STRENGTHENING THE CAPACITY FOR EXCELLENCE OF SLOVENIAN AND CROATIAN INNOVATION ECOSYSTEMS TO SUPPORT THE DIGITAL AND GREEN TRANSITIONS OF MARITIME REGIONS

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LONG-TERM JOINT R&I STRATEGY

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Abstract	This document outlines the strategic framework for research and innovation in the Western Slovenia and Adriatic Croatia maritime sectors. The strategic framework is developed based on analyses and mapping of the maritime innovation ecosystems in Western Slovenia and Adriatic Croatia. It takes into consideration a wider strategic context (supranational, national, and regional) and is built on four strategic objectives. They are further decomposed into priority areas and corresponding measures, whose implementation is expected to lead to the achievement of a jointly set vision.
Keywords	Research and innovation, maritime sector, strategic objectives, priority areas, measures, indicators

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4. BSC, Business Support Centre Kranj – Regional Development Agency of Gorenjska, Slovenia
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6. UNIRI, University of Rijeka, Croatia
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7. STEP RI, Science and Technology Park of the University of Rijeka, Croatia
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EXECUTIVE SUMMARY

Many activities undertaken in the maritime areas of Slovenia and Croatia are intertwined, linked, and bring diverse impacts in both countries. Technological trends, climate changes, unexploited potential for the use of renewables, increasing negative impact on the Adriatic Sea and the coastal areas from various economic activities, growing environment-related problems, waste generation, lack of coordination in the implementation of various (mainly planning) documents call for more concerted action of decision makers and stakeholders in maritime innovation ecosystem. As a response to that, one of the deliverables of the project *Strengthening the capacity for excellence of Slovenian and Croatian innovation ecosystems to support the digital and green transitions of maritime regions* – INNO2MARE is this Long-term joint R&I strategy for Western Slovenia and Adriatic Croatia (R&I Strategy). It is a result of combined and joint actions undertaken by all participating partners and stakeholders and is based on several inputs as follows:

- Analytical assessment, identification, and quantification of the key economic and technical indicators of the Croatian maritime innovation ecosystem
- Report on the ecosystem's mapping (for both countries)
- Report on the ecosystem's needs (for both countries)
- Findings and conclusions of the workshops with project partners and stakeholders conducted during the project implementation
- Other relevant documents and sources.

The strategic framework developed here reflects the response to the ecosystem's needs, striving to bridge the gaps identified in both ecosystems and provide strategic directions for future actions to be implemented to achieve the vision. A jointly developed vision is future-oriented and in compliance with all current trends at the EU and global levels. The vision is as follows:

> *Western Slovenia and Adriatic Croatia are innovative, resilient, and sustainably using marine space and resources developed contributing to emission reduction and supporting blue economy growth. The maritime research and innovation ecosystem of the region is globally recognized and adaptive, fostering Adriatic Sea cooperation, knowledge sharing, and advances in innovation and technology.*

The overarching vision was useful in setting the strategic objectives, which are the following:

I. Digital advancement of the maritime innovation ecosystem
II. Green transition of the maritime innovation ecosystem
III. Attractive and in full capacity maritime ecosystem labour market
IV. Excellence in maritime ecosystems' governance.

For each strategic objective, priority areas and measures are defined, containing a number of projects, activities, and initiatives that contribute to the achievement of strategic objectives. The strategic framework also provides indicators that will serve to measure progress and evaluate implementation, performance, and achieved targets, which will be used to give directions for future actions.

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

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ABBREVIATIONS

AI	Artificial Intelligence
BELSPO	Belgian Science Policy Office
CFP	Common Fisheries Policy
DESI	Digital Economy and Society Index
DTO	Digital Twin Ocean
EC	European Commission
ECMAR	European Council for Maritime Applied R&D
EMB	European Marine Board
EMFAF	European Maritime, Fisheries and Aquaculture Fund
ESFRI	European Strategy Forum on Research Infrastructure
ESIF	European Structural and Investment Funds
EU	European Union
EUSAIR	European Union Strategy for the Adriatic and Ionian Region
EWI	Department of Economy, Science & Innovation in Flanders
GDP	Gross Domestic Product
ICT	Information and Communication Technology
INNO2MARE	Strengthening the Capacity for Excellence of Slovenian and Croatian Innovation Ecosystems to Support the Digital and Green Transitions of Maritime Regions
INTERREG	European Territorial Cooperation Programme
IPA	Instrument for Pre-Accession Assistance
IPA ADRION	Instrument for Pre-accession Assistance for Adriatic-Ionian region
JRC	Joint Research Centre
LGBTI	Lesbian, gay, bisexual, transgender
MSME	Micro, Small and Medium Enterprises
MSP	Maritime Spatial Planning
NAPA	North Adriatic Port Association

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NDS	National Development Strategy of the Republic of Croatia until 2030
NpAI	National Programme to Promote the Development and Use of AI in Slovenia
NUTS	Nomenclature of Territorial Units for Statistics used by European Union
R&D	Research and Development
R&I	Research and Innovation
R&I Strategy	Long-term joint R&I strategy
S3	Smart Specialisation Strategy
S4	Smart Specialisation Strategy 4 (Digital Slovenia 2020)
S5	Slovenian Smart Specialisation Strategy
SBEP	Sustainable Blue Economy Partnership
SDGs	Sustainable Development Goals
SEA	Shipyards' & Maritime Equipment Association of Europe
SME	Small and Medium-Sized Enterprise
SO	Strategic objective
SWOT	Strengths, Weaknesses, Opportunities, and Threats analysis
TRL	Technology Readiness Level
UN	United Nations
VC	Venture Capital

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1. INTRODUCTION

The project *Strengthening the capacity for excellence of Slovenian and Croatian innovation ecosystems to support the digital and green transitions of maritime regions* – INNO2MARE is a Horizon Europe project in which 19 organizations from Slovenia, Croatia, and Belgium participate. The main goal of INNO2MARE is to strengthen the capacity for excellence of Western Slovenian and Adriatic Croatian innovation ecosystems through a set of jointly designed and implemented actions that will support the digital and green transitions of the maritime and connected industries. Besides Slovenian and Croatian partners, the Belgian partners participate in the project in different project activities to support the development and later implementation of the Long-term joint R&I strategy[1]. Their support is to a large extent provided through various knowledge exchange activities and presentation of good practices in the Belgian maritime innovation ecosystem, with an aim to apply (what is applicable) and/or adapt solutions and positive examples to the Western Slovenia and Adriatic Croatia maritime innovation ecosystem.

INNO2MARE aims to initiate joint actions to boost cross-border cooperation and create scientific and economic synergies, primarily through:

- Formulating a shared Long-term joint R&I strategy and action & investment plan
- Implementing three R&I pilot projects addressing key challenges related to the maritime sector
- Creating opportunities for the effective transfer of innovative technology to the markets
- Improving conditions for talent attraction and retention following the principles of equal opportunities and gender equality
- Fostering knowledge creation and transfer based on the "Quadruple-Helix" model.

The Long-term joint R&I strategy for Western Slovenia and Adriatic Croatia (R&I Strategy) is one of the deliverables of the project. It is closely related to all the other project WPs and deliverables as it represents an "umbrella" for the implementation of various complementary, innovative, and future-oriented activities that will contribute to enhancing cross-border cooperation and strengthening the maritime innovation ecosystem of Western Slovenia and Adriatic Croatia. R&I Strategy is a result of combined and joint actions undertaken by all participating partners and stakeholders and is based on several inputs as follows:

- Analytical assessment, identification, and quantification of the key economic indicators of the Croatian maritime innovation ecosystem
- Report on ecosystem's mapping (for both countries)
- Report on ecosystem's needs (for both countries)
- Findings and conclusions of the workshops with project partners and stakeholders conducted during the project implementation

[1] *A full list of project and associated partners is presented in Table 7 List of project and associated partners.*

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- Other relevant documents and sources.

The analysis conducted through the INNO2MARE project revealed that the maritime innovation ecosystems of Western Slovenia and Adriatic Croatia are heavily industry-oriented, with over 80 % of all identified stakeholders belonging to the industrial helix. Nevertheless, the presence of software companies and start-ups has become increasingly visible, representing an emerging source of digital innovation and entrepreneurship. These actors play a crucial role in accelerating the twin transition by developing smart-port solutions, digital design tools, and green-technology applications.

The Strategy places particular emphasis on strengthening cross-helix collaboration, ensuring that academia, government bodies, and societal actors are more actively engaged alongside industry. The four-helix analysis quantifies the composition, expectations, collaboration and potential impacts for each stakeholder group, providing evidence that balanced cooperation will be decisive for achieving the vision of a globally recognised, digitally advanced, and sustainable maritime ecosystem.

We believe that the Strategy in which relevant strategic objectives, priorities, and measures have been identified can be used as a high-quality document to guide future projects and actions aimed at enhancing the capacity for excellence of Slovenian and Croatian innovation ecosystems, supporting the digital and green transitions of their maritime regions.

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2. PURPOSE AND OBJECTIVES OF THE DEVELOPMENT OF A LONG-TERM JOINT R&I STRATEGY

Many activities undertaken in the maritime areas of Slovenia and Croatia are intertwined, linked, and have diverse impacts in both countries. Technological trends, climate changes, unexploited potential for use of renewables, increasing negative impact on the Adriatic Sea and the coastal areas from various economic activities, lack of coordination in the implementation of various (mainly planning) documents, call for more concerted action of decision makers and stakeholders in the maritime innovation ecosystem[2]. This project, along with the R&I Strategy as one of its deliverables, is a response to the current state and guidance for future action that addresses many issues and challenges identified in analyses conducted to date within the project.

None of the actors in our maritime areas should act in an isolated way. The project has brought actors and stakeholders together and sought a joint vision, strategic objectives, priority areas, and measures that are quite realistic and likely feasible to implement.

This joint exercise of a strategy elaboration proved the need for a joint engagement in identification of critical areas that need improvements and/or setting up of missing organizational/institutional structures, further research and innovation related activities, cooperation, collaboration and networking to create desirable environment and atmosphere for achieving the strategic objectives set in a Long-term joint R&I strategy.

Innovation ecosystems are a complex process that spans the generation of ideas, their translation into products, and the commercialisation of these products on a large scale. The success of this progression depends on multiple factors, such as a business culture that rewards entrepreneurship, risk-taking and a will to embrace change, a set of regulations and administrative norms that incentivize this attitude, a strong knowledge-generation sector (universities, research centres and laboratories), and collaboration between these knowledge centres and commercial businesses. Innovation can be successfully steered towards applications particularly valuable to society (World Economic Forum, 2020).

When we add maritime to the innovation ecosystem (the Ecosystem), then it refers to the companies and organisations from the coastal region (in our case, Western Slovenia and Adriatic

[2] *Note: There are intrinsic strategic competition and even conflicts of interest between Croatia and Slovenia, which affect collaboration in sectors relevant for this project, i.e. energy, maritime and on-shore transport, fisheries, maritime domain management, territorial disputes in the Savudrija Bay etc. Although they are present and acknowledged, they however do not present a significant direct concern for R&I collaboration, but they may have a limiting impact on the implementation of joint strategies.*

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Croatia) and those from the continental region, but with major business operations carried out in the Adriatic region. In terms of the four-helix framework, Industry is the dominant category in both ecosystems, comprising companies that constitute the supply side of innovation (the innovative production firms) and the demand side of innovation (infrastructure, logistics, shipping, public, etc.).

Based on these premises, an analytical background has been prepared, needs and key challenges identified, and through a series of workshops, they have been translated in more concrete and operational steps, listing the projects and activities that could be implemented to enhance maritime innovation ecosystems of both countries and create more synergetic developmental effects.

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3. ANALYTICAL BACKGROUND

In this chapter, summaries of various analyses undertaken have been provided which present how the ecosystem has been mapped, what are the needs and challenges that are recognised in Slovenian and Croatian ecosystems, identification and quantification of key economic and indicators for Croatian maritime innovation ecosystem, financial analysis of Slovenian maritime stakeholders by category, and the findings included in SWOT analyses for both ecosystems.

3.1 Ecosystems' mapping – summary

3.1.1 Mapping of the ecosystems

The INNO2MARE project aims to map the Western Slovenian and Adriatic Croatian maritime innovation ecosystems to support digital and green transitions in the maritime and connected industries. The Report on Ecosystems' mapping (Deliverable D2.1) [1] represents a comprehensive analysis that examines the Slovenian and Croatian maritime and nautical industry ecosystem, including its innovation ecosystem canvas, SWOT analysis, and a list of all stakeholders.

The objectives of the mapping are understanding the current state of the industry, identifying strengths and weaknesses, opportunities and threats, developing recommendations for improvement, and supporting informed decision-making. The mapping should be a continued strategic activity for the ecosystem's sustainability and resilience to changes, as well as it should strive to include as many companies as possible, all those companies that may have great potential within the R&I ecosystem. Project-specific objectives include understanding key stakeholders, ongoing processes, past, present, and future activities, as well as relationships between the four-helix framework stakeholders.

The outcome of the ecosystem's mapping is a visual representation of the ecosystem, which can be used to understand the structure and dynamics of the ecosystem, identify areas of opportunity and risk, and develop strategies to enhance the sustainability and competitiveness of the ecosystem. The ecosystem mapping will also help better understand how the Slovenian and Croatian maritime and nautical ecosystems are interconnected.

Maritime and nautical innovation ecosystem mapping aims to understand its strengths and weaknesses, identify opportunities for improvement, and identify potential partners and collaborators. Stakeholders within the ecosystem are categorised by the four-helix framework and by categories that include logistics, production, shipping, software development, service, infrastructure, startups, incubators, VCs, research and academia, and other services related to the maritime and nautical industry. The number of identified stakeholders exceeds those included in the ecosystem canvas, mainly due to the difference between private companies that are innovative in their business model and companies that are not innovation drivers due to their core business. Within the mapping, the innovation driver is defined as a factor that promotes the development

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and adoption of new ideas, technologies, or processes that lead to significant positive change or improvement in the industry.

3.1.2 Slovenian maritime & nautical ecosystem

The Slovenian ecosystem is diversified, with a focus on promoting innovation, addressing niche markets, and rapid growth of the entrepreneurial ecosystem. The industry includes shipbuilding, transportation, logistics, and ports, with Luka Koper being the only colossal company that ranks among the larger Slovenian companies in terms of the number of employees and revenue. As such, it plays a vital role in the entire Slovenian ecosystem, being very small in terms of the size of the industry.

However, the industry's small size makes it primarily dependent on the private sector, which can be an advantage or a disadvantage. The largest share of stakeholders in Slovenia is represented by companies involved in production, logistics, start-ups, and software development. The number of start-ups, production companies, and software development companies drives innovation. The Slovenian maritime &nautical ecosystem is presented in Figure 3.1.

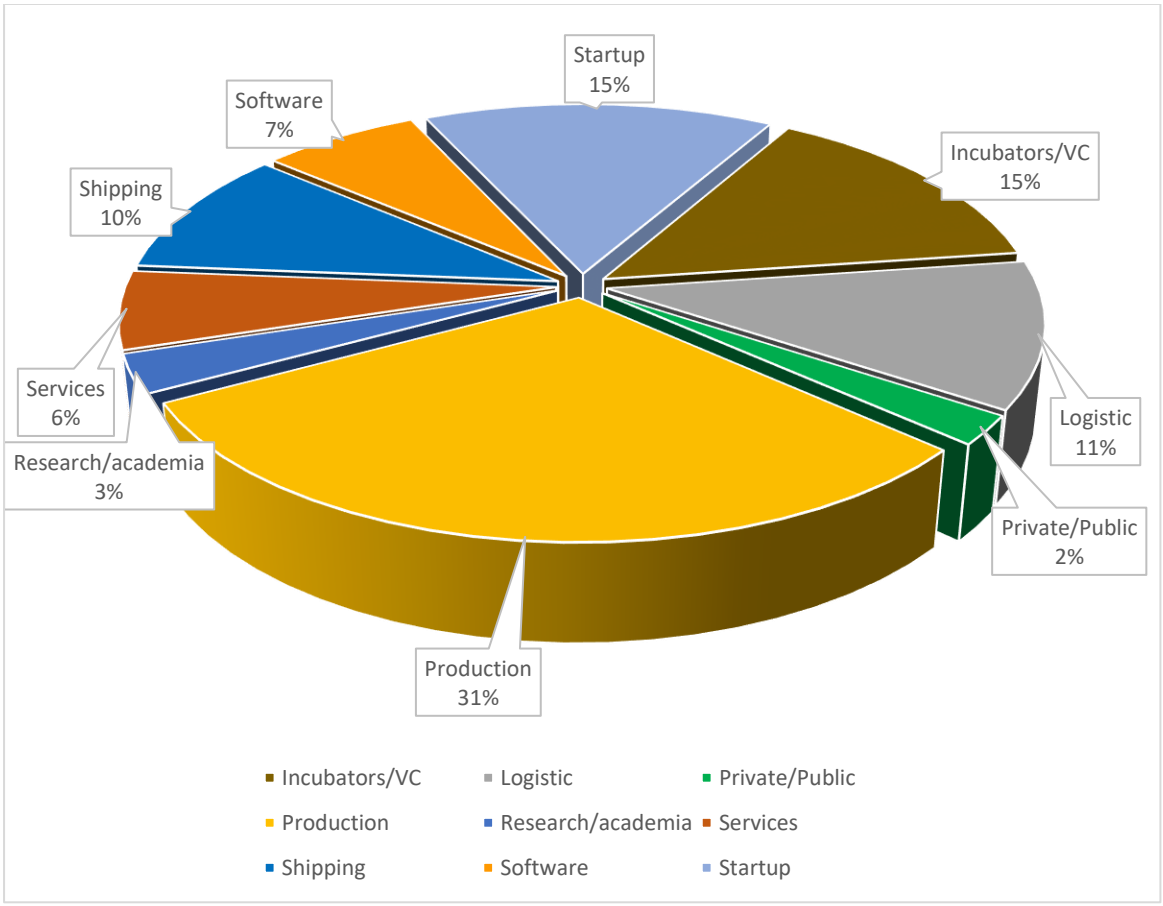

Figure 3.1: Slovenian maritime & nautical ecosystem (by categories with percentage shares of total stakeholders). Source: The Report on Ecosystems' mapping (Deliverable D2.1, V1.0) (2023).

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The Slovenian maritime and nautical industry is heterogeneous due to the dispersion of identified stakeholders in various categories. The largest share is represented by companies involved in production representing 31% of the ecosystem, and 39 such companies in Slovenia also fulfil the innovation criterion.

In terms of size, the next category is startups, representing 15% of the ecosystem. This is followed by a category of nine companies (7%) developing software related to the nautical or maritime industry.

The next largest category is logistics, with 15 logistics companies in Slovenia linked to the Port of Koper and thus to the maritime industry, and 13 companies were identified in the shipping category.

All the remaining categories, namely business incubators, research institutions, and public institutions, are smaller.

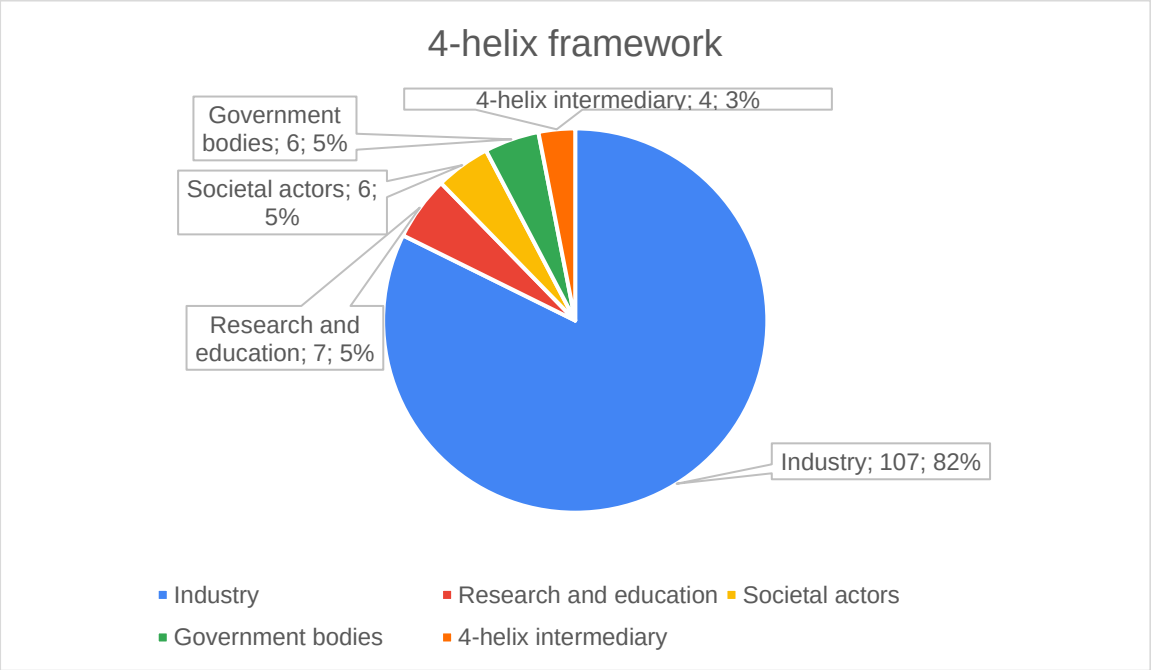

Figure 3.2: Categorization of Slovenian maritime and nautical industry stakeholders by the four-helix framework (by categories with percentage shares of total stakeholders).
Source: The Report on Ecosystems' mapping (Deliverable D2.1, V4.0) (2023).

As shown in Figure 3.2, while outlining the structure regarding the four-helix framework, Industry represents 82% of the Slovenian maritime innovation ecosystem with 107 stakeholders, and the remaining 18% is divided among Government bodies (5% - six stakeholders), Research and education (5%- 7 stakeholders), Societal actors (5%- six stakeholders), and the 4-helix intermediary which represents 3% of the ecosystem and counts for 4 stakeholders.

