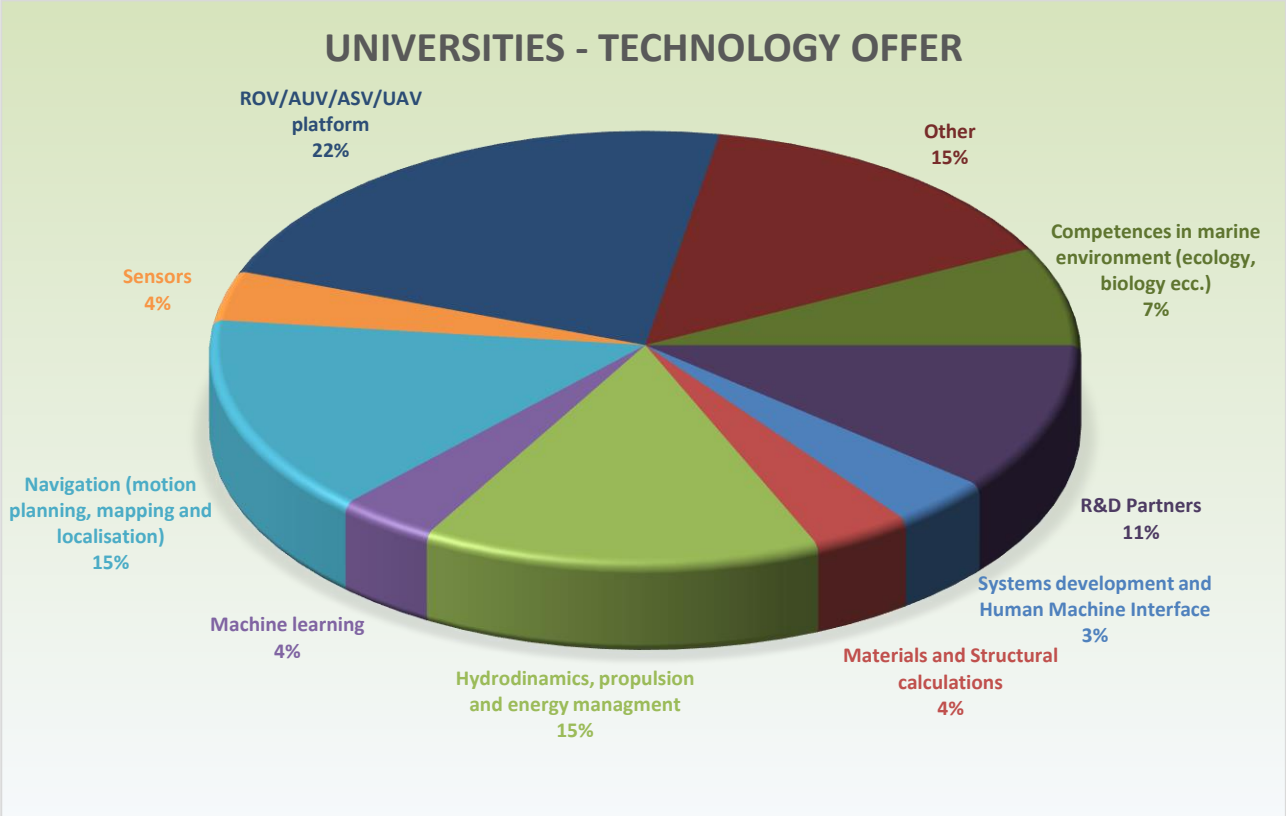
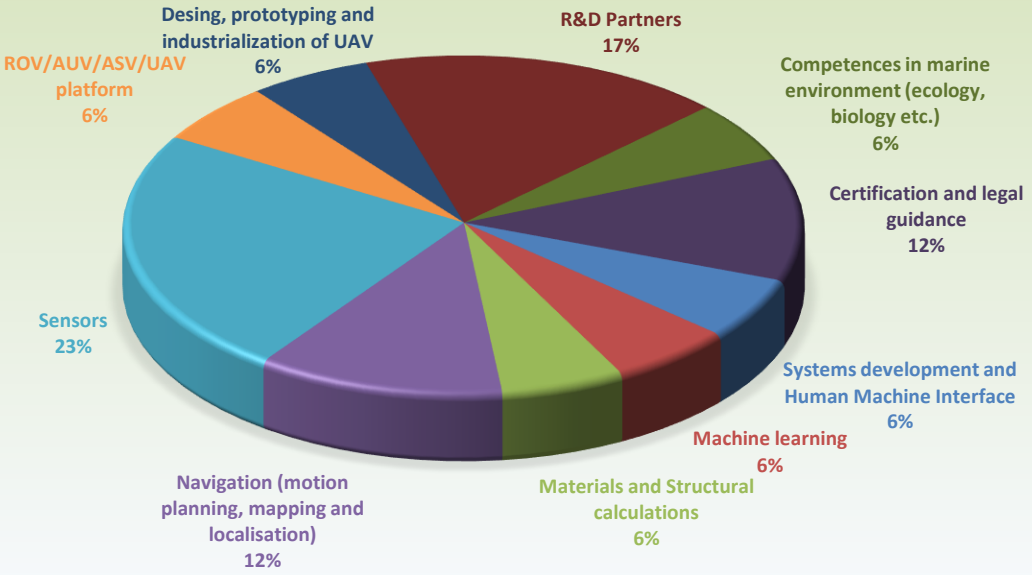


