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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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ACTION AND INVESTMENT PLAN INCLUDING MONITORING METHODOLOGY

Deliverable 4.1

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Abstract	This deliverable presents a comprehensive action and investment plan aimed at enhancing the innovation ecosystems of Slovenia and Croatia, with a particular focus on supporting the digital and green transitions in their maritime sectors. The report outlines strategic initiatives that foster cross-border collaboration, strengthen research and innovation (R&I) infrastructure, and promote sustainable maritime development. Drawing from Flemish best practices, the plan integrates measures to support startups, improve workforce skills, and deploy collaborative tools, including the development of a virtual innovation portal. A detailed monitoring and evaluation methodology is included to ensure transparency, adaptability, and impact tracking through Key Performance Indicators (KPIs), qualitative assessments, and annual progress reports. By leveraging regional strengths, aligning with EU funding instruments, and emphasizing public-private partnerships, the strategy aims to position Slovenia and Croatia as leaders in sustainable and innovative maritime economies.
Keywords	Maritime Innovation, Sustainability, Collaboration, Digital Transformation, Funding Strategy

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EXECUTIVE SUMMARY

This paper outlines a comprehensive plan to promote the digital and green transitions in these sectors by applying Flemish best practices to strengthen Slovenia's and Croatia's maritime innovation ecosystems. Due to their advantageous locations along the Adriatic Sea, Slovenia and Croatia's maritime sectors are vital to their economy. Large shipbuilding, maritime transportation, and nautical tourism industries are well-supported by Croatia's long coastline, while Slovenia's Port of Koper is an important hub for trade. To promote growth and sustainability in these industries, both nations are putting a strong emphasis on innovation.

Significant economic forces, the maritime sectors significantly influence both nations' GDPs, employment rates, and trade volumes. Croatia uses its extensive coastline and large number of islands to its advantage in shipbuilding and maritime tourism. Slovenia's economy, on the other hand, depends heavily on the Port of Koper, which facilitates trade between Central Europe and international markets. It is imperative that these industries continue to innovate and adopt sustainable practices to remain competitive and economically stable.

Encouraging strong cooperation between Slovenia and Croatia is a crucial part of the plan for bolstering the maritime innovation ecosystem. This entails encouraging R&D, helping startups and SMEs, building a competent workforce, and updating infrastructure. A cross-border innovation task force will be formed to supervise the coordination and execution of cooperative projects, guaranteeing that endeavours are in line with regional and national interests.

This strategy's execution plan is extensive and consists of multiple well-coordinated measures. The commencement of collaborative research and innovation initiatives centered on green and digital technologies will be aided by investments in common maritime infrastructure. Policies and regulatory frameworks should be harmonized to cultivate innovation and cross-border cooperation. Joint training initiatives will also be put into place to improve the qualifications of the maritime labour forces in both nations. The projects' progress will be tracked by a robust monitoring and evaluation structure, which will guarantee that the plan stays efficient and adaptable to changing industry demands.

Goals and objectives are outlined clearly, and Key Performance Indicators (KPIs) are developed to track advancement. Timely interventions and ongoing improvement will be made possible by regular data collection, monitoring, and reporting. This methodology guarantees that interested parties can precisely evaluate the results of strategies put into practice and make well-informed choices to propel future advancements.

The use of qualitative evaluations is essential to this tactic. Slovenia and Croatia can obtain important insights into effective knowledge-sharing mechanisms, public-private partnerships, and sustainable development strategies by recording and analysing best practices from the Flemish environment. Sustainable growth will be aided by addressing issues within their ecosystems and carrying out in-depth requirements studies.

An indispensable instrument for monitoring the status of implementation of the actions outlined in the action plan will be the annual monitoring report. These reports will give stakeholders a clear picture of accomplishments and opportunities for development by delivering insights into investments, talent acquisition, and business growth.

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Collaboration tools and capacity building are essential for stimulating creativity. In addition to developing entrepreneurial and leadership abilities, the introduction of new collaboration platforms and focused training programs will improve stakeholder participation. The goal of these programs is to make sure that the labour force is competent and equipped to lead innovation in the maritime industries.

Another key component of this plan is the creation of a specific virtual portal for participants in the maritime ecosystem. With its extensive knowledge center, collaboration tools, innovation marketplace, training materials, and data analytics tools, this website aims to promote cooperation, creativity, and knowledge sharing. The competitiveness and sustainable development of the maritime industry will be accelerated by this hub.

Through its successful implementation of integrated innovation initiatives, public-private partnerships, and sustainable development practices, the Flemish ecosystem offers invaluable lessons. Slovenia and Croatia can utilize this strong foundation of principles to improve their marine innovation ecosystems.

To guarantee the methodical and punctual implementation of the action plan, comprehensive schedules and significant dates have been delineated. The project's success depends on careful financial planning and budgeting, as well as the identification of both public and private funding sources. To ensure the project's resilience, thorough risk analysis and mitigation plans address potential financial, operational, regulatory, technological, environmental, and stakeholder risks.

A strategy framework for improving Slovenia's and Croatia's marine innovation ecosystems is provided in this research. The policy seeks to promote sustainable growth and competitiveness by leveraging best practices from the Flemish region, guaranteeing that both nations can successfully manage the digital and green transitions in respective maritime sectors.

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ABBREVIATIONS

ARRS	Slovenian Research and Innovation Agency
ASHE	Agency for Science and Higher Education
CSF	Croatian Science Foundation
EMFF	European Maritime and Fisheries Fund
EU	European Union
HAMAG-BICRO	Croatian Agency for Small Business, Innovation, and Investments
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
KPI	Key Performance Indicator
M&E	Monitoring and Evaluation
NDS	National Development Strategy
NIC	National Innovation Council
NRRP	National Recovery and Resilience Plan
OPCC	Operational Programme Competitiveness and Cohesion
R&I	Research and Innovation
S3	Smart Specialisation Strategy
SME	Small and Medium-sized Enterprise
SPIRIT	SPIRIT Slovenia Business Development Agency
SPS	Slovenian Enterprise Fund
SRIP	Strategic Development-Innovation Partnerships
WP	Work Package
ZDDPO-2	Corporate Income Tax Act
ZPOP-1	Supportive Environment for Entrepreneurship Act
ZRRD	Research and Development Activity Act
ZSInv	Investment Promotion Act
ZTDK	Venture Capital Companies Act

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1 INTRODUCTION

1.1 Overview of the Croatian and Slovenian Maritime and Nautical Industries

The maritime and nautical industries of Croatia and Slovenia are vital components of their respective economies, driven by their strategic locations along the Adriatic Sea. Both countries display a rich maritime heritage and have developed significant capabilities in shipbuilding, maritime transport, nautical tourism, and related industries. This chapter introduces the Croatian and Slovenian maritime and nautical ecosystems, highlighting their key attributes, stakeholders, and the importance of innovation in these sectors.