This configuration demonstrates a clear dominance of the industry helix, reflecting the strong role of private companies—particularly SMEs involved in production, logistics, and digital solutions—in shaping innovation activity. The comparatively smaller representation of academia, government,

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and societal actors indicates the need to reinforce inter-helix collaboration, especially in research transfer and innovation policy coordination.

The Slovenian maritime industry presents opportunities for innovation and new technological approaches, with a strong manufacturing and technical knowledge base. Opportunities include large infrastructure projects, emerging technologies, and a growing demand for sustainable and eco-friendly solutions. However, Slovenia faces challenges, such as limited access to funding, long administration processes, high taxation, public ownership of the Port of Koper, dependence on public financing, and outdated infrastructure.

3.1.3 Croatian maritime & nautical ecosystem

The Croatian maritime innovation ecosystem is a dynamic environment that includes various stakeholders, including universities, research institutions, software companies, start-ups, shipyards, shipping companies, ports, clusters, boatbuilders, and marinas. Apart from new technologies and environmental challenges, the driver of innovative performance in Croatia is the networking of public, private, and scientific research sectors to strengthen the competitiveness and innovation of the shipbuilding sector and related industries in Adriatic Croatia. The ecosystem is heterogeneous, with major stakeholders acting as competitors, especially in terms of high-skilled workforce acquisition, or collaborators, especially on specific projects. Some stakeholders are not interested in local collaboration due to their global market presence. Production is a crucial aspect of the Croatian maritime innovation ecosystem, consisting of naval design offices, shipyards, and marine equipment producers and suppliers. Design offices play a crucial role in the ecosystem, collaborating with shipyards, marine equipment producers, and suppliers. Among the most technologically advanced companies contributing to the industry are branches of multinational companies present in the ecosystem, including Luerssen, Mayer Group, Royal IHC, Kongsberg Group, Vard, and NAOS Group.

The Croatian maritime innovation ecosystem is undergoing significant transformations to tackle climate and environmental challenges while maintaining a competitive position in the global markets. The restructuring process of most Croatian state-owned shipyards presents challenges, but the industry has managed to survive and obtain new contracts with government intervention. State-owned shipyards in Croatia face weaknesses due to technological lag, lower productivity, inadequately skilled workers, and low financial potential.

The Croatian maritime &nautical ecosystem is presented in Figure 3.3.

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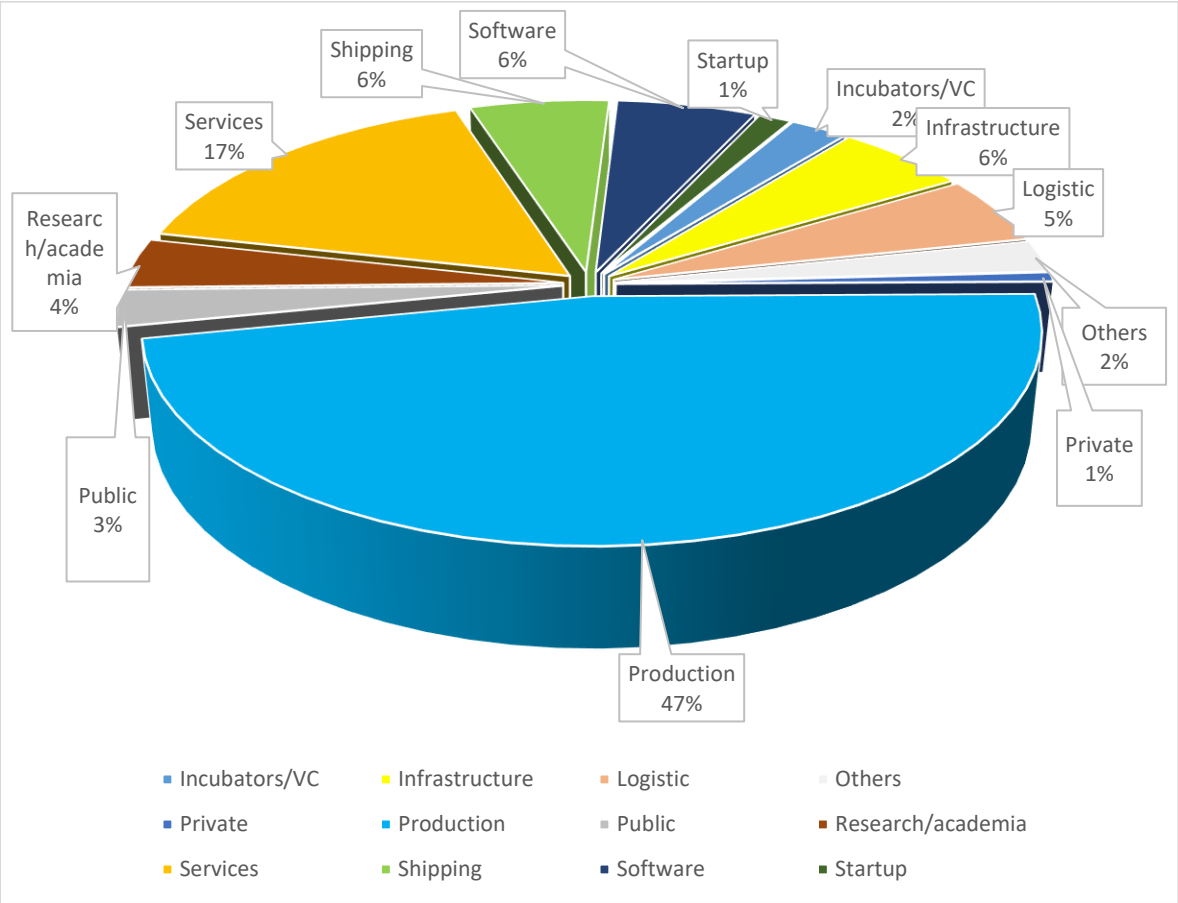

Figure 3.3: Croatian maritime & nautical ecosystem (by categories with percentage shares of total stakeholders). Source: The Report on Ecosystems' mapping (Deliverable D2.1, V1.0) (2023).

As shown in Figure 3.3, the largest share of the Croatian maritime innovation ecosystem is represented by companies involved in production (47%) of the ecosystem, with a total of 134 companies, of which 34 companies also fulfil the innovation criterion.

The next largest category is services, comprising 47 companies and accounting for 17% of the ecosystem, followed by shipping and software, each with 17 identified companies representing 6%.

In terms of size, the next categories are infrastructure and logistics, with 15 and 16 companies. This is followed by startups with only 4 companies identified, and a category labelled "others", which includes 7 companies.

All the remaining categories, namely business incubators, research institutions, and public institutions, account for a smaller number of identified entities.

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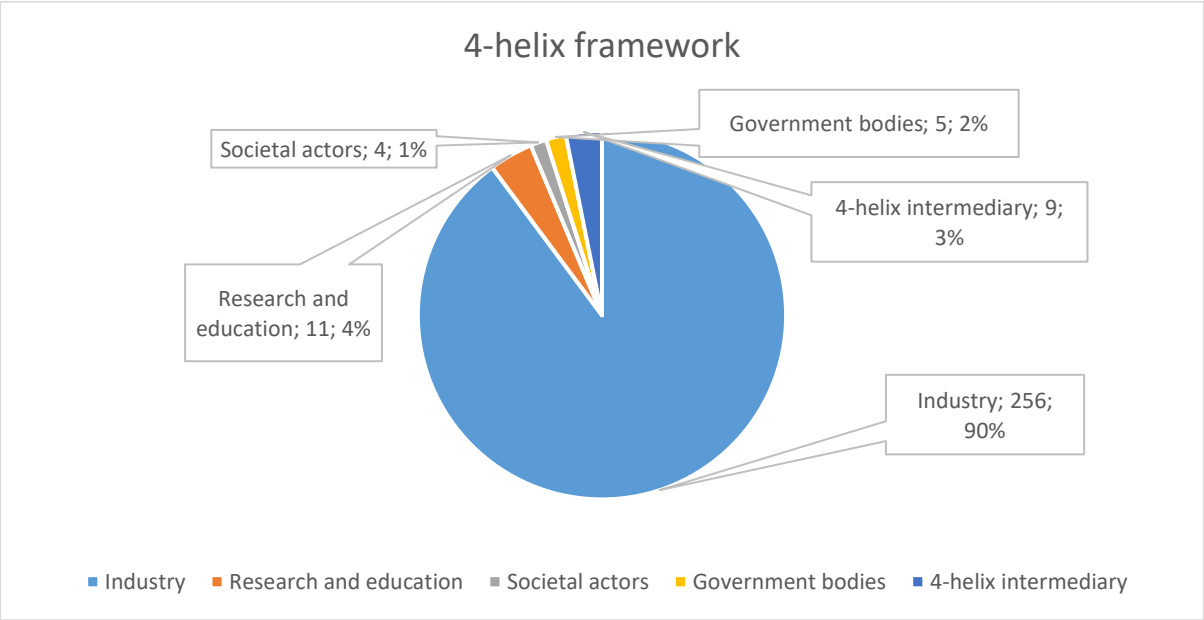

Figure 3.4: Categorization of Croatian maritime and nautical industry stakeholders by the four-helix framework (by categories with percentage shares of total stakeholders).
Source: The Report on Ecosystems' mapping (Deliverable D2.1, V4.0) (2023).

Figure 3.4 showcases the structure of the Croatian maritime innovation ecosystem by the four-helix framework. The core of the ecosystem is the industry category, which dominates the structure, encompassing approximately 90% and 256 identified stakeholders. The remaining 10% of the ecosystem is divided between Research and education (4% - 11 stakeholders), Government bodies (2% - 5 stakeholders), the 4-helix intermediary (3%- 9 stakeholders), and Societal actors as the least represented component of the ecosystem (1% - 4 stakeholders).

The Croatian maritime and nautical ecosystem displays an even more pronounced industry orientation. Such distribution underscores the business-driven nature of the Croatian innovation landscape, where private firms—particularly in ship design, shipbuilding, services, logistics, and software development—act as the main innovation engines. The limited involvement of academic, public, and societal actors points to an opportunity for greater policy alignment and cross-sectoral collaboration to balance the quadruple-helix structure.

One major stakeholder who acts as an innovation initiator and generator does not exist, but the ecosystem is heterogeneous and comprises many intersecting links between them.

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3.1.4 Mapping process

The mapping process was conducted in several phases, which are presented in Figure 3.5:

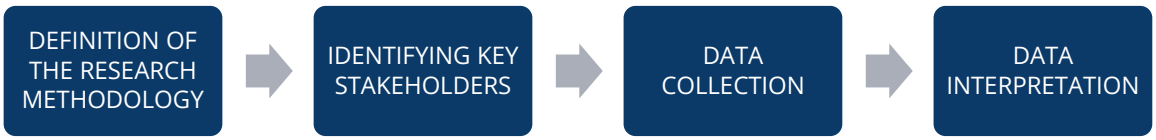

Figure 3.5: Mapping process.

The first phase involved defining the research methodology. The research methodologies used included desk research, database search, questionnaires, and interviews. The methodology involved designing the questionnaire, pretesting it, administering it, and collecting and analysing the data.

The second phase of the ecosystem mapping involved identifying key stakeholders, which include companies, research centres, maritime industry associations, governmental organizations, non-governmental organizations, startup incubators, academic institutions, and cooperatives.

Data collection was the third phase of the mapping, which involved searching databases and/or distributing a questionnaire to stakeholders. Additional data was collected using other research methodologies, such as the public business registers, which contained data about legal entities and their beneficial owners.

In the data interpretation phase, the analysis of the collected data was performed, extracting meaningful insights and relationships between stakeholders within the ecosystems and between ecosystems. The stakeholders were classified by the 4-helix framework and by categories.

The results of ecosystem mapping were presented in the form of an ecosystem map.

The maritime innovation ecosystem scheme, representing all 4-helix stakeholders, is presented in Figure 3.6.

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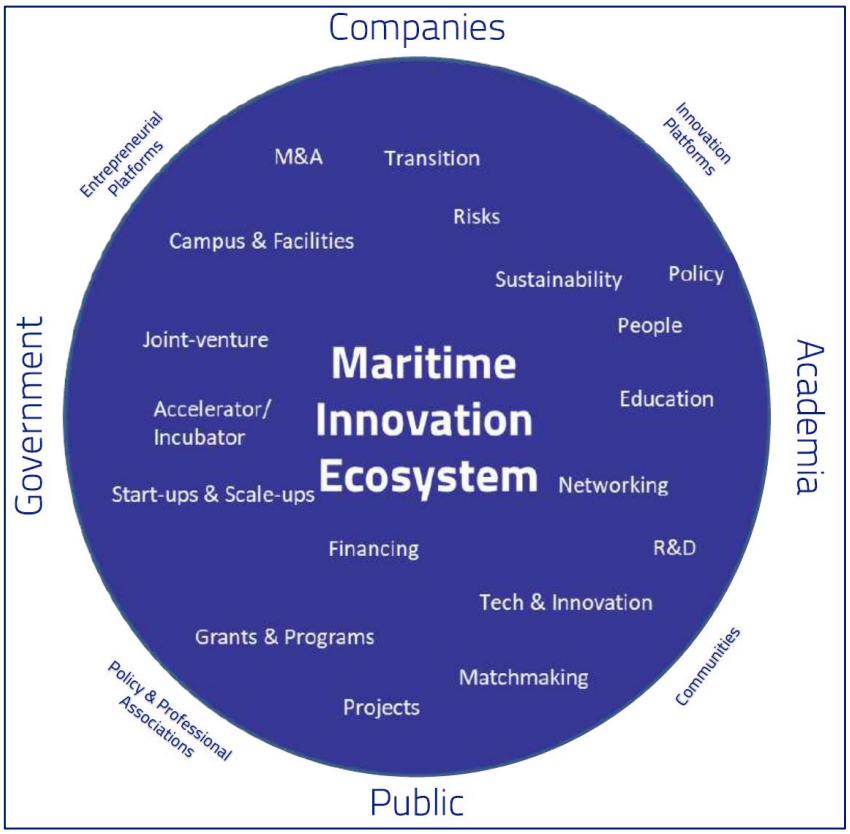

Figure 3.6: Maritime Innovation Ecosystem.
Source: Mehta, D. (2023), Navigating Innovation, INNO2MARE Antwerp visit, 13.12.2023. – presentation material.

3.2 Innovation ecosystems' needs – summary

The Report on Ecosystems' Needs is the output of Task 2.2 – Gap Analysis [2], whose purpose is to collect stakeholders' views regarding common and distinct R&I needs, gaps, challenges, and opportunities, as well as best practices, unmet needs, and possible solutions. The purpose of the Analysis is to identify gaps and deficiencies in the Croatian and Slovenian maritime innovation ecosystem and determine areas of improvement. Various aspects of the maritime industry have been assessed, including production, shipping, regulations, education, financing, and environmental impact, considering economic, environmental, and social factors affecting the ecosystem. In that respect, both internal and external factors are taken into account, which provides a comprehensive and more complete understanding of the ecosystem's current state and desired future state.

A gap analysis is used to assess the difference between the ecosystem's current state and its desired or ideal state. It helps identify areas where disparities or "gaps" exist between the two, which can then be addressed to achieve better performance and improvements. The importance of the Gap analysis is in providing insight relevant to strategic decision-making for industry stakeholders and policymakers. In bridging the gap and building successful ecosystems with all their components, an important role is played by the academic community. Academic institutions

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are in charge of the preparation of new education and training Programmes for future engineers and other experts who gain the knowledge required for companies and the market. Besides this important role, the institutions and the members of the academic community are often involved in the preparation, reviewing, commenting, and advising of strategic documents at national, regional, and local levels as well as in EU projects, identification of relevant research areas, developments and technologies that should be implemented in companies to increase their competence and values of various economic and technical performance indicators.

The results of the Gap analysis are based on conducting two workshops with Croatian stakeholders and two workshops with the Slovenian stakeholders in the maritime innovation ecosystems.

The results of the Gap analysis of the Adriatic Croatia and Western Slovenia Maritime Innovation Ecosystems are presented in Table 3.1 and Table 3.2.

Table 3.1: Results of the Gap Analysis of the Adriatic Croatian Maritime Innovation Ecosystem.

CURRENT STATE	IDENTIFIED GAP	POSSIBLE ACTIONS	DESIRED FUTURE STATE
Communication between stakeholders is not satisfactory, being sporadic, scattered, and practically non-existent	No systemic approach to communication	• Creation of a centralized hub/ platform where information can be exchanged between all stakeholders • Establishing a project registry of all ongoing innovation projects • Organizing conferences and workshops on a regular basis • Organizing forums with the purpose of presenting industrial achievements and the needs of businesses to universities and other stakeholders	Stakeholders share a continuous, open communication
• Large number of universities with a long tradition present in Adriatic Croatia that offer high-quality	• Mismatch of study programs with needs of the modern maritime industry • Demand for a high-	• Creation of new study programs aligned with the needs of the maritime industry • Use of new	• Study programs are compatible with the needs of the modern maritime industry • Universities produce

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CURRENT STATE	IDENTIFIED GAP	POSSIBLE ACTIONS	DESIRED FUTURE STATE
programs of maritime studies and engineering • The programs are, in some aspects, outdated and need to be modernized • Decreasing interest among students in enrolling in maritime studies, especially naval engineering	quality workforce, especially engineers, is higher than the supply	technologies within the educational process like VR, etc. • Introducing software that is used in companies to students within the study programs • Creation of alternative courses that match the specific needs of companies within the maritime industry • Promotional campaigns that promote the benefits of engineering and maritime studies	sufficient graduates that satisfy the needs of the Croatian maritime industry • The new graduates adapt quickly to companies' requirements and easily enter the workforce
• Funds for financing innovation are not sufficient, companies rely mostly on their own resources • Procedures to obtain grants are complicated and take a long time • Most of the funds are directed at universities, not companies • Dependence on EU funding is present • Large shipyards are excluded from obtaining financing due to their size	• The companies struggle to find financing to invest in innovation • Shipyards can't obtain the financing needed for their modernization	• Opening more funds and programs that finance innovation in the maritime sector • Encouraging and forming consortia and clusters between stakeholders within the Croatian maritime innovation ecosystem so that they can apply funds from the Plan of Industrial Transition of Adriatic Croatia	• The process of obtaining financing for innovation is quick and easy • Companies as well as universities, research institutions, and shipyards have equal access to financing
• Mindset of the maritime industry is closed and conservative when compared with	• The maritime sector is slow to change and adapt to new technologies	• Change the mindset to be more open and risk-embracing by emphasizing the need	• The open mindset of the maritime ecosystem that embraces change and encourages the

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CURRENT STATE	IDENTIFIED GAP	POSSIBLE ACTIONS	DESIRED FUTURE STATE
other industries • Closedness of companies, instead of sharing knowledge, resources, and experience • The reluctance of the key people in the maritime industry in accepting innovations The problem of the" big ship paradigm" existing in our history and maritime tradition	• Closedness of stakeholders within the ecosystem causes a disconnection between innovators with the users of the innovation • "Service mindset" which signifies the belief there is no need for market research and development • The pilot projects remain in the pilot phase; the focus is mainly on big ship production	and benefits of innovation • Acceptance of mistakes as a normal part of research and innovation • Changing the "Service mindset" to a mindset of production, which includes market research and development • Education of the key people in the maritime industry to accept innovative solutions	environment in which innovations are quickly accepted • Innovations are more easily introduced to the market and monetized
• Croatian maritime industry is, except international regulators (IMO), also regulated by Croatian laws, which include both maritime and land regulations • The governance of various sectors within the maritime ecosystem (i.e., ports, shipyards, etc) falls under different Ministries The complex and long-term procedure of certification of equipment and products	• There are problems with respecting maritime and land regulations because in many cases, they contradict each other • The authorities in different counties of Adriatic Croatia interpret the same laws in a different manner •The companies must contact different Ministries in order to conduct business which is very demanding and time-consuming • The companies are exhausted by requirements and give up on innovations due to the complexity and duration of the process of certification	• Action is needed from the Government to adjust the maritime and land regulations in the greatest way possible to be coherent with one another • Providing a clear and concise interpretation by the Ministries of the laws that have to be used in all Counties of Adriatic Croatia in the same way • Companies from the same sectors within the maritime industry should jointly approach Ministries by demanding open communication • Changing the laws and requirements to be faster and easier to	• The Croatian maritime industry is completely in line with all regulatory requirements • Local regulations are clear, and stakeholders can easily respect them • The process of certification is quick and easy for companies • The Croatian maritime industry is sustainable and respects the environment (IMO requires decarbonization of the industry by 2050)

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CURRENT STATE	IDENTIFIED GAP	POSSIBLE ACTIONS	DESIRED FUTURE STATE
		implement to encourage innovative business activities	
• A long tradition of shipbuilding • Shipyards are partially state-owned, and their future depends on the Government's decisions • Regional naval design hub concentrated in Rijeka • Presence of subsidiaries and branches of foreign companies and groups • Non-existence of value chains in the maritime sector • Non-existence of specialization strategy	• Shipyards are mostly devastated and need state support • Shipyards need modernization and transition from Industry 2.0 to Industry 4.0 • Non-involvement of Croatian companies owned by foreign groups in innovation and development • The lack of action plans due to the absence of a strategy for the maritime sector • Trying to follow all trends and "buzzwords" within the maritime industry without concentrating strategically on any goal	• The synergy between engineers who carry out processes in Croatian shipyards and have domain knowledge with IT experts to digitalize and improve processes • Persist with bringing the innovation from the owner company headquarters to Croatia, work together with teams from headquarters and teams situated in Croatia • Creation and establishment of value chains and reaching a consensus on the values and priorities of the digital, circular economy, and Industry 4.0 • Focus on new niches in shipbuilding, yachts, and special vessels • Start with "small wins" that multiply over time, do not get lost in problems that are "too big a challenge."	The maritime sector of Adriatic Croatia is a highly specialized export-oriented sector that produces innovative products and represents a force in the Croatian economy, and is recognized on international markets

Source: Report on Innovation Ecosystems' Needs, Deliverable D2.2 (2023).