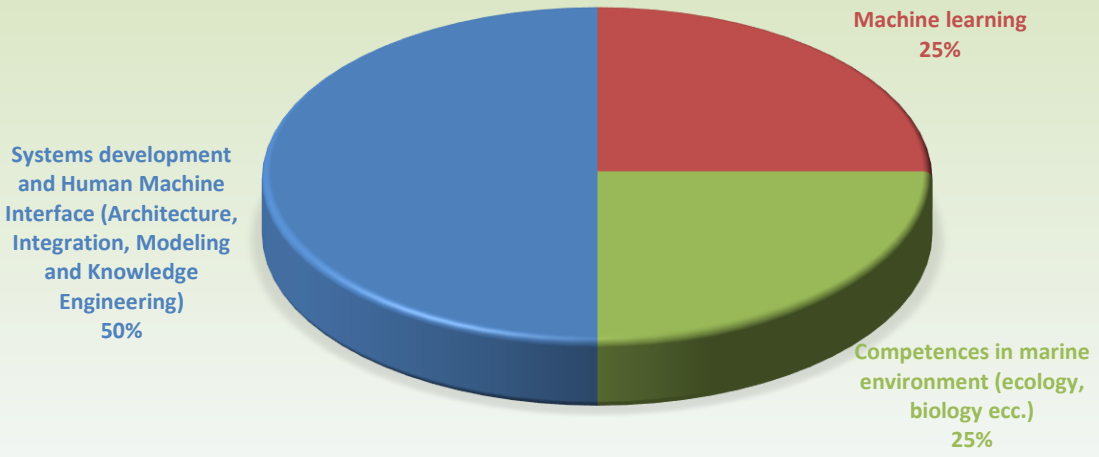
Under the category "other", stakeholders have specified the following keywords related to technology requests:

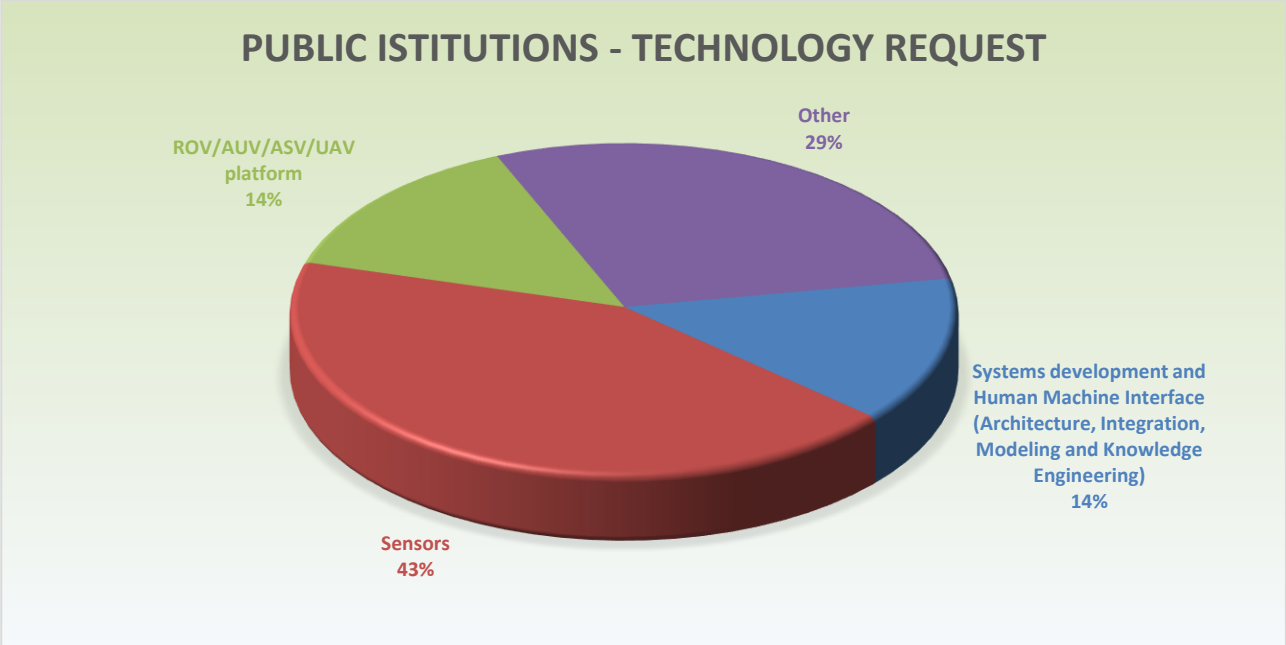
- 2D and 3D physical and numerical models of marine and environmental hydraulics
- Sea monitoring full infrastructure
- Full system of underwater noise monitoring
- Underwater device with acoustic beacon
- Low-cost portable environmental lab with IoT functionalities

UNIVERSITIES - TECHNOLOGY REQUEST



PUBLIC ISTITUTIONS - TECHNOLOGY OFFER





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- Infrastructure inspections and perimeter surveillance
- Buoy with sensors and IT tool

As figures show, technology offers and technology requests are uniformly distributed among the stakeholders, except in some cases, e.g. technological demand of sensors by enterprises and by public institutions, the robotic platforms offered by universities, the demand of sensors by universities and by enterprises. The high percentages in the technological offer of public institutions are due to the very low number of offers submitted (only four technological offers).

Section 2 – Technology matching

The purpose of this chapter is to understand whether the number of offers is able to answer the requests expressed in the area, at least potentially. A group of 52 questionnaires in the geographical area considered and in relation to the specificity of the sector (marine robotics and sensors) has to be considered a good reference group.

Before entering into detail, a first consideration should be performed comparing roughly the number of offers and needs expressed for every category:

CATEGORY	NUMBER OF REQUESTS	NUMBER OF OFFERS
Systems development and Human Machine Interface (Architecture, Integration, Modelling and Knowledge Engineering)	2	6
Machine learning	1	3
Materials and Structural calculations	1	1
Hydrodynamics, propulsion and energy management	1	7
Sensors	10	3
Competences in marine environment (ecology, biology etc.)	2	3
ROV/AUV/ASV/UAV platform	3	9
R&D Partners	3	3
AUV/USV certification/validation process	1	0
Navigation (motion planning, mapping and localisation)	2	7
Communication technologies	0	2
Desing, prototyping and industrialization of AUV/ASV	1	1
Other	5	8

When considering a potential matching between request and offers, on a primary and entry level assessment, we underline that addressment between the two categories in not strictly one to one. We recognized that in certain cases one request was addressed by more than one offer and, in reality, even after this first assessment some matching was already tracked. The outcomes witness a need in terms of **underwater mapping** through dedicated USV platform and for autonomous AUV platform, in this case specific **modelling competences** and customized devices could contribute and give an answer. In addition, tailored laboratory analysis for water assessment could be improved with devices for **water monitoring** and AUV and ROV or multisensory data logger. **Micro plastics** is another topic that raised needs when considering sensors and sampling processes, in that cases customized software and hardware design may be adapted and dedicated calculations and machine learning tools could be applied.