Croatia's extensive coastline, stretching over 1,700 kilometres and encompassing more than 1,200 islands, positions it as a dominant maritime force in the Eastern Adriatic. This geographical advantage has raised a robust maritime industry, making Croatia a hub for shipbuilding, maritime transport, and nautical tourism. Croatian shipyards are internationally recognized for their high-quality construction of various vessel types, including luxury yachts, commercial ships, and specialized vessels. The shipbuilding sector not only contributes significantly to the national economy but also upholds a long-standing tradition of excellence and innovation.

Maritime transport is another cornerstone of Croatia's maritime industry, with major ports such as Rijeka, Split, and Ploče serving as critical nodes for international trade. These ports handle a wide array of cargo, from bulk goods to containers, underscoring their strategic importance in the regional and global supply chains. Nautical tourism, propelled by Croatia’s picturesque coastline and pristine waters, attracts millions of tourists annually. This sector encompasses marinas, yacht charters, and various recreational maritime activities, significantly contributing to the tourism industry's revenue and overall economic health.

Slovenia, although possessing a shorter coastline of just 46 kilometres, has effectively capitalized on its maritime access through the Port of Koper. This port stands as one of the most crucial in the Northern Adriatic, acting as a crucial junction for trade between Central Europe and the Mediterranean. The Port of Koper's efficiency and strategic location facilitate the handling of a diverse range of cargo, including containers, vehicles, and bulk commodities, making it a vital asset to Slovenia's economy and a key player in global maritime trade routes.

Slovenia's shipbuilding industry, while smaller in scale compared to Croatia’s, has carved out a niche in producing specialized vessels and components, contributing to the maritime sector’s diversity. The country also boasts a growing nautical tourism industry, supported by modern marinas and an increasing number of yacht charter services. The charming coastal town of Piran and Slovenia's pristine coastal waters enhance its appeal as a premier nautical destination.

The maritime industries in both countries are supported by a diverse range of stakeholders who play crucial roles in sustaining and advancing these sectors. These stakeholders include shipyards, shipping companies, port operators, marine equipment manufacturers, research institutions, universities, government agencies, and startups. Each of these actors contributes to the ecosystem's vibrancy and resilience, stimulating an environment where innovation and collaboration can thrive.

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Innovation is a critical driver of growth and competitiveness in the maritime and nautical industries of Croatia and Slovenia. Both countries are increasingly investing in advanced technologies such as digitalization, automation, and green energy solutions to enhance their maritime operations. For instance, the adoption of hybrid and electric propulsion systems in vessels aligns with global trends towards sustainability and environmental responsibility. This shift not only reduces the environmental impact of maritime activities but also positions Croatia and Slovenia as leaders in sustainable maritime practices.

In Croatia, the emergence of maritime-focused startups and technology firms is stimulating a culture of innovation, while established shipyards are ramping up their research and development efforts to maintain a competitive edge. Slovenia's strategic initiatives, particularly those enhancing the capabilities of the Port of Koper and supporting maritime research, reflect the country's commitment to innovation and sustainable growth.

The maritime and nautical industries of Croatia and Slovenia are integral to their economic landscapes, characterized by a rich maritime heritage and a forward-looking approach towards innovation. These sectors are well-positioned to capitalize on their historical strengths and embrace modern advancements, ensuring sustained growth and competitiveness in the global maritime arena. The following chapters will examine deeper into the innovation ecosystems within these industries, examining key stakeholders, their interconnections, and the strategic importance of stimulating innovation to sustain and enhance their global competitiveness.

1.2 Importance of Maritime and Nautical Industries in the Croatian and Slovenian Economies

The maritime and nautical industries hold a key role in the economies of Croatia and Slovenia, serving as critical engines of economic growth, employment, and international trade. This section explores the multi-layered importance of these industries, detailing their contributions to the national economies, their role in stimulating economic resilience, and their strategic significance in the global maritime landscape.

In Croatia, the maritime industry is a cornerstone of the national economy, contributing significantly to GDP, employment, and trade. The shipbuilding sector, with its long-standing tradition and expertise, is a major economic driver. Croatian shipyards, such as Uljanik, 3. Maj, and Brodosplit, are renowned for producing high-quality vessels that meet stringent international standards. These shipyards not only provide direct employment to thousands of skilled workers but also support a wide range of ancillary industries, including marine equipment manufacturing, engineering services, and logistics. The multiplier effect of the shipbuilding industry extends to numerous sectors, amplifying its economic impact.

Maritime transport is another critical component of Croatia's economy. The country's strategic location along the Adriatic Sea, coupled with its well-developed port infrastructure, makes it a vital transit point for international trade. Major ports like Rijeka, Split, and Ploče facilitate the efficient movement of goods, enhancing Croatia's connectivity to global markets. The Port of Rijeka is undergoing significant modernization and expansion, aimed at increasing its capacity and efficiency. These developments are expected to bolster Croatia's position as a key logistics hub in the region, attracting further investment and trade opportunities.

Nautical tourism is a rapidly growing sector within Croatia's maritime industry, driven by the country's stunning coastline, clear waters, and rich cultural heritage. This sector encompasses a diverse array of

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activities, including yacht charters, sailing tours, and marina operations. Croatia's marinas are among the best-equipped in the Mediterranean, providing world-class services to recreational boaters and contributing substantially to the tourism revenue. Nautical tourism not only boosts the economy through direct spending by tourists but also creates jobs in hospitality, maintenance, and related services, promoting local economic development.

In Slovenia, the maritime industry, although smaller in scale compared to Croatia, plays a crucial role in the national economy. The Port of Koper, Slovenia's only commercial seaport, is a key asset, facilitating the flow of goods between Central Europe and global markets. The port's strategic location and efficient operations make it a vital node in international trade routes, handling a diverse range of cargo, including containers, vehicles, and bulk commodities. The Port of Koper's contribution to Slovenia's economy extends beyond cargo handling, as it stimulates economic activities in transport, logistics, and related services, creating jobs and supporting local businesses.