Table 3.2 represents the results of the Gap analysis for the Western Slovenian Maritime Innovation Ecosystem.

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Table 3.2: Results of the Gap Analysis of the Western Slovenian Maritime Innovation Ecosystem.

CURRENT STATE	IDENTIFIED GAP	POSSIBLE ACTIONS	DESIRED FUTURE STATE
Communication between stakeholders is not satisfactory, being sporadic, scattered, and practically non-existent	No systemic approach to communication	Organizing any type of collaborative invention events regularly • Better digital collaboration between public and private entities • Organizing conferences and workshops on a regular basis • Developing new data sharing platforms • Forming working groups focusing on specific topics and regularly reporting on duties	Stakeholders share a continuous, open communication
Large offer of various programs and studies at various faculties, especially naval engineering	Demand for enrolling in maritime studies, especially among engineers, is decreasing in new generations and is not nearly close to expectations, compared to offered studies	• More campaigns and publicity that will encourage young people to study engineering and maritime studies • Use of new technologies within the educational process, like VR, etc. • Introducing software and future opportunities that is used in companies to students	• Study programs are compatible with the needs of the modern maritime industry •The new graduates adapt quickly to companies' requirements and easily enter the workforce • The study offer is more effective in practice
• Lack of resources • Directed financial support mostly to universities and public	•The companies struggle to find financing to invest in innovation •Shipyards can't obtain the financing needed for	• Opening more funds and programs that finance innovation in the maritime sector	•The process of obtaining financing for innovation is quick and easy • Companies, as well as

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CURRENT STATE	IDENTIFIED GAP	POSSIBLE ACTIONS	DESIRED FUTURE STATE
institutions, instead of entrepreneurs • Dependence on EU funding is present • Lack of pragmatic funding sources for the maritime industry, funding sources that are fast and easily obtained • Slow pace of change due to lack of resources, particularly personnel and funding to support innovation efforts	their modernization • There is no clear structure of accessibility and form of financing	• Create a structured and clear picture of financing • Find new resources • More pragmatic funding • Open more funding to private entities and start-ups	universities, research institutions, and shipyards, have equal access to financing • A new, clear structure of financing is made
• Mindset of the maritime industry is closed and conservative when compared with other industries • Closedness of companies, instead of sharing knowledge, resources, and experience • The reluctance of the key people in the maritime industry in accepting innovations • Overload of the companies with regular business activities • Mistrust of the state when allocating funds to lesser-known entrepreneurs due to previous bad experiences of fraud	• The maritime sector is slow to change and adapt to new technologies • Closedness of stakeholders within the ecosystem causes a disconnection between innovators with the users of the innovation • "Service mindset," which signifies the belief there is no need for market research and development • The pilot projects remain in the pilot phase; the focus is mainly on big ship production	• Change the mindset to be more open and risk-embracing by emphasizing the need and benefits of innovation • Acceptance of mistakes as a normal part of research and innovation • Changing the "Service mindset" to a mindset of production, which includes market research and development • Education of the key people in the maritime industry to accept innovative solutions	• The open mindset of the maritime ecosystem that embraces change and encourages the environment in which innovations are quickly accepted • Innovations are more easily introduced to the market and monetized

Source: Report on Innovation Ecosystems' Needs, Deliverable D2.2 (2023).

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3.3 Identification and quantification of key economic indicators for the Croatian maritime innovation ecosystem - summary

The Croatian maritime innovation ecosystem regarding the industry part, as per the four-helix framework, consists of 261 companies from the coastal region of Adriatic Croatia, and a few from the continental region, but with major business operations carried out in Adriatic Croatia. The Ecosystem comprises companies that constitute the supply side of innovation (the innovative production firms) and the demand side of innovation (infrastructure, logistics, shipping, public, etc.). In 2022, companies within the Ecosystem had 11,315 employees, generated €1,293.4 million sales revenues (67.9% from sales abroad) and €626.2 million value added [3]. The Ecosystem's distinctive feature is a strong international business orientation, and due to this, exposure to global economic developments and disturbances. The central part of the Ecosystem is production companies that are innovating.

The results of the economic analysis of the Ecosystem's size and importance are seen in the contribution that it is providing to Adriatic Croatia. In 2022, the Ecosystem employed 4.06% of people in Adriatic Croatia, generated 5.37% of total business revenues, 4.63% of sales revenues, 6.33% of the total newly created value, and 14.1% of exports of the entire entrepreneurial part of the Adriatic Croatian

economy. Added value per employee (€55,346) of the Ecosystem is 56.11% higher than the average of Adriatic Croatia, and the monthly gross salary is 41.18% higher, all pointing to above-average productivity. Ecosystem's contribution to the innovation output of the region is also important and is reflected in the following: as much as 10.65% of the value of concessions, patents, licenses, trademarks and service brands, software, and other rights of the entrepreneurial sector of Adriatic Croatia was achieved by the maritime sector.

In terms of company size, the majority belong to micro (47,9%), followed by small-sized entities (36,8%), medium companies (10,7%), and big companies (4,6%). From a spatial point of view, more than two-thirds of maritime ecosystem entrepreneurs operate in only two counties, Primorje-Gorski Kotar County (44.8%) and Split-Dalmatia County (23.8%),

As mentioned, at the core of the Ecosystem are innovative maritime production companies, namely several shipyards (but not all), ship producers and some engineering & design companies, a service company, and also to a smaller degree software firms and start-ups. In total, 41 companies can be considered innovative. The group is heterogeneous, with both large, medium, and smaller firms as well as different market niches and product portfolios. The common feature among innovative product manufacturing is the use of an innovative approach in product development through innovative materials, designs, or innovative techniques, also these are private companies, export-driven and sell their products in the international market, as reported by BSC & Lemur Legal, based on input by PRIGODA (D2.1, 2023). In 2022, Innovative maritime companies had 1,441 employees, generated €134.6 million of sales revenues (58.6 % being generated from sales abroad) and €51.7 million of value added. In terms of sales revenues and similar aggregate business indicators, a major shipyard, BRODOSPLIT, stands out at the beginning

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of the period 2018 – 2022, but over time, its performance declined, and a shift in the structure of the Innovative companies towards a larger share of medium and smaller companies is noted.

The appearance of new players (ISKRA brodogradilište d.o.o., Lürssen Design Center Kvarner d.o.o., BRODOTROGIR CRUISE d.o.o.) and strengthening of some more mature firms (MEP d.o.o., NUIĆ NAUTIKA d.o.o., SALONA GRUPA d.o.o.) contribute to the overall sales revenues of Innovative companies.

Given the business results of the Croatian maritime ecosystem by individual sectors, the largest shares in total sales revenues of the Croatian maritime ecosystem are generated by production (36.5%), shipping (28.9%), and infrastructure (18.5%). At the same time, the logistics and services sectors generate just over 6%, and software only 1.5% of total sales revenues.

Regarding the key economic indicators that were examined, some truly indicate that innovation activities are present in the group of Innovative companies, but it is also likely that some of the innovation-related activities do not show up in the typical innovation-related items in companies' annual accounts (statements).

3.4 Financial analysis of Slovenian maritime stakeholders by category – summary

The maritime ecosystem in Western Slovenia is a fundamental pillar of the regional economy, contributing over €450 million in sales revenue and employing more than 3,000 people across various sub-sectors such as port operations, shipping, logistics, and tourism-related activities. The largest maritime company in the region, Luka Koper, generates €309.3 million in annual sales and employs 1,695 workers, making it the dominant player in the ecosystem [4]. Another key logistics provider, Intereuropa, contributes €126.1 million in revenue and has a workforce of 600 employees. Other maritime infrastructure companies, including Porting Izola and Marina Portorož, collectively employ over 60 workers and generate millions in revenue. The average business revenue per employee in this sector is notably high, reaching €189,374 in Luka Koper and €215,474 in Intereuropa, indicating high productivity and strong financial performance.

Beyond its economic contributions, the maritime sector is undergoing a transition towards digitalization and sustainability, with increasing investments in green technologies and modernized logistics systems. Ports and shipping companies are integrating smart logistics solutions, improving cargo handling efficiency, and reducing carbon footprints. Investments in environmental protection-related technologies are becoming more prevalent, as seen in the €6.43 million in new machinery and equipment investments by Luka Koper. However, some firms, such as Porting Izola, show negative investment trends in fixed assets, indicating restructuring or financial challenges. Maritime salaries vary across companies, with Luka Koper employees earning an average gross salary of €3,719 per month, significantly higher than in other logistics firms such as Marina Portorož, where the average monthly gross salary is €2,053.

The innovative production sector in Western Slovenia is another key driver of industrial

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advancement, generating between €300 and €350 million in total revenue and employing over 2,000 workers. Leading companies such as Iskra and Elan stand out in terms of financial performance and workforce size. Iskra, for instance, reports €136.1 million in revenue with 786 employees, achieving a business revenue per employee of €177,937. Similarly, Elan, a major player in sports and maritime-related production, has €104.9 million in revenue and 753 employees, with a revenue per employee of €149,228. Other strong performers include Kolektor Sisteh (€28.6 million in revenue, 132 employees, and €222,553 per employee revenue), Podkrižnik (€17.7 million in revenue, 134 employees, and €143,734 per employee revenue), and Bobič Yacht Interior (€6.2 million in revenue, 62 employees, and €108,485 per employee revenue).

The sector's strength lies in its efficiency and strong focus on technological innovation, with companies making significant investments in research, development, and automation. Many firms in this sector are export-oriented, such as Iskra and Kolektor Sisteh, which contribute to Slovenia's global trade competitiveness. Moreover, the average gross monthly salaries in the sector reflect a skilled workforce, with salaries ranging from €2,340 in Elan to over €3,200 in Kolektor Sisteh. The sector also shows dynamic capital investment trends, as companies like Bobič Yacht Interior allocate significant resources to research and development, while others like Podkrižnik invest heavily in new production machinery.

Both the maritime and innovative production sectors are experiencing significant transformations, shaped by digitalization, sustainability efforts, and evolving global market conditions. While the maritime sector continues modernizing its port infrastructure and logistics networks, the production industry is accelerating its adoption of automation and smart manufacturing technologies to maintain its competitiveness. Together, these sectors not only form the backbone of Western Slovenia's economic identity but also position the region as a key player in European trade, industrial innovation, and technological progress. The extent of their continued growth will depend on how well they adapt to green transition policies, technological advancements, and global economic fluctuations.

3.5 SWOT analysis

To assess and evaluate the internal strengths and weaknesses, as well as the external opportunities and threats of each ecosystem, a SWOT analysis was prepared for Western Slovenian and Adriatic Croatian maritime innovation ecosystems.

The said analysis comprehensively summarises some of the key aspects of the ecosystems.

The Western Slovenian maritime innovation ecosystem SWOT analysis is presented in Table 3.4 below:

Table 3.3: SWOT analysis for the Slovenian ecosystem.

Strengths	**Weaknesses**
Port of Koper is the main driver in the maritime industry;	• limited access to funding and capital for maritime industry specialized companies

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• strategic geolocation of Slovenia (Mid Europe with direct access to the sea); • awareness of modernization and digitalization needs in the industry; • strong start-up and scale-up ecosystem; • excellence in design, engineering, and construction; • a large percentage of companies from a traditional industry (e.g., shipbuilding) build their solutions by promoting innovation and new technological approaches; • strong manufacturing and technical knowledge base (sound school system, companies with legacy); • high existing awareness of the importance of the green industry (compliance with ESG standards); • a large number (per capita) of filled patents and models (Slovenian and EU).	(no special public financing Programmes for the nautical/maritime industry); • only one for the nautical/maritime industry specialised incubator • maritime/nautical industry not listed as a priority by existing (or any of the past) government; • long administration processes (obtaining permits, negotiations with bigger companies, etc.); • high taxation; • public ownership of Port of Koper (instability in governance); • dependence on Port of Koper (only one large stakeholder in the Slovenian maritime ecosystem); • existing dependence on public financing for start-ups and scale-ups; • existing infrastructure (railways, roads, capacity in Port of Koper); • no innovation hubs of foreign large companies in Slovenia (mostly only sales departments).
Opportunities	**Threats**
• large infrastructure projects in the process (railways, expansion of Port of Koper capacity); • emerging technologies such as automation, digitalization, and alternative fuels; • growing demand for sustainable and eco-friendly solutions in the maritime sector; • rapidly rising venture capital opportunities for Slovenian start-ups and scale-ups; • EU public funding schemes (e.g. SME instrument); • due to its size, the Slovenian market is ideal for testing new technologies, and products (“proof of concept phase”); • agility in state governance due to the county’s size; • bringing back to Slovenia the individuals who are successful in entrepreneurship and	• start-up and scale-up “brain drain „due to lack of funding opportunities, unfriendly tax environment and slow changes in the regulatory framework; • economic downturns; • geopolitical instability; • political instability (internal); • regulatory changes (too slow, always waiting for the EU regulation to be adopted); • no government strategy for the future development of maritime/nautical industry; • competition from low-cost producers in Asia and other regions.

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in other industries (the government is implementing such Programmes).	

Source: D2.1_ Report on Ecosystems' Mapping_V1.0 (2023).

The results of the SWOT analysis of the Adriatic Croatian maritime innovation ecosystem are presented in Table 3.5:

Table 3.4: SWOT analysis for the Croatian ecosystem.

Strengths	**Weaknesses**
• strong maritime heritage and long tradition of high-quality shipbuilding and craftsmanship • strategic geolocation of Croatian ports and their infrastructure • strong maritime ship design engineering companies with state-of-the-art know-how • strong maritime and engineering universities providing excellent education • professional and high skilled labour force (engineers, etc), competitive on global market • region is a traditional Hub for maritime sector workforce due to long tradition and educational facilities • long term presence of Croatian companies on global market • presence of multinational companies branches and subsidies in maritime sector • excellence in ship design, engineering, construction, and production • presence of local IT companies that support maritime innovation ecosystem • awareness and implementation of green technologies • presence of research centre for new materials (light materials, advance materials, nanomaterials)	• limited access to funding and capital for R&D projects from the government and venture funds • dependence on EU funding for innovative projects • SMEs lack in-house funding for innovations • Insufficient investment in R&D&I • weak connection between the business and scientific research centres and universities on innovative projects, insufficient partnerships between them • lack of networking in local/regional value chains • lack of broader strategy for shipbuilding industry (local/state level, EU) • reliance on government subsidies for state-owned shipyards • rigid administrative regulations • competition for highly skilled workforce between companies • brain-drain and import of expat workforce in shipyards • lack of investment in zero emission technologies in traditional shipping companies • lack of supportive infrastructure readiness • outdated technology and infrastructure • lack of smart skills for the industrial transition to new technologies • lack of strong high-tech player in the field of maritime technologies that could lead R&D process in the region

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	• smaller companies existing in the ecosystem do not have strong or any R&D departments • only one nautical/maritime industry specialised incubator • no innovation hubs of foreign large companies in Croatia, only a few local subsidies are involved in collaboration on innovation projects • due to size and complex structures, ecosystems resist embracing innovation and change, and when enforced, innovative performance is brought slowly and with great difficulty • no real effort form governmental sector in sense of legislation change that would be in favour of green transition, for example, shipyards are excluded from any kind of subsidy even for green shipping • outdated infrastructure
Opportunities	**Threats**
• transition towards niches with higher added value (autonomous ships, green ships, luxury yachts and floating hotels, special purpose ships) • possibility of participating in EU founded R&D projects • large infrastructure projects for expansion in the port of Rijeka (railway, highway, new container terminal) and smart marina • establishment of an effective regional ecosystem and an ecosystem for entrepreneurs through establishment of maritime innovation clusters • creation of knowledge transfer centres between universities and industry • development of smart skills through lifelong learning • digital transformation and application of digital technologies in maritime industry • orientation on services with high added value (R&D, Ship design)	• climate change and environmental challenges • shifts in global order and demographic • geopolitical instability • political instability • economic cycles/crisis • global competition, namely from East Asian shipyards especially in terms of lower labour cost and financial capacity • existing uncertainties and regulatory challenges/ changes related to green and digital transition in maritime technology (EU regulations to be adopted) • international standards for implementation of advanced ship technology are not in mature stage therefore, a close cooperation and liaising with certifying authorities early in the design phase is needed to enable effective transition • the development and adoption of new technologies is associated with

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• willingness of industry experts to adopt new technologies • emerging technologies such as autonomous shipping, AI, VR, and digital twins and their application in maritime industry • transition of vessels to alternative fuels • IT solutions and production technologies, digitization and automatization of business processes, management and planning etc. • development of ecological sustainable propulsion systems, development of intelligent steering systems, production of green energy for production needs, application of robotics • strengthening the capacity of medium and large enterprises • establishing a supportive start-up ecosystem • support of leading maritime companies to public companies in developing modern services and products in maritime sector • attracting the best talents and involving citizens in the innovation process • clear focus on profit and/or changes in maritime legislation enforcing the application of innovations	considerable uncertainties, risks, and high costs

Source: D2.1_ Report on Ecosystems' Mapping_V1.0 (2023).

The findings presented in SWOT analyses for Slovenia and Croatia were discussed at workshops with the project partners and stakeholders and later used in the elaboration of a strategic framework.

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4. STRATEGIC FRAMEWORK

A Long-term joint R&I strategy for Western Slovenia and Adriatic Croatia is one of the deliverables within the project INNO2MARE, *Strengthening the capacity for excellence of Slovenian and Croatian innovation ecosystems to support the digital and green transitions of maritime regions* (WP2, Deliverable D 2.3). As there is no prescribed form for strategy as a document, for elaboration of this strategic framework, a combination of the Croatian and Slovenian methodologies has been used.

Namely, in Croatia, there is a legal framework regulating the elaboration of strategic planning acts [5] while in Slovenia, long-term development documents are adopted based on the Public Finance Act, four-year state Programmes of development policies and mid-term fiscal strategy, which are updated annually. Additionally, a number of national maritime strategies have been consulted to align this strategy with relevant points of departure. During the workshops, the first two were conducted in March (vision development and setting strategic objectives), the third one at the beginning of April (agreeing on strategic objectives, identification of priority areas, elaboration of measures), and one later in April 2024 (further elaboration of measures, projects, and activities) it was jointly agreed that the strategic framework should include strategic objectives, for each strategic objective relevant priority areas, and each priority area there should be measures identified which will lead to the achievement of strategic objectives and ultimately of a joint vision. Additionally, stakeholder consultations were conducted in December 2024, and a Joint Strategy and Action Plan workshop was conducted in May 2025.

Besides this basic hierarchical structure, the indicators are also determined to monitor progress of strategy implementation and as a “traffic light” to notify (or in more extreme cases alarm) on negative divergencies or bottlenecks in strategy implementation. For a better understanding of basic terms, the most relevant ones are listed below:

The strategic objective is determined here as a long-term goal whose implementation will lead towards vision achievement. At this level, it is common to set up impact indicators as quantitative and qualitative measurable data that enable monitoring, reporting and evaluation of success in achieving determined strategic objectives.

Policy priority is an umbrella term for a policy area in which focused interventions, measures, Programmes, projects, and activities will be implemented to address specific issues or problems detected in a particular sector or field of development.

Specific objective is a mid-term objective defined in national plans and plans of regional and local self-government through which a strategic objective from strategies is linked to the Programmes in the state budget or the budget of regional and local self-government. Outcome indicator is a quantitative and qualitative measurable data that enables monitoring, reporting and evaluating of success in the achievement of a determined specific objective. In this Long-term joint R&I strategy, no specific objectives are determined.

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Measure is considered a set of intertwined activities and projects in a specific administrative area that lead to the achievement of specific objectives, and indirectly, their implementation contributes to the achievement of the strategic objective. *Result indicator* is considered here as quantitative and qualitative measurable data that enables monitoring, reporting, and evaluation of success in the implementation of determined measures, projects, and activities.

4.1 Overall strategic context

The Adriatic Croatian and Western Slovenian maritime innovation ecosystems are not isolated from other ecosystems across Europe and beyond. It is expected that the implementation of a Long-term joint R&I strategy will contribute at least to some extent to the achievement of both objectives set in this R&I strategy and objectives defined in different maritime and research and innovation strategic documents above the regional or national level.

The majority of the supranational level documents listed here include objectives, priority areas, measures and/or projects/activities related to digitalisation, green transition, blue economy, challenges in the labour market in the maritime sector, and governance-related issues. In this respect, our R&I strategy takes into consideration these aspects at a higher level of the planning hierarchy and translates them into concrete measures that will be implemented at the national and regional levels in Western Slovenia and Adriatic Croatia. In this way, acting at a lower level of governance is aligned with a wider supranational strategic context and should positively contribute to the overall achievement of targeted values and success in general.

In this section, information on a wider strategic or development context in which this Long-term joint R&I strategy should fit is provided. The list includes supranational, national, sectoral/multisectoral, subnational, and regional development documents of relevance to the maritime innovation theme.

4.1.1 Supranational level

The Long-term joint R&I strategy should take into consideration a wider strategic and development context, as its implementation has wider implications and impacts not only in Western Slovenia and the Adriatic Croatia region but also in neighbouring countries and globally. Also, from a methodological point of view and following EU principles, the strategy should be coherent (or in compliance with) in hierarchical terms with the higher-level strategic documents and public policies. This R&I strategy is coherent with several documents and policies at the EU level, and they are listed below.