Despite, we should highlight there are some critical categories that show higher mismatch between requests and offers. The offer lacks in a crucial segment as **sensors** is with many requests un-addressed. On the other side, when considering requests, there is a lack in relation to ROV/AUV/ASV/UAV platform, as well as

hydrodynamics, propulsion and energy management and navigation (motion planning, mapping, localization): in this case the capabilities are wide but there is not a need at local level for the solutions provided.

CHAPTER 5 – State of the art in underwater robotics

Section 1 – State of the art

The modern needs of industry and civil authorities led to a growing knowledge of the underwater environment and higher interaction capabilities with it. The underwater environment is today seen as integral part of working environment for certain industries, such as shipping industry and oil and gas, but is also seen as integral part of global economic system, as source of minerals and energy from renewable sources. The need of an increased knowledge of underwater environment is also due to a growing environmental sensibility of national and international authorities, which must have technological instruments for marine ecosystems monitoring and protection. All these needs created a context in which the marine robotics development is a key factor in the industrial strategies and in the national and international policies for marine environment protection. Furthermore, an additional thrust to the marine robotics development is given by scientific purposes, such as the underwater exploration aimed to underwater archaeology or the discovery of animal species which live in the sea depths and their behavior analysis.

Underwater robots can be classified in two main categories: the **remotely controlled vehicles** and the **autonomous vehicles**. The first category includes the Remotely Operated Vehicles (ROVs), while the second includes Autonomous Underwater Vehicles (AUVs), often referred to as Unmanned Underwater Vehicles (UUVs).

EU-funded projects are aimed at improving *key enabling abilities* (configurability, adaptability, interaction capability, dependability, motion, manipulation, perception, decisional autonomy and cognitive ability) through *key technology targets* defined by *the Strategic Research Agenda for Robotics in Europe 2014-2020* and by the *Multi-Annual Roadmap for Robotics in Europe*. The *key technology targets* include systems development, a seamless human-machine interaction, marinisation of equipment (including actuators, energy sources, and computers) for deep water operations, advanced sensors for long-range underwater vehicle navigation, systems for single motion planning in the presence of known current fields and obstacles, In addition, other types of underwater robots are recently under development, such as the Hybrid Remotely Operated Vehicles (HROVs), which may perform either as ROVs or AUVs depending on the mission and Intervention AUVs (I-AUVs), which may perform manipulation tasks, in the past reserved to ROVs. In the upcoming years HROVs will increase their visibility thanks to the flexibility of use. Also, marsupial robotics, swarm robotics and morphology-changing modular vehicles are quite new trends in marine robotics applications, exploiting their suitable and unique capability to transform and adapt to missions and the

environment, and to carry heterogeneous and complementary payloads and sensors to meet a variety of scientific and commercial mission requirements. Thanks to their high flexibility, marsupial robots can be exploited for complex missions in harsh and dangerous environments but, in any case, they need new methodologies and brand-new concepts in perception, control and communication, being this still a big open challenge.
There are also formidable challenges in the general area of Cooperative Motion Planning, Navigation and Control using a Networked Systems Approach. Indeed, worldwide, there is a tremendous surge of interest in the development of the methodologies and technologies required to enable groups of robotic vehicles linked via communication networks to collectively inspect, survey, and map challenging underwater environments, while allowing operators to access the data collected during a cooperative mission. On this regard, the purpose of the *SubCULTron (Submarine Cultures Perform Long-Term Robotic Exploration of Unconventional Environmental Niches)* project has been to create an artificial society underneath the water-surface to the service of a human society above the water, specifically in the natural habitat monitoring, including biological agents like algae, bacterial incrustations of the environment and fish. The projects *Underwater Robotics Ready for Oil Spill – URready4OS and Expanded Underwater Robotics Ready for Oil Spill – e-URready4OS* were focused on using a cooperative team of marine robots (underwater, at surface and aerial drones) to detect and track in-water oil spills. The *SeaClear (SEarch, identificAtion and Collection of marine Litter with Autonomous Robots)* project also aims at automating the process of searching, identifying and collecting marine litter, using a team of autonomous robot that work collaboratively. The project uses advanced techniques for robotic sensing and motion control involving AI and machine learning in several key roles, such as distinguishing between litter and life forms.