Slovenia's nautical tourism sector, though less extensive than Croatia's, is growing steadily. The country's short but picturesque coastline attracts tourists seeking a blend of natural beauty and cultural experiences. Marinas in towns like Portorož and Piran offer high-quality services, supporting the tourism industry and contributing to the local economy. Additionally, Slovenia's efforts to promote sustainable tourism practices align with global trends, enhancing the appeal of its nautical tourism sector.

The strategic importance of the maritime and nautical industries in both countries cannot be overstated. These industries are not only crucial for economic stability and growth, but also for national security and sovereignty. Control over maritime resources and infrastructure ensures that Croatia and Slovenia can protect their interests and remain resilient to external economic shocks. According to statistics from the Croatian Bureau of Statistics regarding research and development in 2022, the maritime industry in Croatia contributes approximately 2% to GDP, with shipbuilding alone accounting for 10-15% of exports. In Slovenia, Resolution on the Slovenian Scientific Research and Innovation Strategy 2030 (ReZrIS30) states that the maritime industry contributes approximately 1.5% to the country's GDP, with the Port of Koper and its associated logistics making a significant contribution. In addition, the development of green and sustainable maritime practices positions both countries as responsible actors in the global maritime community, addressing environmental issues and contributing to the fight against climate change.

Innovation plays a critical role in maintaining the competitiveness and sustainability of the maritime and nautical industries in Croatia and Slovenia. Investment in advanced technologies, such as digitalization, automation, and green energy solutions, is essential for modernizing these industries and enhancing their efficiency. In Croatia, major shipyards employ over 7,200 people, accounting for more than 5% of the workforce in the industrial sector. In Slovenia, the maritime industry employs around 3,500 people directly, with the Port of Koper itself employing approximately 1,000 people and indirectly supporting many jobs in the logistics and transport sectors. For instance, the adoption of hybrid and electric propulsion systems in ships is projected to reduce carbon emissions by up to 30% and operational costs by approximately 20%. Furthermore, the integration of digital technologies in port operations, such as Optical Character Recognition (OCR) systems and advanced tracking systems at the Port of Koper, optimizes processes, reduces turnaround times by approximately 15%, and improves overall service quality with a reported 10% increase in customer satisfaction.

Research institutions, universities, and industry stakeholders in both countries are increasingly collaborating on innovation initiatives. These partnerships cultivate knowledge transfer, drive technological advancements, and support the development of a skilled workforce. For example, maritime clusters and innovation hubs provide hubs for collaboration, enabling stakeholders to work together on

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cutting-edge projects and share best practices. The support from government policies and funding mechanisms, such as EU grants, further accelerates innovation in the maritime sector.

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2 BACKGROUND

Slovenia and Croatia possess rich potential for maritime innovation, supported by their existing research and innovation (R&I) systems. Both countries have made significant strides in stimulating R&I activities, albeit with varying degrees of emphasis on maritime sectors.

2.1 Slovenia's R&I System

Slovenia's Research and Innovation (R&I) system is intricately woven into the fabric of its educational, governmental, and industrial sectors, reflecting the country's commitment to scientific advancement and technological development. It has undergone significant transformation since the country's independence in 1991. This evolution is particularly influenced by Slovenia's transition from a socialist to a market economy and its integration into the European Union (EU) in 2004.

In the European Commission's prepared European Innovation scoreboard for 2023, Slovenia was classified as a moderate innovator for the fifth time in a row with performance at 95.1% of the EU average, having been classified among the strong innovators before 2018 according to the European Innovation Index (EII). In the previous years, Slovenia's performance increased at a relatively lower rate due to annual performance decreases in 2017 to 2020. However, in the period from 2021 to 2023 performance improved strongly, mostly due to improved performance on foreign doctorate students and Venture capital expenditures. When it comes to innovation performance in human resources, in 2023, Slovenia had the strongest decline out of all EU Member States. The European Innovation Scoreboard identifies strengths and weaknesses in the context of innovation for each Member State. Slovenia's strengths and weaknesses are listed in the table 2.1[1].

Table 2.1: Slovenia's strengths and weaknesses in innovation performance.

Relative strengths	Relative weaknesses
Public-private co-publications.	Non-R&D Innovation expenditures.
Lifelong learning.	Venture capital expenditures.
International scientific co-publications.	Innovation expenditures per employee.
Enterprises providing ICT training.	Knowledge-intensive services exports.
Product innovators.	Environment-related technologies.

Strong increases in innovation performance since 2022 occurred in the areas of business process innovators, lifelong learning, and venture capital expenditures, some of which have since been identified as Slovenia's strengths according to the table 2.1. However, there have been strong decreases since 2022 in the areas of Public-private co-publications, government support for business R&D and doctorate graduates. Currently, Slovenia's innovation performance is above the average in the group of Moderate Innovators, but its performance is increasing at a rate lower than that of the EU. This led to Slovenia's performance gap becoming larger in comparison to other EU Member States.

[1] Ibid.

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Key actors in Slovenia's R&I system

The political system in Slovenia, responsible for crafting and executing policies in research and development (R&D) and innovation, comprises various agencies including the Ministry of Economic Development and Technology, the Ministry of Education, the Slovenian Research and Innovation Agency (ARRS), SPIRIT Slovenia Business Development Agency (SPIRIT), the Slovenian Enterprise Fund (SPS), and regional and local development agencies. Therefore, the Ministry of Education and SPIRIT in a document from 2021 about Strengthening the Innovation Ecosystem in Slovenia report that the current state of play of the Slovenian national innovation ecosystem isn't a centralized entity for coordinating innovation, research, and development. Instead, there are two primary coordination branches: one is dedicated to research and development, falling under the Ministry of Education, Science and Sport and associated entities like ARRS. The other branch focuses on growth, smart specialization, and startups, and operates under the Ministry of Economic Development and Technology along with its implementing bodies such as SPIRIT, SPS, the SIO (Slovensko izobraževalno omrežje) network, and Strategic development-innovation partnerships (SRIPs). Additionally, a third dimension exists within the Government Office for Development and European Cohesion Policy, which oversees the Smart Specialization Strategy and liaises with the European Commission on matters related to Smart Specialization. The SRIPs network is intricately connected with the Ministry of Economic Development and Technology and SPIRIT in terms of funding and execution plans.