European industrial strategy

On 10 March 2020, the Commission laid the foundations for an industrial strategy that would support the twin transition to a green and digital economy, make EU industry more competitive globally, and enhance Europe's open strategic autonomy. The day after the new industrial strategy

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was presented [6], the World Health Organisation announced COVID-19 as a pandemic. On 11 May 2021, the Commission updated the EU Industrial Strategy to ensure that its industrial ambition takes full account of the new circumstances following the COVID-19 crisis and helps to drive the transformation to a more sustainable, digital, resilient, and globally competitive economy. As a primary vehicle of innovation in the various ecosystems, small and medium enterprises (SMEs) need to be kept in mind in all actions under this R&I strategy. This is reflected horizontally by increased attention to regulatory burdens for SMEs. New actions strongly benefit SMEs and start-ups, whether it be from a strengthened Single Market, reduced supply dependencies or accelerated green and digital transitions. The updated Industrial Strategy is proposing new measures to take into account the lessons learned from the crisis and sustain investment. In particular, it focuses on: Strengthening the resilience of the Single Market, Supporting Europe's Open Strategic Autonomy through dealing with dependencies and supporting the business case for the twin transitions.

Maritime technology challenges 2030 – New Technologies and Opportunities (European Council for Maritime Applied R&D (ECMAR))

ECMAR's [7] vision for 2030 is for more energy-efficient design and operation for shipping and maritime activities, utilising new technologies and green energy sources. The objective is to achieve a globally connected and competitive European Waterborne Sector, decarbonised and digitalised for a sustainable marine and maritime economy. Digitalisation will spur automation and positively impact safety and environmental performance. New cloud technologies will dramatically affect the design, manufacture, and operation of vessels and their components. The Internet of Things will help to deliver smart vessels with shore-based control. Cybersecurity and Human Factors will become important issues with digitalisation and automation. The next generation of connectivity between ship and shore will help shipowners reduce costs, avoid expensive repairs, and improve operational efficiency. Automated processes and the introduction of "big data" in maritime operations will lead to advances in engine monitoring, remote maintenance, and real-time weather data and routing. The seas and oceans are drivers for the European Blue Growth economy and have great potential for innovation and growth. Given the new challenges raised by the scarcity of resources, Blue Growth will be important for fulfilling the growing needs for food, energy, water, organic or mineral resources, etc. ECMAR's maritime technology outlook for 2030 addresses societal, global, and industrial challenges to secure a safer, smarter, more competitive, and sustainable maritime industry.

Many of the technology areas will need to adopt the application of new disruptive technologies that, together with digitalisation and connectivity, will be transformative and make a significant contribution to the competitiveness and sustainability of the European maritime industry. ECMAR's main objective through Research, Development and Innovation is to achieve a globally connected and competitive European Waterborne Sector, with zero emissions and zero-accident ships, digitalised shipping and autonomy, to ensure a sustainable marine and maritime economy.

The Shipyards' & Maritime Equipment Association of Europe (SEA Europe) and the Federation of Trade Unions Industrial Europe – the social partners for shipbuilding and ship repair – have called on the next European Commission to issue a robust EU maritime industrial strategy' that will

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enable European shipyards and maritime equipment manufacturers, as well as their employees to maintain Europe's position as a global technology leader while regaining strategic markets and tapping into emerging markets. It is expected that the EU will reinforce its industrial production capacity and support the business case for sustainable and digitalised vessels. The key pillars of a future European maritime industrial strategy are four-fold: 1) Reinforce Europe's industrial sovereignty and competitiveness, 2) A supportive regulatory framework, 3) Reinforce Europe's technological leadership, and 4) Attract a skilled workforce [8].

EU Valorisation Policy

Industry-academia collaboration is one of the key channels to foster a mutual exchange between knowledge generators and business actors, boost private investments in research, lead to more inventions and patents, facilitate the flow of knowledge and talents into companies, enhance researchers' skills and understanding of the market needs and increase entrepreneurial culture among researchers. This improves not only the competitiveness of European industry and the research and innovation system but also supports the development of green, innovative, and digital solutions for society.

Although many policy instruments are in place to promote collaboration between academia and industry in Europe, such as grants for mobility, collaborative research, and public-private partnerships, stronger interaction is needed. Citizens expect science to be a driving force that addresses societal challenges and delivers solutions for ongoing green and digital transitions. The objective is to increase access to and the use of research results, particularly when publicly funded. Making research results work for society is crucial to overcoming the current needs and challenges faced by Europe.

Knowledge valorisation is the process of creating social and economic value from knowledge by linking various areas and sectors and transforming data, know-how, and research results into sustainable products, services, solutions, and knowledge-based policies that benefit society. EU knowledge valorisation policy covers both technological and non-technological solutions that can bring benefits to society as a whole. It calls for the participation of all actors in the research and innovation ecosystem, including users, citizens, and policy-makers. This cross-fertilisation of knowledge among different actors and sectors happens through academia-industry collaboration and mobility, the creation of spin-offs and start-ups, intermediaries and knowledge transfer professionals, citizens and local communities' engagement, intellectual assets management, standardisation, knowledge dissemination, and policy uptake. [9]

In the framework of Horizon Europe (2021-2027), the EC invests in a mission-driven approach to research and innovation to develop solutions to some of the major societal challenges. Hence, this will provide the underpinning for important policy initiatives such as the Green Deal, the Climate Adaptation Strategy, etc. The objective of the Restore our Ocean and Waters Mission (Mission Ocean) is to protect and restore the health of our ocean and waters by 2030 through research and innovation (through targeted project calls and tenders), citizen engagement, and blue investments. In this way, the Mission will contribute to achieving climate neutrality and restoring

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nature. The aforementioned objective is supported by cross-cutting enabling actions, in particular broad public mobilisation and engagement, and a digital ocean and water knowledge system, known as the European Digital Twin Ocean (DTO). The Sustainable Blue Economy Partnership (SBEP) consists of 60 partner institutes from 25 countries and the EC. It aims to pool investments in marine research and innovation and align national programmes on a pan-European scale. SBEP is co-funded by Horizon Europe and builds on the blue R&I agendas of the sea basins (Mediterranean, Black Sea, Baltic Sea, and North Sea) and the Atlantic Ocean. Several European initiatives facilitate collaboration concerning marine research infrastructures to optimise their use. The European Strategy Forum on Research Infrastructure (ESFRI) supports a coherent and strategic approach to the European policy on this infrastructure. Within the ESFRI context, several pan-European infrastructures have already been established, of which some are of particular importance for marine research in Flanders and Belgium.

There are several consortia and networks representing (parts of) the European marine research and innovation community. The European Marine Board (EMB) is the leading think tank for marine science policy, representing an important part of the European marine research institutes and funding organisations. EMB elaborates on various types of publications with recommendations for research priorities and strategies for European marine research.

Blue Economy Report for 2023 (European Commission Directorate General for Maritime Affairs and Fisheries, and the Joint Research Centre (JRC))

According to the Blue Economy Report for 2023 [10], the Blue Economy established sectors include Marine living resources, Marine non-living resources, Marine Renewable energy, Port activities, Shipbuilding and repair, Maritime transport, and Coastal tourism. The Blue Economy's emerging and innovative sectors include Marine renewable energy (i.e., ocean energy, floating solar energy, and offshore hydrogen generation), Blue biotechnology, Desalination, Maritime defence, security and surveillance, Research and Infrastructure (submarine cables, robotics). The Blue biotechnology and Ocean energy sectors offer significant potential for economic growth, sustainability transition, as well as employment creation.

European Maritime, Fisheries and Aquaculture Fund (EMFAF)

The EMFAF [11] operates from 2021 to 2027 and supports the EU common fisheries policy (CFP), the EU maritime policy, and the EU agenda for international ocean governance. It assists in developing innovative projects, ensuring that aquatic and maritime resources are used sustainably. As a global ocean actor and a major seafood producer, the EU has a responsibility to protect and sustainably utilise the oceans and their resources. It is also in the EU's socio-economic interest to guarantee the availability of food supplies, the competitiveness of the maritime economy, and the livelihoods of coastal communities. The fund aids in achieving sustainable fisheries and conserving marine biological resources, leading to food security through the supply of seafood products, the growth of a sustainable blue economy, and the maintenance of healthy, safe, and sustainably managed seas and oceans. Additionally, it helps realise the UN's Sustainable Development Goal 14 ('conserve and sustainably use the oceans, seas and marine resources'), to

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which the EU is committed. Furthermore, the EMFAF contributes to fulfilling the objectives of the European Green Deal, the roadmap for the EU's climate and environmental policies.

The EMFAF supports innovative projects that contribute to the sustainable exploitation and management of aquatic and maritime resources. In particular, it facilitates the transition to sustainable and low-carbon fishing the protection of marine biodiversity and ecosystems the supply of quality and healthy seafood to European consumers the socio-economic attractiveness and generational renewal of the fishing sector, with the focus on small-scale coastal fisheries, the development of a sustainable and competitive aquaculture, contributing to food security, the improvement of skills and working conditions in the fishing and aquaculture sectors, the economic and social vitality of coastal communities, innovation in the sustainable blue economy, maritime security towards a safe maritime space, international cooperation towards healthy, safe and sustainably managed oceans.

INTERREG IPA ADRION 2021-2027

The Interreg IPA ADRION [12] Programmes (2021-2027) act as policy drivers and governance innovators, fostering European integration among Partner States, taking advantage of the rich natural, cultural, and human resources surrounding the Adriatic and Ionian Seas, and enhancing economic, social, and territorial cohesion in the Programme's area. Through the IPA ADRION, the following impacts are expected:

- Development of a regional innovation system for the Adriatic-Ionian area
- Enhanced capacity to transnationally tackle environmental vulnerability, fragmentation, and the safeguarding of ecosystem services in the Adriatic and Ionian areas.
- Enhanced capacity for integrated transport and mobility services and multi-modality in the Adriatic-Ionian area
- Enhanced institutional capacity of public administrations and key stakeholders, and assisted the progress of implementation of joint priorities in the framework of the EUSAIR.

INTERREG EURO-MED

Interreg Euro-MED [13] is a European Territorial Cooperation Programme that aims to make the Mediterranean region smarter and greener and to improve governance between its stakeholders. It provides funds for projects developed and managed by public administrations, universities, and private and civil society organisations. The Programme's cooperation area includes 69 regions of 14 countries from the Northern shore of the Mediterranean: 10 EU Member States and 4 countries from the Instrument for Pre-Accession Assistance (IPA). Interreg Euro-MED supports projects, initiatives, and policies related to climate change and the environment in line with the priorities and specific objectives set out by the European Commission for the Cohesion Policy. Four missions have been identified: 1) Strengthening an innovative sustainable economy, 2) Protecting, restoring, and valorising the natural environment and heritage, 3) Promoting green living areas, and 4) Enhancing sustainable tourism.

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Position paper - A European Blue Technology Fund, SEA The Shipyards' & Maritime Equipment Association of Europe

SEA Europe represents the European shipbuilding industry in 16 nations, encompassing the production, maintenance, repair, retrofit, and conversion of all types of ships and floating structures, commercial as well as naval, including the full supply chain with the various producers of maritime systems, equipment, material, and services. It is the voice of the maritime civil and naval technology industries in Europe [14]. SEA promotes better management of the European Blue Technology Fund, which will overcome fragmented and complex EU funding for the maritime sector.

A European Blue Technology Fund should be supporting innovative projects that will bring a sustainable and digitalised blue economy and waterborne value chain. To remedy this situation, SEA Europe calls upon the European Commission to put in place a European Blue Technology Fund under the Multiannual Financial Framework starting in 2028, with a budget of €10 billion. SEA advocates the development of impactful and innovative strategic technologies and flagship projects, which should be geared towards the scaling-up of maritime technologies in support of a competitive and sustainable blue economy in Europe, through the Blue Technology Fund.
SEA Europe believes that this new fund should take over the EMFAF and extend it to the following objectives:

- reinforcing European maritime technological leadership on a global strategic scale,
- contributing to EU maritime sovereignty,
- help businesses investing in carbon-neutral, sustainable, and digital maritime technologies (from low TRL technologies to de-risking projects' upfront investments),
- strengthen the resilience of the maritime technology industrial value chain,
- create future-proof jobs in the sustainable blue economy.

NAPA (North Adriatic Port Association) Declaration on joint policies and actions

The five NAPA [15] seaports (Ports of Koper, Rijeka, Trieste, Venice, and Ravenna) are located at the northern tip of the Adriatic Sea, a natural waterway that penetrates deep into the middle of the European continent, thus providing the cheapest naval route from the Far East via Suez to Europe with a distance that is about 2,000 Nm shorter than other North-European ports. More than 100 million tons of waterborne cargo are handled in the NAPA seaports every year. The cargo consists mainly of general cargo, containers, cars, ores and minerals, fossil fuels, chemicals, and other types of cargo. Due to the huge variety of logistics services and the extensive traffic network, NAPA forms a perfect multimodal gateway to the key European markets. The nearby fifth Pan-European transport corridor provides a quick link to 500 million European consumers. Large commercial and industrial hubs like Vienna, Munich, and Milan are just a few hours' drive away.
The NAPA seaports combine their strengths to promote the Northern Adriatic route and present themselves as an alternative to the North European ports. In addition, the association anticipates cooperation in the development of maritime and hinterland connections, visits from cruise lines, environmental protection, safety, and information technology. The ports of NAPA will also invest

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efforts into the coordinated planning of road, rail, and maritime infrastructure, as well as the harmonisation of regulations and procedures in the field of port service provision.
The Vision of NAPA*: NAPA will form a European logistics platform, with regard to servicing the markets of the Far East as well as Central and Eastern Europe*.

4.1.2 National – Slovenia & Croatia

The overarching strategic development document in Slovenia, which defines further development, is the **Slovenian Development Strategy 2030** [16] The document lists as a strategic orientation a highly productive economy, which creates added value and requires lifelong learning, cooperation, etc. The Strategy also highlights the importance of technological progress and development, innovation, and harnessing the digital potential enabled by digital technologies.

The Slovenian Smart Specialisation Strategy (S5) [17] is a development document and the starting point for focusing development investments on areas where Slovenia has a critical mass of knowledge, capacity, and competencies, and where it has innovation potential. The Smart Specialisation Strategy identifies ten priority areas, which are in a heterogeneous relationship. These include (i) Smart Cities and Communities, (ii) Horizontal ICT Network, and (iii) Factories of the Future. The Government Office for Development and European Cohesion Policy have upgraded Slovenia's Sustainable Smart Specialization Strategy S5 taking into account the suggestions and comments received, however, the previous Smart Specialization Strategy S4 (Digital Slovenia 2020) has still been in force and it served well as a background material for elaboration and upgrade of S5.

The Digital Slovenia 2030 [18] is the overarching strategy for the digital transformation of Slovenia by 2030 and is the response of the Government of the Republic of Slovenia to the development challenges of digitalisation. It is intended to provide strategic planning for promoting Slovenia's digital transformation in the development period by the year 2030. The strategy takes into account the ambitions and principles of the European Union (EU) and is the result of coordination between government representatives, institutions, academics, civil society, and the interested public. It addresses the key areas of Slovenia's digital transformation, building on European strategic documents and focusing on the main challenges of digital transformation in Slovenia. The strategy anticipates orientations and targets with indicators to address the biggest development gaps to accelerate the development of digital transformation in all areas, from gigabit infrastructure to the digital transformation of the economy, digital public services, the path to Smart Society 5.0, cybersecurity, digital competences and inclusion, and related content such as enabling environments and the green transition. The Digital Slovenia 2030 Strategy is a strategic document and contains specific, measurable indicators in each of the thematic areas. The overarching objective of the strategy is to promote digital transformation of Slovenia in all segments – society, government, local communities, and the economy. The Ministry for Digital Transformation is responsible for managing the implementation of the strategy. It links and complements the Plan for the Development of Gigabit Infrastructure by 2030, the Strategy of the Digital Transformation of the Economy, the National Programmes to Promote the Development

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and Use of Artificial Intelligence in the Republic of Slovenia by 2025, and the Digital Public Services Strategy 2030, the strategic focuses of which are described below. Digital Slovenia 2030 is subordinate to and consistent with some of the key objectives of the Slovenian Development Strategy 2030. The following objectives are determined in the Digital Strategy 2030, and this Long-term joint R&I strategy is highly linked to them:

- To increase the competitiveness of Slovenian companies and value-added per employee
- To support the growth of the ICT sector, which is key to the successful digitalisation of the economy
- To increase the share of investments in research, development, and innovation in advanced digital technologies in companies to 2% of total costs per year by 2030
- To increase grants to support the digital transformation, especially for SMEs
- To support the improvement of digital competencies among employees (regardless of profiles), including opportunities for retraining (micro-credentials)
- To support an enabling environment, which is an important element of the overall enabling environment to support the digitalisation of the economy (including chambers, Digital Innovation Hubs, European Digital Innovation Hubs, Strategic Development, innovation partnerships, etc.), in addition to direct action by ministries.

The Slovenian Industrial Strategy 2021–2030 [19] sets out the guidelines for the development of industry and the wider economy under a common denominator: green, creative, and smart development. Smart development emphasises the strengthening of digitalisation and smart solutions, as the modernisation of the economy must focus on the use of the most modern technologies, the highest process safety, increasing the level of automation and robotics, and the use of digital technologies and artificial intelligence. Digitalisation must also support the green transition of the economy. Our joint R&I Strategy is coherent with the Slovenian Industrial Strategy 2021 - 2030.

National Programme to Promote the Development and Use of Artificial Intelligence in the Republic of Slovenia by 2025 (NpAI) [20]. Slovenia has joined the ranks of EU Member States that have already prepared national strategic orientations for artificial intelligence and have committed to cooperation in this field at the EU level. The NpAI aims to ensure people's confidence in AI, limit its negative impacts on individuals and society, and reap the benefits that AI can provide so that we can all benefit from AI, especially in improving living conditions and standards of living. Our joint R&I Strategy is compliant with the NpAI to a large extent.

At the beginning of 2022, the Slovenian Government adopted the **Strategy of Digital Transformation of the Economy** [21] that was prepared in parallel with the digitalisation, informatisation, and Digital Single Market processes already underway in the EU. It highlights current advanced digital technologies such as artificial intelligence, the Internet of Things, Big Data technologies, blockchain technologies, high-performance computing, quantum computing, and 5G technologies, which will be drivers of economic growth and competitiveness. It addresses three main or priority areas. The first is advanced digital technologies that enable the digital transformation of the economy in the first place, the second focuses on an efficient ecosystem for a competitive economy, and the third focuses on an open and sustainable society as the basis for

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the growth of the digital economy. The key areas of this Strategy are: (1) Technology as the enabling tool for the economy's digital transformation; (2) An Efficient ecosystem for a competitive economy, and (3) An open and sustainable society as the basis for the growth of a digital economy. Our Long-term Joint R&I strategy is compliant with this Strategy to a large extent.

National Development Strategy of the Republic of Croatia until 2030 (NDS) [22] is the national strategic action plan for the period 2018 - 2030. It aims to support the twin digital and green transition of Croatian society and economy. The NDS establishes a strategic framework for several other planning documents and processes in a more detailed manner, including those related to regional and local development. Croatia's development directions have been set taking into account the circumstances of the pandemic and its consequences. The first is a sustainable economy and society, the second is strengthening crisis resilience, the third is a green and digital transition, and the fourth is balanced regional development. The NDS outlines four strategic priority clusters: Sustainable economy and society, Strengthening resilience to crises, Green and digital transition, and Balanced regional development.

The Chapter on the Green and Digital Transition of the Strategy offers further insight into the specific actions planned to support the development of digital skills and jobs for all citizens, the labour force, and the education sector, including more advanced skills for digital experts. Its first strategic objective is to enhance the digital transition of society and the economy, and a key focus under this objective is to reach the EU average Digital Economy and Society Index (DESI) rating by 2030. Croatia ranked in 20th place within the EU according to the 2020 DESI (scoring 47.6). The EU average for 2020 is 52,57. Another focus is the creation of initiatives to develop digital competencies and promote the availability of digital jobs for all. Activities and actions launched by the NDS aim to support the four pillars of the Digital Skills and Jobs Coalition in Europe through strategic initiatives targeting Croatian society at all levels. Priorities include:

- Digital skills for all citizens, the labour force, and ICT professionals, and education
- Improve and facilitate access to quality adult education programs (for digital competencies) for all
- Raise the level of basic and advanced digital skills of citizens and enable their active participation in the digital society and economy
- Ensure the skills match of employees with appropriate digital competencies and recruitment needs, promote the development of digital jobs, and create the necessary conditions to enhance individuals' career prospects
- Raise the digital competencies of professionals from non-technical professions and industries outside of the information and communication technology (ICT) sector
- Retrain and reskill the existing workforce and support the acquisition of digital competencies throughout the economic sectors
- Adapt and develop further human resources for traditional industries and occupations so that they respond to the needs of the digital environment, society, and economy.
- Increase the number of competent, highly educated young ICT professionals and support their entry into the job market.

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- Upskill existing ICT competences, retaining and attracting digital talent through incentives for employed professionals and opening up research and innovation to foreign students and dedicated professionals from all over the world.
- Encourage an increase in the number of professionals with higher and secondary education and the development of advanced digital competencies from an early age.
- Support initiatives and actions launched by secondary schools and higher education institutions for jobs to raise awareness of digital jobs.

Our R&I Strategy is compliant with this Strategy to a large extent.