REFERENCES

[1] Enrica Zereika, Marco Bibuli, Nikola Miskovic, Pere Ridao, Antonio Pascoal, Challenges and Future Trends in Marine Robotics, Annual Reviews in Control, Volume 46, 2018, Pages 350-368, https://doi.org/10.1016/j.arcontrol.2018.10.002
[2] Strategic Research Agenda For Robotics in Europe 2014-2020, 2013.
[3] Robotics 2020 Multi-annual Roadmap, 2016.
[4] SubCULTron website, URL https://cordis.europa.eu/project/id/640967
[5] e-URready website, URL https://ocean.upct.es/urready4os/
[6] SeaClear website, URL https://www.seaclear-project.eu/

Section 2 – InnovaMare positioning

Positioning of INNOVAMARE analysis. Adriatic Sea compared to World and EU scenario.

InnovaMare is perfectly integrated in the vision for marine robotics outlined by the *Multi-Annual Roadmap for Robotics in Europe [1]*. According to questionnaires submitted by organizations, InnovaMare covers many field and functional applications of marine robotics, such as environmental surveys, oil and gas surveys,

harbour and borders surveillance and protection, underwater intervention, scientific data collection and sampling, underwater archaeology and cultural heritage conservation, scientific data collection and sampling, companion robots for divers.
In addition, InnovaMare contributes to many of the *key technology targets* identified by the *Multi-Annual Roadmap* for a new generation of advanced marine robotics systems. There are in fact several cases of offers which can contribute to the technical advance, both from Italy and Croatia.
There are many contributions to the systems development from the Italian side. In particular, there are offers of multiple robot systems which can operate using machine learning algorithms for a variety of purposes, such as surveillance of maritime borders, of natural reserves, of archeological sites and for searching dangerous objects, but also there are offers of vehicle modeling competences or propulsion systems to improve the energy efficiency and environmental sustainability. In Italy there are also offers relate to the perception ability of robot in self built maps with Simultaneous Localization and Mapping (SLAM) techniques, which is one of the most important technologies with high potential impact on marine underwater robotics and other domains of mobile robotics, according to the *Multi-Annual Roadmap*. There are also advanced solutions from the Croatian side, such as offers relate to the propulsion systems which can improve the energy efficiency and the environmental sustainability, reducing maintenance at the same time. Croatia also offers systems of heterogeneous marine robots which ca be used for hydrological surveys with the ability to autonomously follow the preplanned mission using IMU and GPS localization system. In addition, also Croatia like Italy offers solutions which using machine learning to detect waste or objects in general, including aquaculture applications. Thanks to Croatian stakeholders, InnovaMare can also contribute to the field of cognitive human-robot interaction providing marine robots for diver assistance and localization with the possibility to be controlled using an intelligent diving gesture recognition glove that communicates with the robot acoustically.
However, InnovaMare points out some demands for marine robotics in Adriatic Sea. Some stakeholders have indeed expressed their need to use systems for deep water operations. In particular, some Adriatic Sea stakeholders are looking for high energy density and pressure tolerant energy systems in order to conduct Inspection, Maintenance and Repair (IMR) campaigns in deep water for the oil and gas sector. According to the scenario proving by InnovaMare project, another challenge for Adriatic Sea stakeholders is the development of sensors for several purpose and in several fields of application, from the development of sensors to detect and to classify hydrocarbon leaks for the field of oil and gas to the development of sensors for the marine science and for the marine environmental sustainability.

REFERENCES

[1] Robotics 2020 Multi-annual Roadmap, 2016.

CHAPTER 6 – Services to be developed for the Digital Innovation Hub

The collection of TO&TR beside the first assessment in terms of technologies and capacity of the territories involved in the domains of marine robotics and sensors, highlighted also some significant elements about the collaboration and the support that this specific branch would need. The purpose of this chapter is thus to translate the situations emerged into potential spillovers helpful to design the concrete support of the InnovaMare DIH.