The landscape of these actors is diverse, encompassing government bodies, research institutions, universities, and private sector entities, each contributing uniquely to the ecosystem. They can be divided into relevant groups as listed below:

Governmental Institutions: The core of the R&I system's governance lies with the Ministry of Education, Science and Sport. This ministry is responsible for shaping national research and education policies. Additionally, the Slovenian Research and Innovation Agency (ARRS) is key in funding research activities and managing Slovenia's research infrastructure. These bodies not only provide the strategic direction but also the necessary funding and regulatory framework for research activities. Their roles extend beyond mere administrative functions, as they actively engage in shaping the future of Slovenian research and innovation, ensuring that it remains competitive and aligned with both national developmental goals and international research trends.

The Ministry of Education, Science and Sport role in the research and innovation landscape is many-sided, encompassing the development of policy frameworks, strategic planning, and allocation of resources for education and scientific research. It works in collaboration with other government entities, educational institutions, and research organizations to align Slovenia's R&I activities with national priorities and global trends. On the other hand, ARRS plays a key role in the Slovenian R&I system, when it comes to funding research activities. This agency is tasked with financing basic and applied research, developing competitive research programs, and managing research infrastructure. ARRS's funding mechanisms are designed to support scientific excellence, cultivate innovation, and encourage international cooperation. The agency also plays a key role in monitoring research performance and assessing the impact of research funding on Slovenia's scientific output. The Ministry of Economic Development and Technology focuses on boosting economic growth through technological and digital development. Central to its mission is the digital transformation of the economy, aligning with the European Union's digital single market initiatives. This involves enhancing Slovenia's capabilities in advanced digital technologies, such as artificial intelligence, big data, and 5G technologies, to cultivate economic growth and competitiveness. Additionally, the Ministry is involved in creating a more effective ecosystem for a competitive economy and an open and sustainable society. Part of its strategy includes

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increasing public R&D expenditure, providing incentives for innovation cooperation, running several co-financing programs, and making decisions for the granting of state aid that promotes innovation.

Public Research Institutes: Slovenia has a network of public research institutes that are significant contributors to the national R&I output. Among them, the Jožef Stefan Institute stands out as the largest and leading research institute in Slovenia, specializing in natural sciences, technology, and sustainable development. Other notable institutes include the National Institute of Chemistry, the Institute of Information Science, and the Scientific Research Centre of the Slovenian Academy of Sciences and Arts, each contributing to different scientific fields. Together these institutes provide the necessary research infrastructure, cultivate collaboration between academia and industry, and contribute to the training and development of future scientists and researchers in Slovenia.

Universities: Universities form a cornerstone of the R&I system in Slovenia, with the University of Ljubljana and the University of Maribor being the most prominent. These institutions are not only educational centres but also active in research, contributing significantly to scientific publications and projects. Their research activities span across various fields, including technology, social sciences, humanities, and natural sciences.

Private Sector and Industry: The private sector's involvement in the R&I system, although growing, is an area Slovenia is keen to develop further. Companies in the technology and pharmaceutical sectors, such as Krka and Lek, are examples of private entities actively engaged in research and innovation. Collaboration between academia and industry is increasingly emphasized to enhance the practical application of research and boost innovation.

Intermediary institutions and support services: Intermediary institutions and support services play a vital role in bridging the gap between research outputs and their application in industry and commerce. These entities facilitate the transfer of knowledge, provide financial support, and cultivate innovation across various sectors. The Chamber of Commerce and Industry of Slovenia and the Chamber of Craft and Entrepreneurship of Slovenia are key actors in this ecosystem. They act as hubs for businesses and entrepreneurs to engage with the R&I community, offering networking opportunities, advocacy, and a range of support services aimed at enhancing innovation and competitiveness in the business sector. SRIPs are collaborative entities that bring together companies, research institutions, and other stakeholders to focus on specific areas such as smart cities, health, sustainable tourism, and advanced manufacturing. These partnerships aim to drive innovation in key economic sectors by leveraging collective expertise and resources. SID Bank, Slovenia’s national development and promotional bank, provides crucial financial support for research and development projects. It offers a range of financial products designed to cultivate economic growth, innovation, and development projects. Competence Centres and the Digital Innovation Hub Slovenia serve as focal points for technological expertise and digital transformation. They provide businesses, especially SMEs, with access to the latest technologies, knowledge, and support to integrate digital innovations into their operations. Incubators and Technology Parks play a crucial role in nurturing startups and early-stage companies, particularly in technology-driven sectors. They offer essential services like mentorship, networking opportunities, office space, and access to funding, helping startups to grow and scale their operations. Local and Regional Development Agencies are instrumental in regional development, ensuring that the benefits of research and innovation are disseminated throughout Slovenia. They work on the local and regional level to implement development policies, support local businesses, and promote regional innovation ecosystems.

International Collaboration and EU institutions: Slovenia's integration into the EU research framework, especially its participation in EU framework programs like Horizon, plays a crucial role in its

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R&I ecosystem. This not only provides additional funding sources but also opens opportunities for international collaboration and integration into wider European research networks.

Legislative framework of Slovenia's R&I system

Slovenia's legal and regulatory framework, especially its focus on Intellectual Property Rights (IPR) protection, is a fundamental pillar supporting its R&I system. It not only safeguards the interests of creators and inventors but also aligns with broader national and European innovation strategies, ensuring that Slovenia remains competitive and forward-thinking in its R&I endeavours. Two key legislative acts, the Research and Development Act and the Higher Education Act, play crucial roles in structuring and directing R&I activities across the nation.

The **Research and Development Activity Act** (ZRRD) (Official Gazette 22/06 61/06, 112/07, 9/11, 57/12, 21/18 and 9/19) stands as a foundational pillar in Slovenia's R&I legal framework. Its significance lies in establishing a clear governance structure for research activities, ensuring that roles and responsibilities are well-defined across various governmental bodies and institutions within the R&I sector. This act delineates the mechanisms for funding research projects, thereby creating a streamlined process for allocating resources to various scientific endeavours. By structuring the organization of research activities, it provides a coherent and systematic approach to stimulating and managing research within the country. This act effectively shapes the direction of Slovenia's research priorities, ensuring that they align with broader national objectives and contribute meaningfully to the country's overall development and innovation capacity.