Digital Croatia Strategy for the period until 2032 [23] defines the guidelines for a green and digital transformation of our country, as the precondition for future sustainable economic growth and social development. To transform Croatia in a comprehensive and structured manner, this Strategy outlines a set of clear digital transition objectives for the following ten years and defines priority public policy implementation areas in all segments of the digital ecosystem: infrastructure, technology, science, education, innovation, and markets. By creating a regulatory, investment, and tax environment that fosters technological development and innovation, investing in citizens' digital competencies, and increasing the number of ICT specialists in the private and public sectors alike, as well as applying advanced technologies in public and market activities, Croatia wants to become a country with digitally and economically competitive enterprises and digitalised public administration with personalised public services by the year 2032. Our Joint R&I Strategy is coherent with the following strategic objectives and priority public policy implementation areas:

Strategic objective 1: A developed and innovative digital economy

- 4.1.1. Digital transition of the economy - Strategic objective: A developed and innovative digital economy
    - 4.1.1.1. Priority public policy implementation area 1.1: Supporting digitalisation in micro, small, and medium-sized enterprises
    - 4.1.1.2. Priority public policy implementation area 1.2: Digitalising public services for enterprises and securing access to anonymised public data
    - 4.1.1.3. Priority public policy implementation area 1.3: Supporting digital innovation hubs

Strategic objective 4: Develop digital competences for working and living in a digital age

- 4.4.1 Developing digital skills and digital workplaces – Strategic objective: Develop digital competencies for working and living in a digital age
    - 4.4.1.1. Priority public policy implementation area 4.1: Increasing the number of ICT specialists in the labour market
    - 4.4.1.2. Priority public policy implementation area 4.2: Developing citizens' digital competencies for working and living in a digital age, with the help of ICT
    - 4.4.1.3. Priority public policy implementation area 4.3: Digital transition supporting the development of the education and research system

Smart Specialisation Strategy until 2029 [24] - Smart Specialisation Strategy (S3) for the period 2016-2020 has been primarily used as an absorption tool for ESIF funds invested in Research &

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Development and Innovation. Measures and the majority of the projects from that Strategy are mostly in implementation, and their outcomes and achievements in terms of accomplishments measured with result and outcome indicators are still to be realised and analysed. Preliminary evidence shows that Croatia is still lagging with regard to competitiveness and innovation. The new S3 2021 - 2027 takes into account acquired experiences, lessons learned, and available evidence to achieve significant improvements in the current Programmes implementation cycle. S3 by 2029 aims to contribute to the achievement of the cohesion policy objective "Smarter Europe" through innovations and support to economic transformation and modernisation, the industrial transition of regional economies, and in that way support the implementation of strategic objectives of the Republic of Croatia as defined in the National Developmental Strategy until 2030. A new approach to S3 is aligned with real economic conditions, including the effects of the recent COVID-19 pandemic and its social and economic consequences. Priorities and Programmes framework reflects the needs, abilities, and strategies of a business and research sector, while evaluation will serve as a basis for the adjustment of policies during their implementation. To address unbalanced regional development, S3 includes measures for industrial transition for three NUTS 2 regions with GDP below 75% of the EU average. To accept the challenge of economic modernisation, Croatia must strengthen these regions and help them in the creation of new economic values. In these strivings, regions in the industrial transition are facing specific challenges such as a lack of appropriate skills, high costs of work, and deindustrialisation, which hamper the complete exploitation advantages of globalised markets and technological change. Measures of industrial transition will help regions to take advantage of their territorial capital and comparative advantages, face challenges of industrial transitions, create higher added value, approach new markets, and join forces with other regions. Key documents to resolve these challenges are plans for industrial transition, which are prepared through a bottom-up approach at the NUTS2 level regions in the process of industrial transitions. New S3 will keep the previously determined thematic priorities, but it goes one step further to make them perfect and determine their scope, transformation goal, and Programme framework. The new S3 envisages the redesign of structures and processes for guidance and adaptation Programmes. In the multi-year financial framework 2021 - 2027. Smart specialisation strategies are treated as conditions that enable the withdrawal of funds for research, development, and innovation from EU funds (e.g., enabling conditions – ENC).

Transport Development Strategy of the Republic of Croatia 2014-2030 [25] - The Strategy sets out the basic guidelines for the development of the transport sector within the Republic of Croatia over a medium and long-term horizon (2014-2030), aiming to define an overall and coherent framework to ensure the linkage of infrastructure and transport policy and enabling decision making. The Strategy is the result of a deep analysis and reflection process, but also of participation and debate open to society for this purpose. As a result, a committed participation of the main stakeholders has been registered, getting important contributions in the form of suggestions and proposals to improve and enrich the Strategy. The Transport Development Strategy has considered sustainable development with great sensitivity to environmental concerns and criteria. As a result, it constitutes a decisive commitment to the future of the Republic of Croatia, to its economic development and its competitiveness, to its social and territorial cohesion,

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and the improvement of the quality of life of its citizens, with a set of measures designed to create a transport system which is more integrated, safer, efficient and respectful of its environment.

Adriatic Croatia Industrial Transition Plan 2021-2027 [26] - The implementation of the industrial transition process is aimed at strengthening regional competitiveness and is directly connected to the National Development Strategy of the Republic of Croatia until 2030 (in further 2030) and strategic objective 13, Strengthening regional competitiveness, through smart specializations activities and strengthening position of the regional economy in global value chains. To effectively implement the process of industrial transition, industrial transition plans are based on available resources and the potential for their use, identification of competitive advantages, and smart specialisation as the basis of future growth and development of Croatian regions. The industrial transition plans will drive structural change through vertical logic of interventions aimed at modernisation, diversification, transition, or introduction of radical changes in regional economies, and represent an upgrade of horizontal public policies. The purpose of the industrial transition plans is to:

- clarify the unique combination of problems faced by regions in the industrial transition and identify directions of change based on a "place-based" approach to investment;
- support better coordination and complementarity in the planning and implementation of interventions at the regional and local levels;
- enable the development of regional hubs (economic hubs) and branding and internationalisation of regional economies;
- provide a strategic framework for the efficient use of budgetary and EU funds for the deployment of structural changes in regional economies to strengthen regional competitiveness.

Five regional value chains for Adriatic Croatia have been identified, one of which is the Blue Growth Chain that includes vessels of the future and smart fisheries and aquaculture.

To achieve their goals, the industrial transition plan represents a combination of regional, innovation, and industrial policies, applying a subnational approach to specialization and industrial transition towards niches of added value and introducing innovative elements.

4.1.2 Regional

At the regional level in Western Slovenia, there is the Regional Development Programme of Primorje-Notranjska region for the period 2021 - 2027, and in Croatia, there are Development plans for the counties in the Adriatic region.

Regional Development Programmes of Primorje-Notranjska region for the period 2021-2027 [27] - The development orientation of the region is green, sustainable development in all areas. In compliance with the Sustainable Development Goals, the Primorje-Notranjska region highlights similar development directions and builds on the potential for sustainable development. Among a number of them are the Transformation of the economy in the direction of digitization, advanced technologies, circular economy principles, reduction of the environmental footprint, and creation of new, green jobs increasing energy efficiency and achieving a higher proportion of renewable

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energy use, a functioning system of development, financing and investments in energy efficiency (energy renovation of buildings in the public and private sector and renovation of public lighting systems, sensors, technological renovation to increase the energy efficiency of companies, infrastructure for energy distribution). Taking into account development guidelines, as key areas of specialisation of the region (among others) are the Development of manufacturing activities in the direction of increasing added value, digitization, and green transition, and the Development of circular economy in all sectors.

County Development Plans of Adriatic Coast Counties - There are seven coastal counties in the Adriatic region of Croatia. As prescribed by the Law on Strategic Planning and Management System in the Republic of Croatia, they prepare and adopt medium-term (up to 10 years) development plans in which they define their specific objectives, public policy priority areas, and measures that will be implemented to achieve the objectives set. The county development plans contain specific objectives and several measures that are linked to our Long-term joint R&I strategy (the measures are not indicated here); nevertheless, each Development Plan addresses at least three or more measures that fully or partially correspond to the measures identified within our R&I Strategy. The Development Plans are shortly described below to demonstrate linkages to the Long-term joint R&I strategy, based on specific objectives:

The Development Plan of the County of Istria for the period from 2022 to 2027

The Development Plan of the County of Istria [28] is a fundamental medium-term strategic planning act for the development of the County of Istria. It has been prepared following the provisions of the Act on Regional Development of the Republic of Croatia [24] and the Act on the System of Strategic Planning and Managing Development of the Republic of Croatia [29]. The vision of development is the following: a Green, resilient, connected, and smart region of recognisable identity and high quality of life whose development is based on an innovative and competitive economy. There are 16 specific objectives grouped into four areas of development. Under Green and connected regions, the specific objectives are Energy transition and facing the consequences of climate change, Sustainable traffic, communication connecting, and Strengthening capacities for risk management. Under the Region of innovative and competitive economy in sustainability function, the specific objectives are Digital and green economy transformation, Entrepreneurship based on research and innovation, and the Development of sustainable and competitive agriculture, forestry, hunting, fishery, aquaculture, and water management. No explicit measures related to the maritime innovation ecosystem are mentioned; however, they are implicitly indicated under identified specific objectives.

The Development Plan of the Primorje-Gorski Kotar County for the period 2022 to 2027

The vision indicated in the Development Plan [30] is: *Primorje-Gorski Kotar County is a competitive, smart, sustainable, and socially fair region desirable for living and working.* The vision will come true once the specific objectives are achieved, and policies are implemented and coordinated through the five priorities. Consequently, development priorities and corresponding specific objectives have been set, among others, those that could be linked to our Joint R&I Strategy:

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Priority 1. Smart region of a competitive economy based on knowledge and advanced technologies
Specific objectives:
1.1. A competitive economy based on knowledge and innovation
1.2. Economic growth aimed at boosting exports by raising productivity and digital transformation
1.3. Attractive business environment for employment, growth, and investment
Priority 3. Green transition based on sustainable management and the use of its own resources
Specific objective (of relevance to the Joint R&I Strategy): Green and energy transition towards carbon neutrality.

Development Plan of Lika-Senj County for the period until 2027

The vision indicated in the Development Plan of Lika-Senj County [31] is the following: *strengthening the competitiveness and sustainability of agriculture and the economy through investments in green and digital technologies, increasing the efficiency of resource use, developing sustainable and green tourism, developing smart cities and villages, improving the quality of education, demographic recovery and improving the quality of life by investing in health and social infrastructure and security.* In the Development Plan of Lika-Senj County, there are three strategic objectives and corresponding measures that could be linked to our Joint R&I Strategy. The specific objectives are as follows:
Specific objective 1: Strengthening the competitiveness of the economy through investment in green and digital technologies
Specific objective 3: Increasing efficiency in the use of resources,
Specific objective 5: Smart cities and villages.

Development Plan of Zadar County for the period from 2021 to 2027

The vision outlined in the Development Plan of Zadar County [32] indicates the following: *Competitive and developed county leading in blue and green economic growth in Adriatic Croatia. A county of innovative and sustainable development with safe and stimulating environments for all its citizens*. There are four so-called priority directions, two of them with specific objectives (and measures within each specific objective) related to our R&I Strategy. They are as follows:
Priority direction 1: Competitiveness and innovativeness of the economy and society
Specific objective 1: Encouraging the industrial transition towards niches of high added value
Specific objective 2: Creating strong small and medium-sized enterprises and an enabling business environment
Priority direction 3: Resource efficiency and connectivity
Specific objective 14: Improving energy efficiency and infrastructure with the transition to clean energy and renewable energy sources.

Development plan of Šibenik-Knin County for the period from 2021 to 2027

The vision for the development of Šibenik-Knin County [33] is the following: *A region with a high quality of life, attractive, preserved, and valorised natural and cultural-historical heritage, balanced development based on knowledge, and a competitive and innovative economy.* Four priorities include specific objectives with a link to our Joint R&I Strategy, as follows:
Priority 1: Competitive economy

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Specific objective 1: Development of a diversified economy (through digitalisation and innovation, among others)
Priority 2: Inclusive, resilient, and sustainable society
Specific objective 10: Digital transformation of society and economy
Priority 3: Green and functional county
Specific objective 12: Green and energy transition
Specific objective 13: Development of sustainable mobility, Measure 13.2.: Improving maritime transport
Priority 4: Balanced regional development
Specific objective 15: Development of smart and sustainable cities and villages in the context of strengthening the position of regional economies.

Development Plan of Split-Dalmatia County for the period from 2022 to 2027

The vision indicated in the Development Plan of Split-Dalmatia County [34] is the following: *County for everyone - a place of quality, safe, and comfortable living for all its inhabitants, which enables a balanced economic and social development respecting the principles of sustainability and social inclusion*. There are a few priorities and corresponding specific objectives (and measures within each specific objective) that are compliant with our Joint R&I Strategy, and they are as follows:
Priority 1: Competitive and resilient economy
Specific objective 1.1. Creation of a Competitive, sustainable, and knowledge-based resource-efficient economy
Specific objective 1.2. Strengthening of small and medium entrepreneurship and the entrepreneurial environment.
Priority 3: Green and resource-efficient county of sustainable infrastructure
Specific objective 3.1: Environmental and nature protection, and creating resistance to climate change and natural disasters
Specific objective 3.2.: Sustainable development of infrastructure systems
Specific objective 3.3.: Energy transition of the county
Specific objective 3.5.: Development of the overall transport system
Under the Horizontal theme and the development priority of Smart and sustainable management of island resources and environment, there are the following Specific objectives:
Specific objective 3.2.: The development and stimulation of building renewable energy sources systems, the use of clean energy, and energy efficiency
Specific objective 3.3.: Environmental and nature protection, risk reduction and mitigation of consequences, and strengthening of resilience to climate change.

Development Plan of Dubrovnik-Neretva County until 2027

By 2027, Dubrovnik-Neretva County will become a European region of high quality of life, a stable and dynamic economy, with a high degree of social solidarity and inclusiveness, a preserved environment, and cultural heritage that is managed through a participatory and strategically based approach to the well-being of future generations [35].

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The vision defined in this way is a guide for the elaboration of priorities, goals, and measures. Many priorities, strategic objectives (and measures within each specific objective) are compliant with our Joint R&I Strategy, and they are as follows:

Priority 1. Strengthening the resilience of the economy and increasing investment in a sustainable and digital economy

Specific objectives 1.1.: Improvement of the business environment

Specific objective 1.2.: Fostering sustainability, digitalisation, and innovation in the Economy

Specific objective 3.1.: Preservation of the environment and energy transition to the greatest possible well-being of local communities

Specific objectives 3.2: Improving internal and external connectivity and green mobility.

4.2 A route to a strategic framework

Various analyses conducted in the initial stages of the project provided valuable information on the current state of maritime innovation ecosystems in Western Slovenia and Adriatic Croatia. They identified several problems that these regions are facing in the research & innovation sector, the needs that should be satisfied to fill the current gap, and the challenges that stakeholders need to address in these ecosystems.

All these findings are relevant for predicting future trends and setting Western Slovenia and Adriatic Croatia on the global maritime innovation ecosystems map.

The findings, results, and conclusions of the analyses were discussed during the workshops with the project partners. Based on written and oral inputs we have jointly formulated the vision, determined the strategic objectives that we want to achieve, priority areas in which we want to focus our interventions, and measures which we want to implement through projects, activities, and actions to strengthen the two maritime innovation ecosystems' excellence and make them recognised at the European or even global level (concrete paths and tools to achieve this will be more elaborated in the Action and Investment Plan including monitoring methodology, D4.1 and synergies with other initiatives & new partnerships, D4.2).

The path from analysis to the strategic framework for the Long-term joint R&I strategy of the Western Slovenian and Adriatic Croatian maritime innovation ecosystems is presented in Figure 4.1, showing the key inputs for creating the strategic framework.

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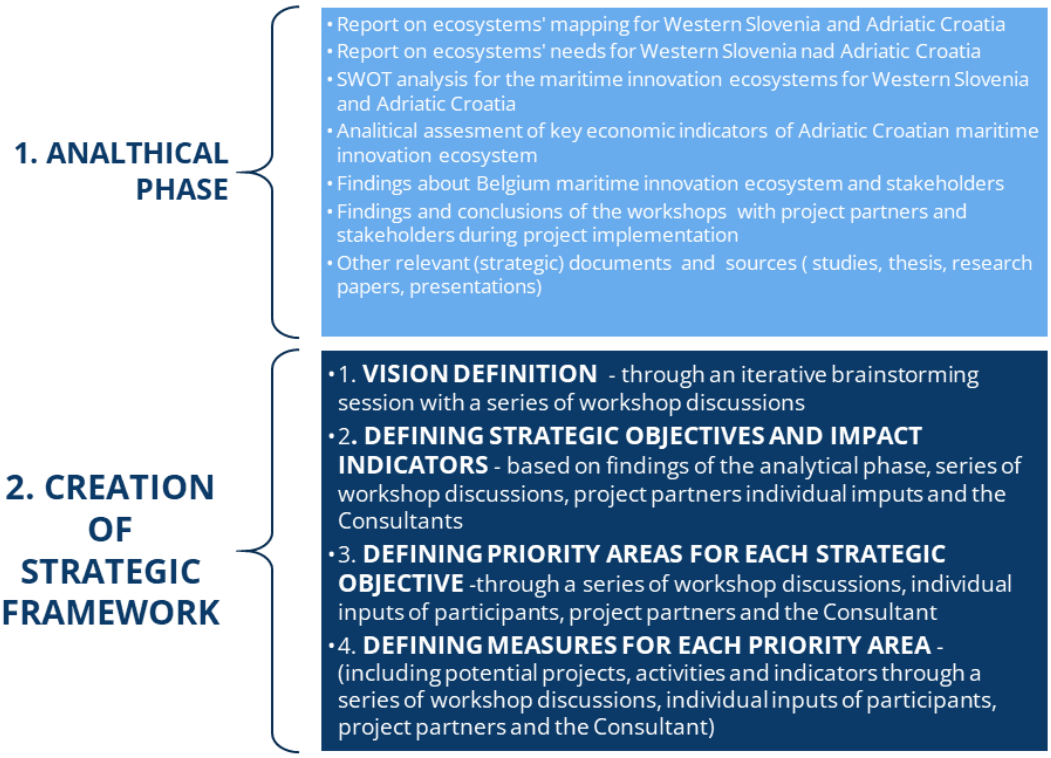

Figure 4.1: From analysis to the strategic framework of the Long-term joint R&I strategy. Source: Authors.

The process described in Figure 4.1 led to the formulation of a vision. Vision is usually described as the key element of strategy development, and it articulates strategic direction for a desired state in the future. It is a summarised statement that describes what we want to achieve in ideal conditions. In forecasting the vision, we have applied commonly used criteria in this exercise:

- Oriented towards the future based on rational hypotheses about the future
- Idealistic, adequate, ambitious, inspirative, purposeful
- It reflects a joint understanding of a problem
- It is based on information collected on relevant and available existing data and facts (trends, alternative futures, political context, potential barriers and risks, experience)
- It has taken into consideration stakeholders' perspectives, although it is significant in all phases of strategy preparation that they are critical in the definition of strategic direction.

In considering how the vision could be formulated, we also consulted other Maritime and Joint Strategies of the countries with rich experience in the maritime sector, which are still valid documents. The maritime (innovation) framework, strategies, and documents consulted are the following:

- Belgian - Belgium, as a country with a rich history of maritime activities, has long been recognised for its maritime heritage and its strategic position as a gateway to international

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markets. Over the years, Belgium has developed a robust maritime landscape that encompasses diverse sectors such as shipping, ports, logistics, offshore energy, and marine technology. In recent times, the importance of fostering innovation within the maritime sector has gained considerable attention worldwide. Innovation has become a key driver for sustainable growth, competitiveness, and resilience in an increasingly globalized and technologically advanced environment [36]. Presentation and other materials provided at the workshops and visit to the Port of Antwerp-Bruges, as ports with best practices in the maritime innovation sector, were valuable inputs for developing a strategic framework and the measures that should be implemented within the Joint R&I Strategy [37].

- Belgian Vision for the North Sea 2050: a Long-Term Vision Document for the Belgian part of the North Sea up to 2050. It guides the development of Maritime Spatial Planning (MSP) in Belgium. Key aspects covered in the vision include 1) Coexistence of uses (e.g., economic, environmental, social aspects), 2) Land-sea interactions, 3) Multi-use approaches, 4) Blue Economy and Blue Growth, and 5) Future perspectives. Unlike the vision, the maritime spatial plan is a concrete, legally binding planning document with a shorter timeline (2020-2026). It focuses on specific spatial arrangements, while the vision sets long-term goals and conditions for sustainable development [38].
- The Belgian Science Policy Office (BELSPO) supports the science policy of the federal government. BELSPO is responsible for the management of research programmes in support of policies about sustainable development, combating climate change, biodiversity, energy, health, mobility and the information society.
- Department of Economy, Science & Innovation (EWI) in Flanders is the entity that is responsible for the development and implementation of the science and innovation policy. In addition, other policy domains can also (albeit to a much lesser extent) take initiatives in the field of science and innovation in order to support and underpin their policy.
- Norwegian Maritime Strategy - Maritim21[39] is a strategy for research, development and innovation for the maritime industry. In this context, maritime industries include the shipping industry, the shipbuilding industry, and service and equipment suppliers for all types of ships and vessels. They also include vessels and maritime technology used in other ocean industries, including aquaculture, fisheries, offshore oil and gas production, and offshore renewable energy, as well as knowledge-building in research groups on topics in technology and social sciences that are significant to the Norwegian maritime industry. The Maritime21 strategy provides an important direction for the development of the Norwegian maritime industry.
- The Dutch Maritime Strategy 2015-2025 [40]. As a trading nation, the Netherlands has succeeded in building a strong global maritime position, partly as a result of the strategic position at the estuary of the rivers Meuse, Rhine, and Scheldt. This is reflected in the international leading position of the industries from the Dutch maritime cluster, a cluster which is predominantly internationally orientated and regulated. The Netherlands has an open economy and is one of the world's ten leading exporters, to which the maritime cluster significantly contributes to that position.

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- Relevant documents from the Nordic cooperation framework [41] which involves Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland, and Åland. Their vision is to make the Nordic region the most sustainable and integrated region in the world. The partner countries and autonomous areas cooperate in a number of priority areas in which they see and use the potential for joint action and synergies. These priority areas are the following: Legislation and justice, Working life, Digitalisation and innovation[3]Disability, Healthy and sustainable food systems, The environment and climate, Sustainable development, Children and young people, Energy, Culture, Education and Research, Gender equality and LGBTI.