1. In total, 72 questionnaires have been collected, but only 52 were complete and valid. In the process of collection, a filled questionnaire was made available as example and project partners were asked to verify the contents and, if needed, to perform a quick interview to the proposer. Moreover, the single form should have included only one offer OR one request, whereas 11 included both. Some proposers affirmed it was not completely clear to them which type of information and at what level should be included in the form. This lead to difficulties in matching offers and requests and level of details that vary a lot.

Suggestion: establish a permanent support for the preparation of TO&TN step-by-step, no matter who is the actor (company, academia, PA). In this way, the announces published on the platform will allow a real marketplace and the matching could be performed automatically and precisely. This support could be provided by staff adequately trained, a technical and specific knowledge or education in the sector is not needed.

2. Keywords and categories to classify offers/requests are essential for a good result in terms of matching. Is it quite normal that the category “other” - when active – is always populated because of the difficulty of assigning a concept to the right category. In this sense, the support suggested at point 1 is a first step to overcome this problem.

Suggestion: a comprehensive description/list of which topic fall into a specific category/keyword is to be implemented, but moreover a timely revision of the categories able to incorporate the technological changes is essential. In this case the task should be assigned to people having a deep understanding and knowledge of marine robotics and sensors.

3. The majority of technology offers show a development status of TRL 4-6, but the requests ask for products already on the market.

Suggestions: the DIH should develop a good-balance range of services in order to support the different project ideas to reach the next development step. Numbers show that it is probably better to start with supporting action able to reach TRL > 7. In parallel, probably not all requests really need a product already on the market, but can wait some time and will appreciate the participation in development stages, at least

as “end users”, not necessarily already under a specific contract. For this second point, specific (in)formative sessions about how to co-develop/co-design products and solutions could be implemented, using the Living Lab facility.

4. Both offers and requests ask for a really well-balanced type of partner and in this case the category “other” is not so much used. There is always a strong request of collaboration with companies (SME, large companies), which are not so represented in the sector.

Suggestion: keep the balance among different actors participating and focus on engaging more and more companies.

5. The three main categories requested in terms of cooperation are R&D cooperation (of which EU cooperation could be considered as part of) and commercial cooperation. Many requests also mention suppliers and sourcing. It is to mention that EU funding is much more requested if compared to investments.

Suggestion: considering that cooperation is very much requested, some services of the DIH should be dedicated to answer this need. Another consideration should be done referring to investments. Since there are not so many private companies in the sector, this is probably the reason why investments are not requested, but with the idea of attracting more private companies some capacity building action about how to use investments in a profitable way and some support for new business ideas about the type of investments (and related funds) could be helpful.

6. There are categories with many offers and requests, compared to the general numbers. Requests are concentrated in the category “sensors” and offers cover “System development and HMI”, Hydrodinamic, propulsion and energy management” and “ROV/AUV/ASV/UAV platform” and “Navigation (motion planning, mapping and localisation”.

Suggestions: organize **working groups** for every category used to map offers and requests. Moreover, for the critical ones (ie those that collect the greatest number of offers or requests) after an specific analysis to understand the potential, if the local value chain does not have the features to be enlarged, one option could be to **establish mutual collaborations with innovation ecosystems** (not necessarily in the same geographical area) with which sign agreement for cooperation, in order to connect value-chains and open the actors of the territory to new opportunities, while complementing the local capabilities.

CONCLUSIONS

In relation to the whole analysis carried out, we can state that 72 questionnaires were collected, but only 52 were validated. In this sense, when considering future perspectives, there are possibilities to increase the number of validated questionnaires through dedicated support in the filling in the preparation and submission phase. The results present a good balance between Italy and Croatia, with a larger number of questionnaires from Italy, but a higher rate of platforms in terms of offer from the Croatian side. Even though the outcomes highlight the lack on specific and targeted topics, especially when considering offers of sensors and requests for navigation and hydrodynamics, the state of the art assessed could represent an opportunity to create the connection with other innovation ecosystems focusing need and priorities expressed through InnovaMare. In terms of requests, we highlight how the needs could be further analyzed in order to stimulate a more intense commitment from public administrations to give voice to their needs in terms of technological solutions. The overall approach helped to understand what the current scenario at the Adriatic level is, and helped to position when compared to the global situation and to extract specific insight for further project related activities.