The **Supportive Environment for Entrepreneurship Act (ZPOP-1)** (Official Gazette 102/07, 57/12, 82/13,

17/15, 27/17, 13/18) in Slovenia, enacted in 2007 and subsequently revised, plays a key role in the country's research and innovation system. Its primary aim is to cultivate a conducive environment for entrepreneurship, which is integral to driving research and innovation. The act focuses on stimulating the creation and growth of new businesses, which are key contributors to innovation, and on enhancing the integration of entrepreneurial initiatives with national economic development goals. Under this legislative framework, the act emphasizes the development of a supportive ecosystem for entrepreneurs at various administrative levels. This includes implementing incentives and programs that encourage research, development, and innovation, particularly in small and medium-sized enterprises (SMEs). The act assigns a significant role to SPIRIT Slovenia and establishes a public fund for entrepreneurship promotion. This fund develops mechanisms to support the early stages of business development and facilitate access to favourable financing for company growth, directly impacting the research and innovation landscape by providing the necessary capital and resources for innovative projects and enterprises.

There are several other acts that have a role in governing research and innovation, each playing a distinct role in facilitating entrepreneurial and innovation activities. The **Public Funds Act** (Official gazette RS, 77/08, 8/10 and in 61/20 – ZDLGPE), crucial in this array of legislations, establishes public funds as legal entities under public law, excluding mutual and pension funds and private law entities. Initiated in 2007 and revised until 2020, this act primarily focuses on setting up public funds for diverse purposes, including social, cultural, environmental, and particularly, entrepreneurship and innovation. These funds are instrumental in supporting the development and implementation of various policies at local, provincial, and national levels, such as promoting scientific creativity, granting scholarships, funding projects, and other incentives. Particularly significant is the Slovene Enterprise Fund, created under this

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act, which plays a vital role in stimulating entrepreneurship and thereby propelling the national innovation landscape.

Meanwhile, the **Venture Capital Companies Act** (ZTDK) (Official gazette RS, 92/07, 57/09) is key in defining the status, investments, and control of venture capital firms in Slovenia. It conceptualizes venture capital as equity investments in non-publicly traded companies and outlines the purposes for such investments, including seed capital for initial business concepts, start-up capital for product development and marketing, and expansion capital for scaling up businesses. This act excludes investments aimed at company rehabilitation, thereby focusing on growth-oriented ventures.

The **Investment Promotion Act** (ZSInv) (Official gazette RS, 13/18), replacing the Promotion of Foreign Direct Investment and Internationalization of Enterprises Act, provides the framework for offering investment incentives. It outlines the conditions, criteria, and procedures for granting these incentives and promotes investment and internationalization activities, including the operation of SPIRIT Slovenia, a public agency for promoting investment and technological development.

The **Corporate Income Tax Act** (ZDDPO-2) (Official Gazette RS 117/06, 56/08, 76/08, 5/09, 96/09, 110/09, 43/10, 59/11, 24/12, 30/12, 94/12, 81/13, 50/14, 23/15, 82/15, 68/16, 69/17, 79/18 and 66/19), and the **Personal Income Tax Act** (Official Gazette RS 48/90, 8/91, 14/92 - ZOMZO, 7/93 , 18/96, 91/98, 1/99, 117/06, 117/06, 24/08, 101/13 and 22/14) facilitate research and development investments by offering tax base reductions for amounts spent on R&D. These provisions ensure that investments in innovation are encouraged and financially supported, albeit with certain restrictions regarding funding from national or EU grants.

Further complementing these is the **Industrial Property Act** (Official Gazette RS, No. 51/06, 100/13 and 23/20), which governs the types and procedures for granting industrial property rights, providing a legal basis for protecting intellectual innovations.

Lastly, the **Regulation on Development Planning Documents and Procedures** (Official Gazette 54/10 and 35/18) outlines methods for preparing and implementing government development policies and budgetary procedures. This regulation ensures that development policies are created considering economic, social, environmental, and spatial possibilities and constraints, stimulating a well-rounded approach to innovation and development.

Together, these acts create a comprehensive legal ecosystem that supports and encourages research and innovation in Slovenia, guiding everything from venture capital investments to industrial property rights and setting the stage for a dynamic and growth-oriented innovation landscape.

In the context of the R&I system it's important to highlight the importance of a robust **IPR framework** in Slovenia that provides a conducive environment for innovation by ensuring legal protection and potential commercialization avenues for inventors and creators. This legal assurance encourages investments in R&D, as innovators are more likely to invest time and resources if they can protect and benefit from their inventions. Additionally, the clear delineation of rights and responsibilities in R&I activities, governed by various laws and regulations, cultivates a stable and predictable environment for researchers, innovators, and investors. Several key elements play vital roles in nurturing an environment conducive to creativity and invention. Firstly, patent protection in Slovenia is strongly upheld through its membership in the European Patent Organization. Adherence to the European Patent Convention enables Slovenian innovators to secure patent protection that is effective in numerous European countries, thus broadening the scope and impact of their inventions. The Slovenian Intellectual Property Office (SIPO) is at the forefront of this process, managing national patent registrations. By doing so, SIPO

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provides inventors with both protection and exclusivity over their innovations, a critical step in encouraging and safeguarding scientific and technological advancements. Moreover, the realm of copyrights and related rights is robustly addressed within Slovenia's legal structure. These rights are crucial in protecting literary, artistic, and scientific works. Slovenia's copyright laws are in sync with EU directives, ensuring creators have comprehensive control over the use and distribution of their works. This aspect of IPR is especially important in industries where creativity and originality are paramount, such as software development, literature, and the arts. It assures creators that their intellectual labour and creative outputs are legally protected against unauthorized use, thereby promoting continued innovation and creative endeavours. Slovenia's approach to trademarks and industrial designs further strengthens its IPR landscape. SIPO's role extends to the registration of trademarks and designs, vital for businesses in establishing and protecting their brand identities and unique aesthetic elements. This form of protection is of immense importance in the business world, as it enables companies to stand out in a competitive marketplace by securing their brand visuals and product designs, which are often central to a company's identity and consumer appeal. Lastly, the legal framework in Slovenia recognizes the importance of protecting trade secrets and know-how. These are particularly crucial for businesses whose competitive edge relies on proprietary information. Such protections are indispensable in industries where traditional patenting may not be feasible or where the pace of innovation outstrips the often-lengthy patenting process. By legally safeguarding these aspects of business knowledge, Slovenia ensures that enterprises can maintain their competitive advantages and continue to drive innovative practices. This many-sided IPR system not only provides the necessary legal protections for a range of creative and innovative outputs but also lays the groundwork for a dynamic and forward-looking R&I environment. The country's alignment with European standards further reinforces its commitment to upholding a robust and efficient system for intellectual property rights protection, crucial for stimulating an ecosystem where innovation can thrive.