Nordic countries and autonomous areas cooperate as well in the field of marine spatial planning, which is considered a promising tool for the management and protection of the marine environment, offering an integrated, ecosystem-based approach to managing the multiple and potentially conflicting uses of the sea [42]. Spatial planning is applied to different maritime sectors.

4.3 Defining the vision

The participants in the workshops, based on all mentioned above, provided valuable inputs (words, phrases, ideas, hints…) for the formulation of the vision, which were plenary discussed. This exercise is followed by joint formulation and agreement on the vision among participants in the following way:

[3] *Digitalization and innovation - The aim of the digitization partnership is to strengthen the Nordic and Baltic countries as a coherent and integrated digital region. Joint efforts to promote the green digital transformation will benefit citizens, businesses and public administrations right across the region.*

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For the preparation and implementation of the R&I strategy, the following values can be applied:

- Quality of research and innovation work – a continuous tendency to secure high-quality work and delivery of high-quality deliverables
- Independence and impartiality in research and innovation work – it should ensure that all research and innovation activities and deliverables (including methodology findings, results, and conclusions) will be independently collected and impartially interpreted
- Relevance - focusing on the topics that are most relevant to strengthening excellence in R&I in Western Slovenia and Adriatic Croatia
- Ethically acceptable – all the work should be carried out in line with ethical standards and norms
- Transparency of work – all the work should be carried out in a transparent manner
- Effectiveness and efficiency – implementing the projects, activities, and actions should be effective (they will deliver the desired impacts) and efficient (they should bring value for money).

4.4 Strategic objectives

The main objective as set in the project is the following: *Strengthening the innovation ecosystems' excellence.* It helped in formulating the vision and determining the strategic objectives and priority areas. The number of objectives is, in general, arbitrary; it can vary, but for practical reasons, we have determined four strategic objectives, which we have further elaborated into priority areas and derived corresponding measures. The strategic objectives are as follows:

I. Digital advancement of the maritime innovation ecosystem
II. Green transition of the maritime innovation ecosystem
III. Attractive and in full capacity maritime ecosystem labour market
IV. Excellence in maritime ecosystems' governance

4.5 Priority areas and measures

As indicated in the project summary, preliminary priority areas for the R&I investments are taken into consideration when developing the strategic framework. They are listed below:

- Vessel security and safety, automated maritime transport, and energy efficiency
- Sharing infrastructure, access to start-up and growth capital
- Creation of innovation culture/collaboration and communication through open innovation approaches (innovation acceleration and networking)
- Employment, skills, and attracting talent in the innovation sector
- Pathways to commercial exploitation, including valorisation and knowledge transfer
- Ecosystems' leadership & governance
- Equality, diversity & inclusion
- Emission reduction

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- Blue economy growth
- Sustainable use of marine space and resources
- Exploring the synergetic potential between maritime transport and other economic activities in the “Blue” sectors

Finetuning of priority areas followed in cooperation with the project partners and stakeholders, through workshops and the results of these participative and interactive processes contributed to the drafting of the Long-term joint R&I strategy.

A strategic framework consisting of strategic objectives, priority areas (15 in total), and elaborated measures (27 in total), with preliminary lists of potential projects and activities, is presented in the table below. The table also includes information on target groups/users at the level of each measure, responsibility (and co-responsibility) for implementation of each measure, indicators that should be monitored, and potential sources of financing implementation of identified projects, activities, and actions. In principle, many projects and activities could be financed through various EU funds/Programmes, state/regional/local budgets, and private capital, where the interest for the private sector engagement is clear.

When discussing the responsibility for implementation of measures, clearly, whenever possible, project partners will be engaged and will support implementation. For some measures, the institutions that should be in charge of implementation have not been directly and intensively involved in this project, but should be involved, and the implementation is expected to be undertaken from their side should be discussed and coordinated.
An agreement was reached as a result of workshop discussions that equality, diversity, and inclusion would be addressed as a horizontal theme and should be integrated within each strategic objective, priority area, measure, project, and activity whenever and wherever applicable. This horizontal theme will be considered and elaborated on in each case.

The information about the strategic framework is presented in Table 4.1.

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Table 4.1: Strategic framework.

No.	Strategic objective	Priority area/Measure	Users/target groups/ beneficiaries	Responsibility/ Co-responsibility	Indicators	Sources of financing
1.	**Digital advancement of the maritime innovation ecosystem** **Indicators: Level of digitalisation of companies in the maritime ecosystem, Total investment in digitalisation advancement**					
	1.1. Introduction of Key Enabling technologies and upgrade of existing ones					
	1.1.1. Demonstration and promotion of digital technologies in Western Slovenia and Adriatic Croatia					
	Purpose: To increase awareness of the potential use of digital technologies and how to implement them **Projects/activities**: • Pilot project: Improved fire evacuation VR model of a ship engine room • Pilot project: Digital twin supported by AI for sustainable and efficient energy management • Pilot project: Autonomous shipping technology (advanced machine vision support systems integrated into existing navigation systems of the ships)		Big companies, SMEs, academic institutions, local and regional government	**Responsibility:** University of Ljubljana **Co-responsibility:** Project and other partners, University of Rijeka	1) Number of developed and tested digital technologies 2) Number of promotion events (at which the technology will be promoted) 3) Number of published papers/articles	Primary source: EU funds/Programmes/grants, private sector (capital); additional/other possible funding (to a lesser extent): University budgets, state, regional, and local budgets
	1.1.2. Developing a global digital twin of the port area					
	Purpose: To enable the development of a modern decision-making system, as an important tool for efficient, strategic, future-oriented area planning & management **Projects/activities:** • Data sharing • Initiating collaboration and gaining support through Digital Innovation Hubs • Development of digital twins for different segments of port operations (for bridges, planning logistics, ship docking, resources management, managing terminals, warehouses, internal & external logistics,		Port authorities, shipping companies, logistic providers, universities, and the government	**Responsibility:** Port Authority, private operators **Co-responsibility:** government	1) Number of developed digital twins 2) Management efficiency (less time required for implementation of activities, increased income, cost reduction…)	Primary source: EU funds/Programmes/grants, private sector (capital); additional/other possible funding (to a lesser extent), VC funds, state, regional, and local budgets

	energy management…) • Tailor-made AI assistant				
	1.1.3. Use of autonomous and automated solutions within port infrastructure				
	Purpose: to increase management efficiency, to help workers in their daily work, decrease exposure to risks related to possible injuries at work, minimise human-based/related errors **Projects/activities:** • Production and use of semi- or fully autonomous vehicles • Production and use of semi- or fully autonomous vessels • Production and use of semi- or fully autonomous cranes • Production and use of semi- or fully autonomous bridges • Production and use of semi- or fully autonomous devices and tools • Production and use of drones	Port authorities, employees, shipping companies, logistic providers, companies and SMEs in manufacturing-related sectors, universities	**Responsibility:** Port Authorities **Co-responsibility:** end users (to explain the role of end users in the implementation of the measures and potential resistance to the implementation of the measures), companies, and SMEs. Universities (they need to provide appropriate tools for end users)	1) Number of implemented semi or fully autonomous vehicles, vessels, cranes, bridges, devices, tools, and drones 2) Management efficiency (less time, increased income, fewer costs…) 3) Number of newly employed persons 4) Number of persons with upgraded employment/work position/station/post	Primary source: EU funds/Programmes/grants, private sector (capital); additional/other possible funding (to a lesser extent), VC funds, state, regional, and local budgets
	1.2. Improvement of interactions between different systems, entities, and organisations				
	1.2.1. Supporting matchmaking and networking				
	Purpose: Establishing collaboration between stakeholders and actors in the innovation ecosystem **Projects/activities:** • Organisation of regular events that bring together all stakeholders in the innovation ecosystem (conferences, thematic events encouraging collaboration…) • Leveraging digital tools for matchmaking and networking • Organisation of study visits (different structures, groups, and organisations visited)	Big companies/industry, SMEs and R&D actors, academic institutions (public and private), funding organizatios	**Responsibility:** Business support organizations/intermediaries **Co-responsibility:** project partners, regional development agencies, NGOs	1) Number of users of digital tools for matchmaking 2) Number of events 3) Number of participants	Primary source: EU funds/Programmes/grants, private sector (capital), funding organizations; additional/other possible funding (to a lesser extent), University budgets, state, regional, and local budgets
	1.2.2. Building joint platforms for cooperation on projects				

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	Purpose: Enhancing virtual collaboration between stakeholders and actors in the innovation ecosystem **Projects/activities:** • Organisation of regular thematic brainstorming sessions on potential platform areas development • Designing and setting up a functional platform for information exchange and learning	Big companies/industry, SMEs and R&D actors, academic institutions (public and private	**Responsibility:** Business support organisations/intermediaries **Co-responsibility:** project partners, regional development agencies, clusters	1) Number of sessions 2) Number of users of the platform 3) Number of joint projects/collaborations	Primary source: EU funds/Programmes/grants, private sector (capital), funding organisations; additional/other possible funding (to a lesser extent): University budgets, state, regional, and local budgets
	1.3 Increasing competencies, building capacities, and cross-sectoral technology transfer, research & development in the maritime innovation ecosystem				
	1.3.1. Supporting the preparation and implementation of tailor-made Programmes for digital advancement in the maritime industry				
	Purpose: To build the capacity of end users in digital technologies in the maritime industry **Projects/activities:** • Pilot projects for training (technology demonstrator) and skills development • Knowledge exchange from other recognised institutions • Pathway design – From school to maritime industry (cooperation between students and companies, to build stronger relationships to potentially enable employment in companies after graduating)	Big companies/industry, SMEs and R&D actors, academic institutions (public and private), scholars (secondary/ vocational education)	**Responsibility:** Academic institutions **Co-responsibility:** vocational schools, companies, NGOs	1) Number of Programmes implemented 2) Number of participants participating in education Programmes 3) Number of industry partnerships (with education institutions	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): University budgets, state, regional, and local budgets
	1.3.2. Supporting cross-sectoral technology transfer and enabling further research & development in the maritime ecosystem				
	Purpose: To increase technology transfer between sectors and explore further areas of research & development in the maritime industry **Projects/activities:** • Fostering cross-sectoral technology transfer • Identification, preparation and implementation of research projects in maritime innovation systems	Big companies/industry, SMEs and R&D actors, academic institutions (public and private	**Responsibility:** Academic institutions **Co-responsibility:** companies, incubators	1)Number of cooperation's 2)Number of implemented projects	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): University budgets, state, regional and local

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	• Introducing industry-academia collaboration tools and schemes				budgets
	1.4. Support for the positioning of SMEs in the value chain				
	1.4.1. Support SMEs and small organisations in the uptake of digital technologies				
	Purpose: Leveraging digital solutions to enable smaller companies to better enter and integrate into the value chain in the maritime industry **Projects/activities:** • Tailor-made support schemes for start-ups and SMEs in the value chain to mitigate specific risks • Increase the offer of training and demonstrator projects for SMEs and start-ups • Ensuring engagement of digitalisation support hubs in assisting SMEs with digital transition	SMEs, start-ups	**Responsibility:** Business support centre, business associations /clusters, HAMAG-BICRO **Co-responsibility:** project partners. EDIH Adria Innovation Hub	1) Number of SMEs and start-ups involved/participated in projects/activities 2) Number of SMEs and start-ups that successfully made an uptake of digital technologies 3) Number of SMEs and start-ups that received the grant	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): state, regional, and local budgets
2.	**Green transition of the maritime innovation ecosystem** **Indicators: Green transition index for the maritime sector**				
	2.1. Improved air quality and waste reduction				
	2.1.1. Emission reduction, carbon capture and storage, eco-friendly port operations				
	Purpose: to reduce emissions (in line with internationally set target values until 2030 **Projects/activities:** • Port emission control system (installation of measuring machines, regular monitoring of emissions)	Port authorities, shipping companies, logistic providers, companies, SMEs, universities, government, public health institutions	**Responsibility:** port authorities, public institutions, and marinas **Co-responsibility:** government	1) CO_2 reduction (in tons)	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): state, regional and local budgets
	2.1.2. Efficient waste management				

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	Purpose: to increase recycling of materials in operations (EU packaging waste directive) **Projects/activities:** • Zero waste project (proper separation of waste, proper collection of waste for recycling, appropriate transfer to final waste disposal destinations) • Protection of local maritime ecosystems • Use of eco-friendly vessels • Reduction of plastic products and plastic components (to reduce the use of plastic whenever and wherever possible) and replace plastic with more sustainable materials	Port authorities, shipping companies, logistic providers, companies, SMEs, universities, government, communal companies, recycling industries/companies, marinas	**Responsibility:** port authorities, public institutions **Co-responsibility:** government, companies, NGOs	1) Waste quantity (in tonnes) 2) Share of recyclable waste in total waste	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): state, regional, and local budgets
	2.1.3. Deployment of Smart Environmental Sensing Technology and specific education				
	Purpose: to reduce environmental risks and potential hazards **Projects/activities:** • Use of smart cameras and high-quality sonars • Installation of various detection systems (oil spill, floating debris, dangerous goods…)	Port authorities, shipping companies, logistic providers, companies, SMEs, universities, government, public health institutions, marinas	**Responsibility**: port authorities, public institutions **Co-responsibility**: government	1) Level of environmental risk	Primary source: EU funds/Programmes/grants; additional/other possible funding, state, regional and local budgets
	2.2. Improving energy management, increased use of renewables, hydrogen and offshore renewable energy				
	2.2.1. Introduction of advanced energy management systems				
	Purpose: to increase energy efficiency and improve energy management **Projects/activities:** • Pilot project and simulations of an advanced energy management system • Subsidy schemes for users of renewables • Analysis of the potential for the use of offshore renewable energy	Big companies, industry, port authorities, shipping companies, logistic providers, SMEs, universities, marinas	**Responsibility:** public institutions **Co-responsibility:** big companies, industry, SMEs, universities, regional and local government	1) Level of energy consumption	Primary source: EU funds/Programmes/grants, additional/other possible funding, state, regional and local budgets

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	2.2.2. Stimulating the use of hydrogen				
	Purpose: to decrease dependency on fossil fuels **Project/activities:** • Analysis/studies of possibilities for the introduction of hydrogen in maritime transport systems • Pilot project with hydrogen-led vessels • Exchange and transfer of knowledge in the field of hydrogen use in the maritime sector • Building the basis for a regulatory framework (laws and by-laws) and guidelines for potential users of hydrogen (vessels) • Subsidy schemes for users of hydrogen	Big companies, industry, shipping companies, logistic providers, SMEs, government	**Responsibility:** public institutions (government) **Co-responsibility:** Universities	1) Draft of a relevant regulation	Primary source: EU funds/Programmes/grants, state budget
	2.3. Biodiversity protection, offshore aquaculture, oil-spill prevention				
	2.3.1. Using alternative fuels and power sources				
	Purpose: to decrease dependency on non-renewable energy sources **Projects/activities:** • Exploring alternative fuels and testing new solutions to increase the use of alternative fuels • Prevention equipment for old ships that still use fossil fuels • Regular checks of old and ships that still use oil (classification check) • To implement rigorous regulation also for tourism-related vessels	Port authorities, shipping companies, logistic providers, companies, SMEs, and the government	**Responsibility:** Government **Co-responsibility:** port authorities, classification associations, regional and local authorities, communities, local companies and SMEs, NGOs and civil society associations	1) Quantity of alternative fuels used 2) Quantity of oil spilled	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): state, regional and local budgets
	2.3.2. Stimulating the development of offshore aquaculture				
	Purpose: to exploit the potential of aquaculture and contribute to the economy **Projects/activities:** • Exploring the potential for offshore (open water/ocean) aquaculture and testing deeper water opportunities • Pilot projects for fish farms	Local) companies, industry, SMEs, research institutions, government, associations,	**Responsibility:** research institutions **Co-responsibility:** regional and local authorities	1) Successfully implemented pilot projects in offshore aquaculture	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent), state, regional, and local

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	• Knowledge building in the offshore aquaculture field • Exploring the potential for co-location of offshore activities (e.g., fish farming/wind energy)	communities			budgets
	2.4. Circular economy principles in maritime activities and supply chain optimization				
	2.4.1. Business support services supporting the transition of companies towards the circular economy				
	Purpose: Enable companies in the maritime sector to transform their business models towards sustainability and the circular economy **Projects/activities:** • Training, workshops, and matchmaking events allowing companies to adopt new knowledge and build innovative "green" business models • Individual consulting/mentoring for business entities that would transition to the circular economy • Analysis of the current supply chain and providing solutions for its optimization	SMEs, business support organisations, and large companies	**Responsibility:** business support organisations **Co-responsibility:** regional development agencies, science and technology parks	1) Number of events 2) Number of participating organisations 3) Number of companies/SMEs/ start-ups who improved their business against circular economy principles (survey at the beginning of the project/activity) 4) Number of solutions for optimization	Primary source: EU funding, regional public funds, and large companies
	2.4.2. Supply chain optimization and service innovation				
	Purpose: Enable companies and SMEs in the maritime sector to introduce/optimize business models and practices to enhance innovation and sustainability-based competitiveness **Projects/activities:** • Training, workshops, and matchmaking events allowing companies to adopt new knowledge and expand their networks and contacts • Provision of individual consulting/mentoring for business entities interested in the improvement of their business models • Analysis of the current supply chain and providing solutions for its optimisation through service innovation	SMEs, business support organizations, large companies, start-ups	**Responsibility:** business support organizations **Co-responsibility:** regional development agencies, science and technology parks, Edih Adria HUB	1) Number of events 2) Number of participating organizations 3) Number of solutions for optimization	Primary source: EU funding, regional public funds, and large companies
	2.4.3. Blue Economy - sustainable growth in the marine and maritime sectors				

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	Purpose: to stimulate activities that are oriented towards Blue Growth and contribute to the economy. **Projects/activities:** • Exploring potentials for development in renewable energies, aggregate mining, shallow and deep-sea mining, offshore oil and gas, shipping, yachting, and marinas • Projects/activities related to sustainable fisheries, maritime security, biotechnologies, desalination, aquaculture, and fish farming Searching for smart and adaptive materials and structures required to improve the vessel or offshore platform's ability to operate	Companies, industries, SMEs, universities, R&D institutions, regional and local authorities	**Responsibility:** regional and local authorities **Co-responsibility:** companies, industries, universities, projects, and associated partners	EU Blue Economy Report (indicators) 1) Port activities 2) Shipbuilding and repair 3) Maritime transport	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): state, regional, and local budgets
	2.5. Improvement of connections of the maritime innovation ecosystem and accessibility				
	2.5.1. Construction of physical rail infrastructure – connections - optical infrastructure				
	Purpose: to enable/improve connectivity and accessibility between the entities in the ecosystem using physical infrastructure **Projects/activities:** • Preparation of relevant technical documentation (corridors, length, type of infrastructure, etc.) • Preparation of tender documentation and tender launch • Construction of physical infrastructure / optical infrastructure • Procurement of trains/wagons	Ports, shipping, logistics, and other companies, SMEs	**Responsibility:** Croatian railways, Slovenian railways, telecoms **Co-responsibility:** government	1)Number of kilometres of newly built infrastructure 2)Optic cables, 5G network	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent): state, regional, and local budgets, public-private ventures
3.	**Attractive and in full capacity maritime innovation ecosystem labour market** **Indicators: Unemployment rate in the maritime sector, Employment rate in the maritime sector**				
	3.1. Increase of employment opportunities in the maritime innovation sector/ecosystem				
	3.1.1. Attracting talents in the maritime innovation sector/ecosystem				
	Purpose: to attract highly skilled workers and retain talents to contribute to higher maritime sector production and added value to the economy in general	Early graduates, students of the final years of their	**Responsibility:** regional and local authorities **Co-**	1) Number of persons employed in the maritime innovation	Primary source: EU funds/Programmes/grants, private sources (capital); state subsidies,

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	Projects/activities: • Reconsidering labour tax for employers in the maritime innovative sector • Designing the schemes/models with an array of benefits for attracting talent and retaining highly skilled workers • Provision of quality service (education, incl. kindergarten, health, transportation, available/affordable housing)	studies, companies, industries, universities, secondary (vocational) schools, regional and local authorities	**responsibility:** companies, industries, universities, secondary (vocational schools), NGOs, clusters	sector/ecosystem	additional/other possible funding (to a lesser extent), state, regional, and local budgets
	3.1.2. Increase of interest in maritime studies and shipbuilding				
	Purpose: to attract potential students and secondary school pupils to continue their education in maritime studies, shipbuilding, etc., to enrich a workforce basis that will contribute to the development of the economy in general **Projects/activities:** • Developing new educational Programmes, including joint multidisciplinary Programmes in the English language • Modernising existing university programs to be more in line with the company's needs (use of cutting-edge software, VR, etc.) • Activities promoting education in maritime and related studies • Scholarships for students • Support in finding jobs during and after the formal completion of studies	Early graduates, students in the final years of their studies, companies, industries, universities, secondary (vocational) schools, regional and local authorities	**Responsibility:** regional and local authorities, universities, and vocational schools **Co-responsibility**: companies, industries, NGOs, civil society associations, projects, and associated partners	1) Number of students/pupils enrolled	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent), state, regional, and local budgets
	3.2. Creating economic, social, and environmental benefits from knowledge valorisation				
	3.2.1. Pathways to commercial exploitation, including valorisation and knowledge transfer				
	Purpose: to increase benefits stemming from commercial exploitation and appropriate valorisation of knowledge transfer **Projects/activities:** • Pilot project of valorisation of knowledge transfer • Education on commercial exploitation with successful examples	Companies, industries, R&D institutions	**Responsibility:** Universities **Co-responsibility**: big companies, industry, R&D institutions, patent offices, clusters	1) Number of products/services commercially exploited	Primary source EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent

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4.	**Excellence in Maritime Innovation Ecosystems' governance** **Indicators: Good governance index**				
	4.1. Creation of innovation culture and strengthening collaboration with actors in R&I				
	4.1.1 Fostering innovation culture through the identification, preparation, and implementation of shared projects between industries and universities/research organizations				
	Purpose: to build capacity for innovative projects and the delivery of innovative products, services, solutions, and processes **Projects/activities:** • Collaboration and communication through open and user innovation approaches (innovation acceleration and networking, international/global access, open internationalized society) • Preparation of shared innovation-oriented projects, innovation acceleration, and ideation workshops • Community facilitation, community trend-watching • Activities and initiatives towards strengthening collaboration in international/EU projects • Improvement of the maritime cluster in its operations and functioning (knowledge transfer, recognition of potentials, networking…)	Companies, industries, R&D institutions, universities, and regional development agencies	**Responsibility:** Universities, innovation incubators/ accelerators, science and technology parks, NGOs, civil society associations, clusters **Co-responsibility:** companies, industry, R&D institutions, patent offices, regional and local government, development agencies, NGOs and civil society associations, project and associated partners	1) Number of innovative projects	Primary source: EU funds/Programmes/grants, private sources (capital); additional/other possible funding (to a lesser extent)
	4.1.2. Active contribution to the implementation of existing and development of future (public) policies, strategies, plans, programs, and active governance				
	Purpose: To analyse and produce findings related to the alignment of policies and policy instruments concerning R&D and the economy in the regions **Projects/activities:** • Workshops, conferences, and events bringing together experts in policy and strategy	Policymakers, development agencies, universities, and local and regional authorities	**Responsibility:** regional development agencies **Co-responsibility:** universities, the project, and	1) Number of events 2) Number of participations in various events 3) Number of outputs (e.g., Joint	EU funds/Programmes, regional and local authorities

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	development, aiming for alignment and long-term collaboration • Establishing transnational working groups • Ensure the continuously active role of the Innovation Council in the implementation of strategy measures (projects, activities) • Improving safety-related protocols, guidelines, and instructions (ship safety, protection at work, cybersecurity, etc.)		associated partners	recommendations, solutions, decisions, protocols, guidelines, instructions, etc.)	