Strategic framework of Slovenia's R&I system

In Slovenia, the trajectory of the R&I system is strategically guided by two key documents: the **Scientific Research and Innovation Strategy 2030 (ZRISS 2030)** and the Smart Specialisation Strategy.

ZRISS 2030 significantly influences the research and innovation system in Slovenia. The strategy is a comprehensive policy document formulated by the Ministry of Higher Education, Science, and Innovation. It outlines the strategic direction for scientific research and innovation in Slovenia up to 2030, emphasizing a wide range of objectives and measures designed to enhance the national research and innovation ecosystem. A key aspect of ZRISS 2030 is its alignment with broader European frameworks, particularly the European Research Area (ERA). This alignment ensures that Slovenia's research and innovation activities are not only locally relevant but also integrated into wider European research and innovation efforts. The strategy aims to position Slovenia among the innovation leaders on the European Innovation Scoreboard by 2030. To achieve this, the strategy sets out five overarching objectives: effective governance of the scientific research and innovation system, enhanced investment in research and innovation, researchers' career development and excellent science, excellent and internationally competitive research infrastructure, and accelerated cooperation between science and industry, including knowledge transfer and innovation.

ZRISS 2030 emphasizes the need for increased funding for scientific research and innovation, aiming for public investment in R&I to reach 1.25% of GDP by 2030. It also focuses on stimulating a culture of innovation, encouraging the transfer of knowledge from research organizations to industry, and promoting the development of high-quality research and technological infrastructures. The strategy highlights the importance of integrating research and innovation into all sectoral policies and ensuring gender equality in research and innovation.

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ZRISS 2030 focuses on increasing the autonomy of research organizations (ROs) and integrating research, higher education, and innovation into a single, effective system. This includes the establishment of a national information hub, periodic international evaluation of the R&I system, and dedicated resources for popularizing scientific research. Furthermore, emphasis is placed on improving the career paths of researchers, offering internationally competitive conditions, and doubling funds for young researchers. This focus is expected to nurture the next generation of scientists and contribute to high-quality, groundbreaking research output.

ZRISS 2030 involves modernizing and building new research infrastructure, with a focus on priority research fields. This will enhance Slovenia's ability to participate in international research and develop cutting-edge technological solutions. It also aims to bridge the gap between scientific research and industry through proactive knowledge transfer, innovation in the public sector, and strengthening the innovation potential of start-ups.

The importance of setting horizontal objectives is highlighted including openness and participation in the international space, a commitment to Open Science, socially responsible science, and ensuring gender equality in research and innovation. These objectives aim to make Slovenian research more inclusive, ethical, and globally integrated.

In the context of the INNO2MARE project, it is necessary to assess the importance of maritime innovation in the broader strategic context. While ZRISS 2030 doesn't specifically emphasize this area, the broad scope, and objectives of ZRISS 2030 are likely to encompass maritime aspects within the larger framework of scientific research and innovation, especially considering the relevance of maritime topics to environmental research, sustainable resource management, and technological development.

Slovenia's innovation landscape has undergone significant evolution through its **Smart Specialisation Strategies**, transitioning from S4 to the current S5. The original **Slovenian Smart Specialisation Strategy (S4)**, established during the 2014-2020 programming period, was instrumental in defining national development priorities, stimulating a robust environment for research and innovation collaboration. It laid the groundwork for integrating Slovenia more effectively into international research and innovation networks and created SRIPs to drive economic development. S4's implementation was crucial in revamping Slovenia's policy framework supporting innovation. This framework covered various innovation stages, from startups to pilot projects, and facilitated a more cohesive and coordinated policy implementation across governmental bodies. Notably, S4 was a key factor in Slovenia's eligibility for EU funding under the Cohesion Policy, emphasizing the international competitiveness of research and innovation.

Building on the solid foundation set by S4, Slovenia initiated the development of the **Sustainable Smart Specialisation Strategy (S5)**, adopted in 2023. While S5 retains the essence of S4, it introduces an intensified focus on sustainability and green transformation. This shift is in line with the EU's broader objectives of stimulating a low-carbon, digitally advanced, and knowledge-driven economy, reflecting the goals of the European Green Deal. Table 2.2. shows indicators measuring the strategic goal of S5.

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Table 2.2: Indicators measuring strategic goal of S5 (UMAR, 2022b).

Indicator	Baseline value	Reference year	Target value 2030	Source of data
Labour productivity (GDP per person employed in purchasing power standards), EU = 100	84	2021	95	SURS
European Innovation Index (EII), EU=100	93.5 group of moderate innovators	2022	125 group of innovation leaders	EC
Material productivity, SKM/kg	2.03	2020[1]	3,5	ARSO, Eurostat
Digital Economy and Society Index (DESI), ranking	11th place	2022	9th place	EC
Share of population in the 30–34 age group with tertiary education, in %	46.9	2020[1]	50	UMAR, Eurostat
Share of participants in lifelong learning in the 25-64 age group, in %	8.4	2020[1]	19	UMAR, Eurostat

The formulation of S5 was a collaborative process involving key ministries, SRIPs, and the public, emphasizing the need for empirical analysis and an entrepreneurial discovery process. This approach ensured that S5 would not only enhance the existing strategy but also incorporate newer dimensions of sustainability and digital transformation, necessary for contemporary economic and environmental challenges. S5 thus represents an advancement from S4, upholding the strategic objectives of the original framework but infusing it with contemporary priorities of sustainability and digitalization. This progression from S4 to S5 demonstrates Slovenia's agility in adapting its innovation strategies to align with evolving regional and global goals, ensuring a forward-looking approach to research and innovation.

S5 integrates various features of economic and social development, with a strong emphasis on sustainable practices, technological innovation, and addressing contemporary societal challenges. Central to the S5 strategy is the bolstering of Slovenia's science, research, and innovation ecosystem. This involves coordinated investments across several domains such as R&D, digital transformation, competitiveness of SMEs, and skill development for smart specialisation. By focusing on these areas, the strategy aims to boost productivity and innovation, positioning Slovenia as a competitive player in both national and international value chains.

A distinctive aspect of S5 is its identification and prioritisation of ten strategic areas, including Smart Cities and Communities, Health-Medicine, and Networks for the Transition to a Circular Economy. These areas were chosen based on Slovenia's comparative advantages and potential for global market impact. For

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instance, the focus on Health-Medicine reflects Slovenia's strengths in pharmaceuticals and medical technologies, while Smart Cities and Communities represent an intersection of technological innovation and urban development.

Digitalisation and cross-cutting technologies are other pillars of S5, with a notable emphasis on Key Enabling Technologies (KETs) and Information and Communication Technology (ICT). These technologies are expected to drive digital transformation across all priority areas, stimulating an ecosystem where modern technologies like Artificial Intelligence (AI), High-Performance Computing (HPC), and the Internet of Things (IoT) facilitate the modernisation of industries and sustainable production processes.

S5's alignment with the European Green Deal is evident in its focus on transitioning to a low-carbon, circular economy. This is coupled with an approach to societal challenges such as ageing populations, where S5 envisages sustainable healthcare solutions, smart urban living, and environmentally responsible tourism.

International collaboration is another cornerstone of the strategy. Slovenia aims to strengthen its role in European and global innovation networks through active participation in thematic hubs and consortia, especially in areas like the sustainable blue economy. This is in line with Slovenia's objective to expand its presence and integration in global value chains. Education and skill development are also prioritised in S5, reflecting the need to equip the workforce with knowledge and skills pertinent to future societal needs. This includes not only technological innovations but also non-technological and social innovations, underlining the strategy's comprehensive scope.

The concept of the Sustainable Blue Economy (SBE) in Slovenia's S5 presents a nuanced and integrated approach towards utilizing maritime resources and technologies for economic growth, while emphasizing environmental sustainability and innovation. SBE in Slovenia is not delineated as a separate priority area within the S5 framework. Instead, it weaves through various strategic sectors, signifying its comprehensive impact and relevance across multiple areas of economic and environmental development. This approach aligns with the European Green Deal's objectives, focusing on the development of offshore renewable energy, the decarbonization of maritime transport, greening of ports, conservation of marine biodiversity, and sustainable use of marine resources. The goal is to develop a sustainable, circular model for maritime and related industries, ensuring environmental conservation and economic viability.

Despite its cross-sectoral presence, SBE's influence is particularly notable in specific areas of Slovenia's strategic development. It prominently features in sectors such as Networks for the Transition to a Circular Economy, Materials as End Products, and Health-Medicine. For instance, in the Circular Economy sector, SBE explores algal technologies and alternative raw materials. In the Materials sector, it focuses on developing sustainable materials and recycling processes. In the Health-Medicine sector, research is directed toward marine-derived pharmaceuticals and biocosmetics.

SBE's emphasis on innovation and research underscores Slovenia's commitment to harnessing maritime resources responsibly. This involves R&D in diverse areas, ranging from renewable energy sources to sustainable fisheries and aquaculture, each contributing to Slovenia's economic growth and environmental goals. Collaborative projects like the Blueair project, under the Interreg Adrion Programme, exemplify this commitment, underscoring the need for regional cooperation and integration in maritime research and innovation within the Adriatic and Ionian Region. S5 also recognizes the role of SBE in contributing to broader environmental objectives and climate goals. Investments in areas like renewable energy and eco-friendly maritime technologies are key to achieving the European Green Deal’s target of net-zero emissions by 2050. Moreover, initiatives aligned with EU missions such as Restore Our

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Oceans and Waters highlight SBE's contribution to environmental conservation. Economically, SBE is seen as a potential growth driver for Slovenia, especially in sectors like offshore renewable energy, sustainable tourism, and maritime transport. These sectors are expected to spur innovation, create jobs, and bolster Slovenia's overall economic development. Furthermore, the integration of digital technologies in maritime and coastal activities reflects Slovenia's response to the twin transition to a green and digital economy.

Besides ZRISS 2030 and S5, the key sectoral strategies that aim to advance science and drive the improvement of Slovenia's competitiveness include the Slovenian Industrial Strategy 2021–2030 (SIS), the new Digital Slovenia, the National Programme on the Development and Uptake of Artificial Intelligence by 2025 (NpUI) and the Guidelines for the Implementation of Slovenia's Skills Strategy. In addition, several sector-specific documents play an important role in this context, i.e., the National Energy and Climate Plan and other strategies in the field of environmental protection, energy, a fair transition to a climate-neutral economy and society, education, etc.

Funding of research and innovation

Slovenia and Croatia receive money for research and innovation from a wide range of sources, including national, EU, and private sector subsidies. Through ministries like the Ministry of Economic Development and Technology and the Ministry of Education, Science, and Sport, the government of Slovenia plays a significant role. Funds are provided by organizations like ARRS for infrastructure, scientific research, and the advancement of young researchers' careers. In line with its smart specialization approach, Horizon Europe, an EU program that covers clusters focused on digitalization, climate, energy, and agriculture, also greatly benefits Slovenia. Initiatives for skills development and regional development are also supported by funding from the ERDF and ESF+.

Although it is not as prominent as governmental investment, private sector involvement in Slovenia's R&D landscape is nonetheless very important. It promotes applied research in industries including IT, automotive, and pharmaceuticals, enhancing the work of public and university research institutions. Initiatives like SPIRIT Slovenia, which offers grants and subsidies, are beneficial to startups and SMEs. Innovation-driven businesses are further stimulated by venture capital and equity investments, while private R&D investments are encouraged by tax advantages.

There are still issues that prevent long-term innovation goals and strategic planning, such as financial fragmentation and unpredictability. To address these issues and improve governance in the R&I sector, the EU contributes through initiatives like the National Recovery and Resilience Plan and the Technical Support Instrument, which offer stability and strategic direction.

The marine innovation ecosystem in Croatia encounters comparable obstacles and prospects. The necessity for diversified funding sources that are available to businesses, especially major shipyards, is highlighted by the reliance on EU money. The existing strategy lacks collaboration structures that might better incorporate stakeholders, notably benefiting universities. Streamlining bureaucratic obstacles and expediting innovation require the improvement of accessibility and simplification of grant procedures.