Source: Authors.

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5. FOUR-HELIX INNOVATION ECOSYSTEMS ANALYSIS

Successful innovation ecosystems are founded on the collaboration between the four major actors: Industry, Academia, Government, and Societal actors. In the case of place-based cross-border ecosystems, as the maritime innovation ecosystems of Western Slovenia and Adriatic Croatia, which are predominantly comprised of industry stakeholders, the participation and collaboration of all four major actors are crucial in strengthening the innovation capacity of the ecosystems and thus contributing to overall regional development.

This section provides a comprehensive analysis of the innovation ecosystems of Western Slovenia and Adriatic Croatia by the 4-helix framework and collaborative action between helices to address helix imbalance. combining analytical findings and strategic perspectives to present an integrated overview of its current structure.

Emphasis is placed on the software and start-up segments, which represent a significant and expanding part of the industry helix. These actors perform a pivotal cross-cutting and integrative function, linking academia, industry, government, and society through digital innovation and co-creation processes that advance the green and digital transition of the ecosystems.

5.1 Quantitative structure and composition of the four-helix ecosystems

The quantitative aggregated distribution demonstrates that the industrial helix overwhelmingly dominates both ecosystems, with 107 actors in Slovenia (82%) and 256 in Croatia (90%). This structure highlights a strong private-sector orientation, confirming that both ecosystems are primarily business-driven and production-oriented, but also indicates limited involvement of academic, governmental, and civil-society stakeholders. The small number of governments[4] and civil actors present a need to reinforce institutional collaboration and policy support to achieve a more balanced quadruple-helix dynamic.

In Western Slovenia, 107 stakeholders belong to Industry (82%), 7 to Academia and research (5%), 6 to Government and public institutions (5%), 6 to societal actors (5%), and 4 to intermediary organizations (3%).

In Adriatic Croatia, the bias is even stronger: 256 stakeholders are industry actors (90%), while 11 represent academia and research (4%), 5 are government bodies (2%), 4 are societal actors (1%), and 9 are 4-helix intermediary actors (3%).

[4] *Note*: *In Croatia, most Government actors are situated in the capital city, not in Adriatic Croatia region.*

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This pronounced industrial orientation reflects the economic structure of the Adriatic region, where maritime and related blue-economy sectors are dominated by SMEs involved in ship design, shipbuilding, logistics, and increasingly, software and digital services.

Such a configuration demonstrates a high innovation potential in applied research and technology deployment but also reveals a limited presence of academic, governmental, and societal stakeholders, which are crucial for knowledge creation, policy alignment, and social innovation.

From a strategic perspective, this imbalance has several implications for the INNO2MARE Long-term Joint R&I Strategy:

Need for stronger cross-helix integration – The predominance of industry actors underscores the importance of creating structured mechanisms to engage universities, public authorities, and civil-society organizations more actively in innovation governance and joint project development.

Opportunity for accelerating technology transfer – The large industrial base provides a strong platform for testing and scaling innovations emerging from academic research, particularly through the R&I pilots and cross-border demonstration activities.

Policy alignment– The relatively small number of public and civil-society stakeholders highlights the need for targeted policy measures and training to enhance their participation in R&I processes, ensuring that innovation outcomes align with regional development goals and societal needs.

Inclusion of software and start-up actors – Within the industry helix, a significant portion of entities are software firms and start-ups, which act as digitalization drivers and connectors between helices. Their engagement is strategically valuable for promoting green and digital transition.

Inclusion of societal actors in the innovation popularization, and adoption of innovation culture and policy development.

Overall, the bias toward industry indicates that the innovation ecosystems of Western Slovenia and Adriatic Croatia are mature in terms of industrial capacity but less balanced in governance and research collaboration.

The INNO2MARE strategy focuses on broadening participation, enhancing cooperation mechanisms, and institutionalizing cross-helix linkages to build a more integrated, resilient, and innovation-driven maritime ecosystem.

5.1.1 Role of software and start-up stakeholders in the maritime innovation ecosystems

In the maritime innovation ecosystems of Western Slovenia and Adriatic Croatia, software companies and startups that are a part of the industry helix are key innovation accelerators and drivers of technological advancement, innovation, and knowledge transfer. Following the 4-helix model of innovation, these actors operate at the intersection of industry, academia, government,

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and civil society, fostering collaboration that strengthens both the local and regional maritime sector.

Strategically, their activities support EU and national objectives (S3) for digitalization, smart ports, sustainable maritime operations, and the modernization of maritime infrastructure.

In Western Slovenia, 9 software and ICT companies and 20 start-ups were classified as active contributors to maritime and nautical innovation. These entities are primarily SMEs specializing in digitalization, automation, and data-driven services for logistics, ship design, and port operations. In Western Slovenia software sector combines established companies and a dynamic startup ecosystem, jointly driving digital innovation.

The startup ecosystem has grown significantly, supported by venture capital, programs from the Slovenian Enterprise Fund, and a network of incubators and accelerators. This infrastructure enables innovative software startups to scale, engage in international projects, and collaborate with established firms, reinforcing Slovenia's position in technology-driven initiatives.

In Adriatic Croatia, the mapping revealed 17 software and ICT firms, and 4 start-ups directly linked to the maritime domain that collaborate with local maritime stakeholders and universities to develop innovative solutions. These initiatives illustrate active engagement across the industry–academia–government helix, with universities providing research capabilities, maritime firms defining practical needs, and public programs facilitating funding and strategic alignment.

The Croatian start-up segment focuses on maritime digitalization, simulation platforms, ship energy management, and smart logistics. The startup ecosystem supports innovation among small and medium-sized enterprises in the maritime sector, though few startups focus exclusively on maritime applications.

Table 5.1 presents the summary of software and start-up actors in the maritime innovation ecosystems of Western Slovenia and Adriatic Croatia.

Table 5.1: Summary of software and start-up actors in the maritime Innovation ecosystems.

Country / Region	No. of Software & ICT Firms	No. of Start-ups	Main Technological Focus Areas	Key Supporting Intermediaries & Hubs	Typical Collaboration Links
Western Slovenia	9	20	Port logistics optimization, smart-vessel monitoring, maritime automation, predictive maintenance, digital design tools	Technology Park Ljubljana, ABC Accelerator, Incubator Catapult, Lab26	Collaboration with University of Ljubljana, Port of Koper, and industrial partners (ISKRA, TPV), DIGIT NOO

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Adriatic Croatia	17	4	Smart-port platforms, marine energy management, ship digitalization, simulation systems, logistics software, smart wessels, IoT solutions	STEP RI Science and Technology Park, ICT Hub Split,STECH Accelerator Split, Technology Transfer Office of the University of Rijeka (SuR UTT), Technology Transfer Office of the University of Split (TTO),ALUTech – Development Innovation Center	Collaboration with local SMEs, big companies, research centers, ports, and universities in Adriatic Croatia
Cross-border synergy	—	—	Digitalization of blue economy value chains; software-driven innovation in shipbuilding, ship design, transport, and port activities	INNO2MARE stakeholder network; regional S3 partnerships	Joint pilot projects on digital and green transitions across the Adriatic

Source: Authors.

Collectively, these findings confirm that software developers and start-up enterprises form an important component of the maritime innovation ecosystems. They function as technology enablers and accelerators, introducing new tools and digital services that strengthen cooperation between academia, industry, and public institutions. The INNO2MARE project leverages this potential through pilot actions and networking activities that enhance the integration of these digital actors into the broader four-helix framework.

The strong presence of software and start-up actors, as documented in D2.1, demonstrates that the maritime innovation ecosystems of Western Slovenia and Adriatic Croatia are undergoing a transition from a predominantly production-based structure toward a digitally driven innovation landscape. These actors play an essential role in enabling cross-border cooperation and supporting the twin (green and digital) transition objectives of INNO2MARE.

At the same time, the start-up ecosystem within the maritime ecosystems, especially in Adriatic Croatia, remains at an emerging stage of development, particularly regarding maritime-specific technologies. While national frameworks provide incubators, accelerators, and opportunities for public funding instruments, the number of startups addressing maritime challenges is still limited.

Establishing a more supportive environment for early-stage technology ventures is therefore essential to enhance innovation diffusion and to facilitate access to still insufficient venture capital and private investment.

The INNO2MARE project directly contributes to this objective by creating structured pathways for the commercial exploitation of R&I results and by reinforcing collaboration across the 4-helix model—linking industry, academia, government, and civil society. In this context, software

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companies and startups act as both enablers and beneficiaries of a coordinated 4-helix innovation strategy: universities and research institutions contribute knowledge and testing environments; industry defines practical challenges and adopts solutions; government and public programs provide funding and regulatory support; and civil society ensures sustainability and societal relevance. By strengthening these connections and fostering a supportive startup ecosystem, the maritime innovation ecosystems can maximize the impact of software-driven innovation, accelerate digital transformation, and secure long-term competitiveness in global maritime markets.

5.2 Quantified and aggregated expectations of the four-helix components

Building on the findings of Deliverable D2.2 – Report on Innovation Ecosystem Needs (2024), this subsection aggregates and quantifies the main expectations and needs expressed by the four stakeholder helices in Western Slovenia and Adriatic Croatia maritime innovation ecosystems.

Aggregated expectations and stakeholder priorities vary by 4-helix category. Industry stakeholders prioritize easier access to R&I financing, faster administrative procedures, and improved collaboration mechanisms with universities and public institutions. They express a strong demand for skilled human resources, especially engineers and digital experts.

Universities and research institutes seek stronger links with industry and funding for applied projects. They emphasize the importance of student internships, young researcher support, and joint R&I projects.

Public actors expect better coordination between national and regional innovation policies, and Societal actors stress sustainability and social inclusion, while 4-helix intermediaries call for stronger start-up support. All four-helix actors express the need for stronger communication and the further development of an innovation-oriented culture.

Percentages presented in Table 5.2 are indicative estimates derived from descriptive and qualitative data in D2.2 and are intended to illustrate the relative importance of different themes within each helix.

Table 5.2: Summary of stakeholders' expectations by the 4-helix component.

Helix / Stakeholder	Share of stakeholders	Expectations
Industry	51%	• Stronger collaboration with academia (requested by ~68% of participants) • Access to R&I funding and test infrastructures (requested by 59% of participants) • Simplified procedures and innovation support from government (requested by 44% of participants)

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		• Skills development, workforce availability, modernizing university programs (requested by 37% of participants) • Alignment of maritime and land regulations, consistent legal interpretations (requested by 10% of participants)
Research and Education (Academia)	21%	• Increased cooperation with industry on R&I projects by application of research (requested by 72% of participants) • Funding of R&I research and international networking opportunities (requested by 63% of participants) • Access to shared research infrastructures and pilot facilities (requested by 47% of participants) • Support for young researchers and interdisciplinary projects (requested by 41% of participants) • Faster introduction of new modernized university programs (requested by 41% of participants)
Government bodies	15%	• Evidence-based inputs from academia and industry for policymaking (requested by 58% of participants) • Regional and cross-border alignment of smart specialization strategies (S3) (requested by 52% of participants)
Societal actors	6,5%	• Inclusion in innovation policymaking (requested by 65% of participants) • Awareness campaigns on sustainability and digital transition (requested by 57% of participants)
4-helix intermediaries	6,5%	• Support for start-ups and innovation initiatives (requested by 45% of participants)

Source: Authors.

As presented in Table 5.2, stakeholders from the Industry and Academia categories collectively account for 72% (24) of the total stakeholders, confirming them as the most numerous, active, and interdependent helices, with a shared demand for stronger cooperation and applied innovation opportunities The remaining stakeholders are distributed among Government, Societal actors, and 4-helix intermediaries, indicating a predominance of industry and research-driven perspectives in the maritime innovation ecosystems. This distribution reflects the strong influence of private-sector and academic actors in shaping expectations and priorities across the 4-helix framework.

The analysis provides an evidence-based foundation for aligning the Long-term Joint R&I Strategy with stakeholder expectations, while also addressing the observed industry bias by incorporating

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perspectives from the less-represented helices. These insights inform the strategic framework presented in the previous chapter, supporting a more balanced and inclusive approach to designing targeted actions and promoting innovation across all four helices.

5.3 Strategic impact of the INNO2MARE project on the four-helix components

The INNO2MARE project actively engages all helices, ensuring that each group benefits from project outputs and contributes to long-term systemic change. Across all helices, INNO2MARE has created a foundation for sustained cooperation, shared learning, and capacity building. The project's integrated approach—linking research, policy, industry, and society—has increased the overall resilience and innovation capacity of the maritime ecosystems in Western Slovenia and Adriatic Croatia. These impacts, hopefully, will continue to grow as the developed infrastructures, methodologies, and partnerships are scaled up and embedded in regional and European innovation frameworks.

The strategic framework is designed to deliver cross-sectoral impact by directly addressing the distinct needs of all four helix components.

Industry gains through the initiation of pilot projects focused on digital and green transitions, facilitating cross-border networking and providing improved access to innovation infrastructures. This focused approach fosters crucial collaboration between production, logistics, software, and startup firms, enabling technology transfer and business scaling, particularly for the most dynamic actors in the ecosystem.

Academia and Research benefit from new R&I partnerships, joint strategy development, and increased participation in applied research addressing maritime challenges such as decarbonization and digitalization, leveraging intensive collaboration with Industry to incorporate new, in-demand skills into study programs.

Furthermore, the Government and Public Sector are empowered to utilize project results to strategically align regional innovation policies, enhance governance capacities, and strengthen the evidence base required for informed strategic decisions.

Finally, Civil Society and Intermediaries are actively integrated through dedicated awareness activities, citizen-oriented innovation initiatives, and the promotion of social and environmental responsibility, ensuring the project's long-term sustainability and societal relevance within the maritime sector.

The strategic framework ensures continuity beyond the project duration by embedding INNO2MARE outputs into regional innovation policies and institutional practices. It reinforces collaboration between academia, industry, government, and society, enabling long-term competitiveness, digital resilience, and environmental sustainability of the maritime ecosystems.

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5.4 Stakeholders' collaboration by the four-helix framework

Both Western Slovenian and Adriatic Croatian maritime innovation ecosystems predominantly comprise stakeholders belonging to the industry category, followed by Academia, Government bodies, and Societal actors, which have the lowest representation. Addressing this imbalance requires implementing measures and actions to ensure the participation and engagement of all stakeholder groups, thereby enhancing synergies among them and strengthening the ecosystem's innovation capacity. A joint strategic framework provides a clear sense of direction and defines the roles and activities for each group of stakeholders.

When creating the strategic framework for the Long-term joint R&I strategy, all four groups of actors within the four-helix framework were considered in the implementation of measures and activities, particularly collaboration. As emphasized during the workshops and stakeholder consultations, the need for communication between stakeholders and the importance of building trust within the ecosystem were recognized as crucial by all four-helix stakeholders, although still lacking.

Table 5.3 shows the Quadruple helix conceptual collaboration roles and actions within the ecosystem and concrete project activities aligned with measures within the Strategic framework of the Long-term joint R&I strategy.

Table 5.3: Four-helix collaboration model roles, collaborative actions, and concrete instantiation.

Strategic objective I. Digital advancement of the maritime innovation ecosystem			
Stakeholder	**Role (Conceptual)**	**Collaborative actions (Conceptual)**	**Concrete Instantiation / Project Action**
Industry	• Investing and implementing digital technologies in maritime operations • Designing and investing in autonomous vessels • Building smart port infrastructure • Implementing the use of AI, machine learning, IoT, digital twins, and big data to improve efficiency, safety, sustainability, and competitiveness	• Collaboration with Research and Education institutions on developing and the use of new digital technologies, and collaboration on development projects • Facilitating knowledge transfer between Academia and industry • Collaboration with government bodies regarding policies and regulations	• Deployment of pilot projects in partner facilities leveraging private sector funds with EU financing (Measure 1.1.1) • Developing and testing a digital twin of the port area, and use of tailor-made AI assistants (Measure 1.1.2) • Producing solutions for the use of autonomous and automated solutions within port infrastructure (Measure 1.1.3) • Collaborating with academia regarding tailor-made programs for digital advancement and cross-sectoral technology transfer (Measures 1.3.1 and 1.3.2)

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Research and Education (Academia)	• Research AI, big data, IoT, and applications for maritime logistics • Advocate for security and ethical standards in digitalization	• Cooperating and working with Industry to develop digital solutions for port and shipping operations/ maritime logistics • Collaboration with the government to design curricula for digital marine workforce training/ university programmes	• Demonstration and promotion of digital technologies related to INNOMARE pilot projects (Measure 1.1.1) • Supporting the use of autonomous and automated solutions within port infrastructure by providing the tools for end users (Measure 1.1.3) • Organizing study visits to companies and other universities, government institutions, and conferences (Measure 1.2.1) • Supporting the preparation and implementation of tailor-made programs for digital advancement in the maritime industry- pilot projects for training, knowledge exchange, enabling cooperation between students and companies (Measure 1.3.1) • Supporting cross-sectoral technology transfer and enabling further research & development in the maritime ecosystem by fostering cross-sectoral technology transfer and preparation of research projects introducing Industry-Academia collaboration (Measure 1.3.2)
Societal actors	• Ensuring public awareness of digital tech benefits in the maritime sector	• Provide feedback on how using digital solutions impacts local communities and the environment	• Supporting networking between stakeholders by organizing thematic events (Measure 1.2.1)
Government bodies	• Setting up digital policies and regulations for the advancement of digitalization in the maritime sector • Provide funding for digital infrastructure	• Supporting the creation of smart ports and marinas (through public-private partnerships • Supporting SMEs in the uptake of digital technologies	• Use of autonomous and automated solutions within port infrastructure (Measure 1.1.3) • Supporting matchmaking and networking by organizing policy conferences and encouraging collaboration (1.2.1) • Building joint platforms for collaboration on projects (Measure 1.2.2) • Supporting SMEs in the uptake of digital technologies by tailor-made support schemes for

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			start-ups and encouraging SMEs in digital transition (Measure 1.4.1)
Strategic objective II. Green transition of the maritime innovation ecosystem			
Stakeholder	**Role**	**Collaborative actions**	
Industry	• Adopting green technologies in shipping • Working towards carbon neutrality • Adopting green technologies in port infrastructure • Actively contributing to minimising waste and pollution	• Collaborating with Academia on researching sustainable shipping materials and alternative fuels • Investing in sustainable marine/port infrastructure (with government support) • Contributing to social responsibility efforts by addressing environmental challenges	• Introduction of advanced energy management systems by implementing pilot projects and simulations of advanced systems (Measure 2.2.1) • Using alternative fuels and power sources (Measure 2.3.1) • Promoting sustainable growth in the maritime sector by implementing projects and commercial activities related to sustainable fisheries, maritime security, biotechnologies, desalinization, and aquaculture (Measure 2.4.3)
Research and Education (Academia)	• Research eco-friendly maritime technologies and sustainable port systems • Create study programs promoting green technologies and marine conservation	• Partner with Industry on R&D projects for renewable energy sources in the maritime sector • Advise the Government on the best practices and policies for sustainability	• Research on advanced energy management systems and analysis of the potential use of offshore renewable energy (Measure 2.2.1) • Exploring potentials for offshore aquaculture and knowledge building regarding green technologies (Measure 2.3.2) • Researching the use of smart and adaptive materials and exploring the development of renewable energies (Measure 2.4.3)
Societal actors	• Support and advocate for eco-friendly shipping and infrastructure to support marine conservation • Raise awareness regarding sea protection	• Promote awareness/ campaigns of sustainable maritime practices • Engaging in public discussions on marine ecosystem protection and sustainability • Engaging local communities regarding	• Organizing workshops with citizens in coastal communities regarding efficient waste management and other environmental issues to raise awareness and ensure public engagement and social acceptance of new solutions (Measure 2.1.2)

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		environmental issues • Collaborating with the Government on policy-making	
Government bodies	• Creating and enforcing policies for green shipping, coastal protection, and sustainability • Providing incentives for green innovation practices	• Collaborating with Industry on (co) financing green technologies • Promoting and enforcing international environmental standards	• Implementing regulations regarding emission reduction (Measure 2.1.1) • Implementing efficient waste management and increasing recycling (Measure 2.1.2) • Reducing environmental risks by deploying Smart Environmental Sensing Technology (Measure 2.1.3) • Introduction of advanced energy management systems and creation of subsidy schemes for users of renewables (Measure 2.2.1) • Stimulating the use of hydrogen by building the basis of the regulatory framework and guidelines for potential users of hydrogen (Measure 2.2.2) • Fostering the use of alternative fuels and stimulating the development of offshore aquaculture (Measures 2.3.1 and 2.3.2) • Exploring potentials, stimulating activities, and policies for development of renewable energies (Measure 2.4.3) • Construction of physical rail infrastructure and optic infrastructure to enable and improve connectivity and accessibility between ecosystem entities using physical infrastructure (Measure 2.5.1)
Strategic objective III. Attractive and in full capacity maritime innovation ecosystem labour market			
Stakeholder	**Role**	**Collaborative actions**	
Industry	• Collaborate with Academia to offer internships and apprenticeships • Investing in employee training programs	• Create Industry-Academia collaborations for practical training • Offering scholarships for students	• Attracting talents in the maritime sector by designing company benefits for attracting and retaining highly-skilled employees (Measure 3.1.1)

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		• Collaborate with the Government to align workforce needs with educational outcomes	• Increasing interest in maritime studies by providing scholarships for students and vocational school pupils (Measure 3.1.2)
Research and Education (Academia)	• Offer Curricula focused on/in line with market needs, i.e., digital maritime technologies, green practices and maritime logistics • Research skill gaps • Explore pathways to commercial exploitation, valorisation, and knowledge transfer	• Partner with Industry to align study programs with market needs • Collaborating with Government and Academia to create up-to-date Curricula and certifications for the jobs in the maritime sector	• Developing new educational Programmes, including joint multidisciplinary Programmes in the English language (Measure 3.1.2) • Modernising existing university programs to be more in line with the company's needs (use of cutting-edge software, VR, etc.) (Measure 3.1.2) • Support in finding jobs after completion of studies (Measure 3.1.2) • Pilot projects on valorisation and knowledge transfer (Measure 3.2.1) • Education on commercial exploitation with successful examples (Measure 3.2.1)
Societal actors	• Popularization of maritime-related jobs and education • Supporting initiatives for gender equality and diversity in maritime careers and inclusive workforce policies	• Raising public awareness regarding the benefits of maritime jobs and careers, especially with children, students, and young professionals • Promote gender inclusivity and diversity in maritime occupations	• Awareness campaigns for attracting talents and popularization of maritime professions (Measures 3.1.1 and 3.1.2)
Government bodies	• Developing labour policies that encourage maritime innovation • Funding training programs and certifications for maritime jobs	• Establishing collaborative educational programs with Academia • Creating labour market incentives to attract professionals to the maritime industry	• Increasing employment opportunities in the maritime sector and attracting talents by designing schemes for employment and creating benefits for employees (Measure 3.1.1) • Increasing the interest in Maritime studies (Measure 3.1.2)
Strategic objective IV. Excellence in maritime ecosystems' governance			
Stakeholder	**Role**	**Collaborative actions**	

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Industry	• Collaborate with the Government for policies and regulations • Implementing and fostering an innovation culture within their organisations	• Create industry-led innovation hubs for cross-sector governance • Collaborate with the Government to evaluate policies and suggest improvements • Collaborate with Academia and Societal Actors in promoting and fostering an innovation culture	• Communication with Academia and Government with open user approaches (Measure 4.1.1) • Activities and initiatives towards strengthening collaboration on international / EU projects (Measure 4.1.1) • Community trend-watching (Measure 4.1.1) • Collaborating with Government bodies regarding improving safety protocols, guidelines, and instructions (ship safety, protection at work, cybersecurity, etc. (Measure 4.1.2)
Research and Education (Academia)	• Offering recommendations for better maritime governance • Research for policy effectiveness and governance models	• Work with the Industry to design best practices for governance • Collaborate with Government and Industry to improve and evaluate policies and regulations	• Activities and initiatives towards strengthening collaboration on international / EU projects (Measure 4.1.1) • Community trend-watching (Measure 4.1.1) • Ensure the continuously active role of the Innovation Council in the implementation of strategy measures (projects, activities (measure 4.1.2) •
Societal actors	• Promoting inclusive governance that accounts for environmental, social, and economic interests • Promote citizen engagement in maritime governance	• Ensuring that public interest is represented in policy discussions • Participate in consultations with the Government and Industry on maritime regulation	• Promoting innovation culture and shared innovation-oriented projects by organizing workshops and public events, to ensure broad outreach (Measure 4.1.1) • Active contribution to development of public policies (Measure 4.1.2)
Government bodies	• Providing regulatory frameworks for the maritime sector • Implementing transparency and accountability measures	• Fostering collaborative governance with Industry, Academia, and the public	• Participating in strategic policy dialogue and regulatory alignment for R&I by forming transnational working groups (Measure 4.1.2) • Improvement of the maritime cluster operations and functioning (Measure 4.1.1) Improving safety protocols, guidelines, and instructions (Measure 4.1.2)

Source: Authors.

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6. IMPLEMENTATION FRAMEWORK

The Long-term joint R&I strategy is the delivery of a jointly implemented project. As such, it is "owned" by partners on both sides of the Institutional and organizational framework.

The University of Ljubljana is a key coordinator of the INNO2MARE project, in which this Long-term joint R&I strategy is one of numerous deliverables. The project duration is 48 months, and it is expected that the Action and Investment Plan will be delivered based on the inputs from the R&I Strategy.

Besides the University of Ljubljana as the project coordinator, the following project and associated partners are involved in the project in various segments of the project and at the level of the whole project when necessary. They are presented in Table 6.1 below.

Table 6.1: List of project and associated partners.

Project partners	**Associated partners**
University of Ljubljana (Slovenia) ISKRA d.o.o. (Slovenia) DIGITEH d.o.o. (Slovenia) Business support Centre Kranj d.o.o. (Slovenia) Association for Technical Culture of Slovenia (Slovenia) University of Rijeka (Croatia) University of Rijeka, Faculty of Maritime Studies (Croatia) University of Rijeka, Technical Faculty (Croatia) STEP RI science-technology park of the University of Rijeka d.o.o. (Croatia) MS Tech d.o.o. (Croatia) Maritime Center of Excellence d.o.o. (Croatia) Regional Development Agency of Primorje-Gorski Kotar County (Croatia) Centre of Technical Culture Rijeka (Croatia) University of Antwerp (Belgium) Maritime Academy Antwerpen (Belgium)	Regional energy agency Kvarner (Croatia) Blue cluster (De Blauwe Cluster, Belgium) URBANEX (Croatia) Port of Antwerp (Belgium)

Source: Project Summary.

As the Long-term joint R&I strategy will be adopted at the project level, and there are no strict formal terms, an institutional backup for the implementation, in its early stages of implementation at least, it

will rely much on willingness and disposal of resources of the project and associated partners to start and initiate those projects, activities, and actions within their immediate control and power. In that sense, mobilization of resources, particularly human resources, will be critical to demonstrate devotion to successful strategy implementation. For those measures for which the responsibility is at the institution "outside" of the project, it will be required to present the strategy and introduce these institutions/organizations with planned projects and activities, and expectations in terms of their engagement.

The Innovation Council could also continue to play a role in implementation and intensify its work regarding the implementation of the Long-term joint R&I strategy's requirements. It would be critical to prioritize projects and activities in the continuous provision of advice to the project and its associated partners, to support strengthening and collaboration-related activities, and to bring new ideas, concepts, and proposals for the implementation of proposed projects and activities. Working groups could be set up as per theme (e.g., the one in charge of strategic objective 1 and corresponding measures), they take the responsibility for the implementation of projects and activities, and they coordinate their actions with other working groups. Working groups can have regular, e.g., monthly meetings to discuss progress, decide on the level of priority of projects, identify bottlenecks in implementation, and jointly develop solutions to address challenges arising from the R&I Strategy implementation. In terms of a financial framework, as mentioned above, it includes the most relevant sources of financing for the implementation of the strategy. This will be further investigated and explored at a later stage, when preparing the Action and Investment Plan, where more precise financing/funding-related information is required.

A monitoring, reporting, and evaluation system should be established and functional once set. A practice of annual reporting (minimum) should be introduced as soon as the strategy is adopted, and the first projects and activities begin. The Long-term joint R&I strategy refers to the period of the next 10 years. Therefore, it is envisaged to undertake an interim evaluation (e.g., after 5-6 years of implementation, depending on the number, size, nature, and other requirements of the projects and activities that will be implemented). After the R&I strategy is fully or to a large extent implemented, it is envisaged to conduct an ex-post evaluation to check if the R&I strategy has delivered the desired results, outputs, outcomes, and to some extent impacts.

In this R&I Strategy, the most relevant information on the implementation framework is provided, as within this project (in WP4), it is envisaged to prepare the Action and Investment Plan, which should include the following:

- Actions, responsible actors, required resources, expected results, and timeline for particular plan components
- The overall investment needs and plans for R&I infrastructures and innovation support activities
- Production of annual monitoring report
- Design of common monitoring and evaluation methodology, including relevant quantitative indicators (output, outcome, and impact) and qualitative assessments.

Besides a clear link to WP4, the strategy is linked to WP6 in terms of talent attraction as well as WP5, as it is related to the pilot project scale-up and demonstrators, as well as to the objectives:

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- O5.1: Support the visionary and operational frameworks set out in the joint ecosystems' R&I strategy and accompanying action & investment plan through the development of roadmaps for the three pilot projects.
- O5.2: Develop and test new approaches for the accelerated uptake of new technologies by the ecosystems industry through pre-planning for pilots and demonstrators based on the three R&I pilot projects.

In general, this strategy is closely related to WP3, WP4, and WP5 in terms of how our developments can be scaled up, technology demonstrated, and technologies commercialized, as well as WP6 regarding talent attraction and retention, training, and knowledge transfer.

The implementation of the Long-term Joint R&I Strategy will build upon the strengthened analytical foundation established through the revised four-helix and sectoral assessments. The newly quantified structure of the ecosystems and the explicit recognition of software and start-up actors provide a clearer understanding of how innovation capacities are distributed across helices and sectors. These insights directly inform the Action & Investment Plan and guide the prioritisation of future measures, funding mechanisms, and collaborative projects under INNO2MARE. In particular, the integration of digital and entrepreneurial actors is expected to enhance the adaptability, cross-border cooperation, and overall resilience of the maritime innovation ecosystems in Western Slovenia and Adriatic Croatia, ensuring sustained impact beyond the project's duration.

We hope this strategy will deliver the expected results, outcomes, and impacts, and that Western Slovenia and Adriatic Croatia will become competitive and prosperous maritime innovative regions.

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REFERENCES

[1] BSC Kranj - Regional development agency of Gorenjska region (2023): Report on Ecosystems' mapping, Deliverable D2.1, V1.0 (Project: Strengthening the Capacity for excellence of Slovenian and Croatian innovation Ecosystems to support the digital and green transitions of maritime regions, funded by the European Union), available at: https://www.inno2mare.eu/project-deliverables/ (accessed 19th April 2024).

[2] PRIGODA - Regional Development Agency of Primorje Gorski-Kotar County (2023): Report on Innovation Ecosystems' Needs, Deliverable 2.2, Version 3.0 (Project: Strengthening the Capacity for excellence of Slovenian and Croatian innovation Ecosystems to support the digital and green transitions of maritime regions, funded by the European Union) available at: https://www.inno2mare.eu/project-deliverables/ (accessed 19th April 2024).

[3] PRIGODA - Regional Development Agency of Primorje-Gorski-kotar County (2024): Analytical assessment, identification, and quantification of the key economic indicators of the Croatian maritime innovation ecosystem (Project: Strengthening the Capacity for excellence of Slovenian and Croatian innovation Ecosystems to support the digital and green transitions of maritime regions, funded by the European Union, (Deliverable D2.3 Annex 1), available at INNO2MARE project shared repository, available on request.

[4] BSC Kranj - Regional development agency of Gorenjska region (2025): Financial analysis of Slovenian maritime stakeholders by category (Deliverable D2.3 Annex 3), available at INNO2MARE project shared repository, available on request.

[5] Act on the System of Strategic Planning and Managing Development of the Republic of Croatia, Official Gazette no. 123/17, 151/22 available at: https://www.zakon.hr/z/975/zakon-o-sustavu-strateskog-planiranja-i-upravljanja-razvojem-republike-hrvatske (accessed 10th May 2024).

[6] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy_en (accessed 17th June 2024).

[7] European Council for Maritime Applied R&D (ECMAR) (2022) Maritime technology challenges 2030 – New Technologies and Opportunities, available at: http://www.ecmar.eu/about-ecmar/ecmar-vision/ (accessed 15th May 2024).

[8] https://www.offshore-energy.biz/shipbuilding-sector-trade-unions-demand-eu-maritime-industrial-strategy/ (accessed 17th June 2024).

[9] https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/eu-valorisation-policy_en (accessed 17th June 2024).

[10] European Commission Directorate General for Maritime Affairs and Fisheries, the Joint Research Centre (JRC) Blue Economy Report for 2023 (2024), available at: https://op.europa.eu/en/publication-detail/-/publication/9a345396-f9e9-11ed-a05c-01aa75ed71a1 (accessed 15th May 2024).

[11] https://oceans-and-fisheries.ec.europa.eu/funding/emfaf_en (accessed 15th May 2024).

Funded by the European Union

[12] https://www.interreg-ipa-adrion.eu/ (accessed 17th June 2024).

[13] https://interreg-euro-med.eu/en/ (accessed 17th June 2024).

[14] SEA The Shipyards' & Maritime Equipment Association of Europe (2024) Position paper - A European Blue Technology Fund, available at: https://www.seaeurope.eu/images/Position_paper_on_European_Blue_Technology_Fund_March_2024.pdf (accessed 14th May 2024).

[15] https://northadriaticports.com/ (accessed 14th May 2024).

[16] The Government of the Republic of Slovenia (7th December 2017) Slovenian Development Strategy 2030, available at: https://www.gov.si/assets/ministrstva/MKRR/Strategija-razvoja-Slovenije-2030/Slovenian-Development-Strategy-2030.pdf (accessed 15th May 2024).

[17] The Government of the Republic of Slovenia (9th March 2023) Slovenian smart specialization strategy (S5), available at: https://evropskasredstva.si/slovenska-strategija-pametne-specializacije/ (accessed 14th May 2024).

[18] The Government of the Republic of Slovenia, National Interoperability Framework of Slovenia (2022) The Digital Slovenia 2030 Strategy, available at: https://nio.gov.si/nio/asset/strategija+digitalna+slovenija+2030?lang=en (accessed 14th May 2024).

[19] The Government of the Republic of Slovenia (2021), Slovenian industrial strategy 2021-2030. available at: https://www.gzs.si/Portals/206/Slovenska%20industrijska%20strategija.pdf (accessed 14th May 2024).

[20] The Government of the Republic of Slovenia (27th May 2021) National Programmes to Promote the Development and Use of Artificial Intelligence in the Republic of Slovenia by 2025, available at: https://www.gov.si/teme/digitalizacija-druzbe/ (accessed 15th May 2024).

[21] The Government of the Republic of Slovenia (2022) Strategy of Digital Transformation of the Economy, available at: https://www.gov.si/assets/ministrstva/MGTS/Dokumenti/DIPT/Digitalizacija/Strategy-of-digital-transformation-of-the-economy.pdf (accessed 15th May 2024).

[22] The Croatian Parliament (2021) National Development Strategy until 2030, Official Gazette 13/2021 available at: https://narodne-novine.nn.hr/clanci/sluzbeni/2021_02_13_230.html (accessed 15th May 2024).

[23] The Croatian Parliament (2023) Digital Croatia Strategy for the period until 2032, Official Gazette 2/2023, available at: https://narodne-novine.nn.hr/clanci/sluzbeni/2023_01_2_17.html (accessed 15th May 2025).

[24] The Government of the Republic of Croatia (November 2021) Smart Specialisation Strategy until 2029, available at: https://mzo.gov.hr/UserDocsImages/dokumenti/EUfondovi/PKK-2021-2027/S3-do-2029-Tekst-VRH-2023-12-13.pdf (accessed 14th May 2024).

[25] Ministry Of the Sea, Transport and Infrastructure (2017) Transport Development Strategy of the Republic of Croatia (2017 - 2030), Available at: MMPI Strategija prometnog razvoja RH 2017.-2030.-final.pdf (accessed 14th May 2024).

Funded by the European Union

[26] The Ministry of Regional Development and EU funds (November 2021) Adriatic Croatia Industrial Transition Plan 2021-2027, available at: https://prigoda.hr/wp-content/uploads/2022/03/Plan-za-industrijsku-tranziciju-Jadranske-Hrvatske.pdf (accessed 15th May 2024).

[27] Regionalna razvojna agencija Zeleni kras (2022) Regional development Programmes of Primorje-Notranjska region for the period 2021-2027, available at: https://www.csd-slovenije.si/assets/documents/csd-primorsko-notranjska/RRP%20Primorsko-notranjske%20regije%202021-2027%20-%20Strate%C5%A1ki%20del.pdf (accessed 10th May 2024).

[28] Istarska županija (2024) The Development Plan of the County of Istria for the period 2022 to 2027, available at: https://www.istra-istria.hr/media/filer_public/f1/f9/f1f99026-7de8-432c-8cd6-781f5698ab27/240221_plan_razvoja_2022-2027.pdf (accessed 10th May 2024).

[29] Act on Regional Development of the Republic of Croatia, Official Gazette no. 147/14, 123/17, 118/18, available at: https://razvoj.gov.hr/pristup-informacijama/zakoni-i-ostali-propisi/uprava-za-regionalni-razvoj-3133/3133 (accessed 10th May 2024).

[30] Primorje Gorski-kotar County (2022) The development plan of the Primorje-Gorski Kotar County for the period from 2022 -2027, Available at: Plan razvoja PGŽ 2022.-2027. - Prigoda.hr (accessed 10th May 2024).

[31] Lika Senj County (2023) Development Plan of Lika-Senj County until 2027, available at:

[32] Plan razvoja Ličko-senjske županije za razdoblje do 2027. godine | Ličko-senjska županija (accessed 10th May 2024).

[33] Zadar County (2022) The Development Plan of Zadar County for the period 2021-2027, available at: Plan_razvoja_Zadarske_županije_2021.pdf (accessed 10th May 2024).

[34] Šibenik-Knin County (2022), The Development Plan of Šibenik-Knin County for the period 2021-2027, available at: Plan razvoja ŠKŽ | Dokumenti | Šibensko-kninska županija (accessed 10th May 2024).

[35] Split-Dalmatia County (2022), The Development Plan of Split-Dalmatia County for the period 2022-2027, available at: planrazvojasplitskodalmatinskeupanije20222027.pdf (accessed 10th May 2024).

[36] Dubrovnik-Neretva County (2021), The Development Plan of Dubrovnik-Neretva County until 2027, available at: Plan-razvoja-DNZ-za-objavu.pdf (accessed 10th May 2024).

[37] University of Antwerp – Faculty of Business and Economics (2023) *Belgium Maritime Innovation Ecosystem (Master thesis),* by Rachid Lamane, Jalal Moshayedi, and Kaveh Goshtasbi Pour under the mentorship of Prof. Thierry Vanelslander and Mr. Deepak Mehta (provided by our Belgian partners, not available in open access).

[38] Mehta, D. (2023), Navigating Innovation, INNO2MARE project, Antwerp visit, December 2024 – presentation material.

[39] Flanders Marine Institute, 2023, Indicator Report Marine Research and Innovation 2023, available at: https://www.compendiumkustenzee.be/sites/compendiumkustenzee.be/files/public/_Indicator%20report%20Marine%20Research%20%26%20Innovation%202023_FINAL.pdf (accessed 26th June

Funded by the European Union

2024).

[40] The Research Council of Norway (2022), Maritim21- strategy, Available at: maritim21-strategy--executive-summary3.pdf (accessed 26th June 2024).

[41] Government of the Netherlands (2015), The Dutch Maritime Strategy 2015-2025, available at: The Dutch Maritime Strategy 2015 - 2025 | Report | Government.nl (accessed 26th June 2024).

[42] Norden (2009) *Marine spatial Planning in the Nordic region: Principles, Perspectives and Opportunities, Outcomes* from the Nordic Forum on MPAs in Marine Spatial Planning, Nordic Council of Ministers: Copenhagen, available at: https://www.norden.org/en/publication/marine-spatial-planning-nordic-region, https://norden.diva-portal.org/smash/get/diva2:701398/FULLTEXT01.pdfNordic cooperation framework, available at: https://www.norden.org/en/digitalisation-and-innovation (accessed 29th May 2024).

[43] Marine spatial Planning in the Nordic region Principles, Perspectives and Opportunities Outcomes from the Nordic Forum on MPAs in Marine Spatial Planning (2009), Available at: MSP_in_Nordic_Countries-Handbook_09.pdf (accessed 29th May 2024).

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ANNEXES

[1] Annex 1 Analytical background for identification and quantification of key economic indicators for Croatian maritime innovation ecosystem

[2] Annex 2 Belgium Innovation Maritime Ecosystem

[3] Annex 3 Financial analysis of Slovenian maritime ecosystem stakeholders by categories

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