Funding options from the EU, such as Horizon Europe clusters devoted to environmental sustainability and digitalization, are essential for both nations. Sector-specific grants and public-private partnerships provide more avenues for innovation in fields like digital technologies and the green transition. The goal of initiatives supporting consortia and clusters in the maritime industry is to provide financial access for everybody, encouraging joint innovation efforts between the two nations.

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In conclusion, leveraging EU funds, enhancing private sector engagement, and promoting collaborative approaches are essential strategies for advancing research, innovation, and the maritime sector in Slovenia and Croatia. By addressing funding gaps and streamlining processes, both countries can accelerate technological advancements, enhance competitiveness, and achieve sustainable growth. The diverse funding landscape, coupled with strategic EU initiatives, provides a framework for future innovation and development in these crucial sectors. Furthermore, there is an expressed need for improved stability and predictability in R&I funding mechanisms, expressed by OECD in 2024 in Synthesis of Improving the Governance Model of the Research and Innovation System in Slovenia.

Research and innovation by sectors

In Slovenia, the landscape of R&I is diverse and dynamic, with several sectors contributing significantly to the country's scientific and technological advancements. The R&I system in Slovenia encompasses a range of fields, reflecting the country's strategic emphasis on leveraging its strengths and potential for growth in various areas.

In terms of developed sectors, Slovenia showcases strength in hi-tech, pharmaceutical, and automotive industries. These sectors are recognized for their innovation contributions, underscoring the country's expertise in advanced technologies and sciences. This is bolstered by a network of technology parks, incubators, and research infrastructure like the VEGA EuroHPC Supercomputer, which focuses on cutting-edge fields such as artificial intelligence, big data, medicine, and new materials.

One of the standout sectors is Information and Communication Technology (ICT), where Slovenia has developed robust capabilities in software development, telecommunications, and cutting-edge technologies like artificial intelligence and big data analytics. This sector thrives due to a synergy between academic research, innovative startups, and established tech companies.

Parallelly, the pharmaceuticals and biotechnology sector in Slovenia is known for its contributions to drug development, biotechnological applications, and medical devices. This sector benefits from a deep-rooted pharmaceutical tradition and strong collaboration between research institutions and industry players.

The automotive and smart mobility sector is another key area of focus, encompassing advanced automotive technologies, electric vehicle development, and intelligent transportation systems. This sector is propelled by collaborations between major automotive companies and academic researchers, aiming to innovate in mobility solutions.

In the realm of materials science, Slovenia is investing in advanced materials and nanotechnology research. This sector is exploring new materials with diverse applications, including electronics, renewable energy, and construction, reflecting the country's commitment to innovation in material sciences.

Environmental technologies and renewable energy are also important sectors, aligning with global trends toward sustainability. Slovenia is making significant strides in solar and wind energy and sustainable environmental practices, aiming to contribute to a greener future.

The agriculture and food technology sector focuses on sustainable agricultural methods, food safety, and nutritional advancements. This sector is critical for Slovenia's food security and agricultural development, driving innovation in food production and quality.

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Healthcare and medical research are integral to Slovenia's R&I ecosystem, with efforts concentrated on medical advancements, public health research, and new healthcare technologies. This sector aims to improve health outcomes and advance medical knowledge.

Robotics and automation have emerged as vital sectors, with Slovenia exploring industrial automation, diverse applications of robotics, and the integration of AI and machine learning into robotics systems. These areas represent Slovenia's pursuit of technological innovation and industrial advancement.

Emerging sectors like space technology, cybersecurity, and smart cities technologies signify Slovenia's commitment to staying in touch of global technological trends and addressing contemporary challenges through innovation.

However, its maritime innovation landscape is relatively nascent compared to other sectors. The country's strategic location on the Adriatic Sea offers significant potential for maritime development, particularly in areas such as maritime transport, shipbuilding, marine biotechnology, and coastal management, as explained in reports developed within the INNO2MARE project.

2.2 Croatia’s R&I System

Croatia's R&I system is evolving, with increased emphasis on international collaboration, boosting private sector R&D investment, and enhancing the link between research and industry. Its integration with European research initiatives is expected to continue shaping its research landscape. This system reflects a balance between preserving traditional scientific disciplines and embracing new, innovative areas of research, with ongoing reforms and investments aimed at enhancing its global competitiveness and research output.

According to the European **Innovation Scoreboard 2023 - Country profile for Croatia**, Croatia made significant strides in its innovation capabilities, positioning itself as an Emerging Innovator with a performance score of 69.6% relative to the EU average. This achievement is not insignificant, as it marks a considerable 14.8 percentage point increase since 2016, underscoring Croatia's growing influence in the European innovation ecosystem. The European Innovation Scoreboard identifies strengths and weaknesses in the context of innovation for each Member State. Croatia’s strengths and weaknesses are listed in table 2.3.

Table 2.3: Croatia's strengths and weaknesses in innovation performance.

Relative strengths	Relative weaknesses
Public-private co-publications.	Innovation expenditures per employee.
Venture capital expenditures.	Environment-related technologies.
Product innovators.	Knowledge-intensive services exports.
People with above basic overall digital skills.	Lifelong learning.
Business process innovators.	Design applications.

However, Croatia's innovation journey is not without its challenges. One of the key areas where improvement is needed is in innovation expenditures per employee. The relatively low investment in this regard suggests potential for enhancing the innovative capacity of the workforce. Another concern is the

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country's performance in environment-related technologies. This area, critical for sustainable development, has not seen significant progress, indicating a gap that needs addressing in Croatia's innovation strategy. Additionally, lifelong learning and design applications are areas where Croatia lags.

Over the years, there have been significant shifts in Croatia's innovation landscape. The country has seen a dramatic increase in venture capital expenditures, highlighting growing investor confidence in Croatian innovations. However, this positive development contrasts with a decrease in government support for business R&D, indicating a shifting landscape in innovation funding and possibly a growing dependence on private sector contributions.

Croatia's innovation story is also contextualized by its economic structure. With a lower per capita income but a faster-growing economy compared to the EU average, and a significant role played by SMEs, Croatia's economy presents both challenges and opportunities for innovation. SMEs' substantial share in the economy points to a potential powerhouse for grassroots innovation, but it also suggests the need for targeted support and development initiatives to fully harness this potential.

In 2022, Croatia's commitment to R&D was significantly underscored by its expenditure in this area. According to the **report by the Croatian Bureau of Statistics** regarding research and development in 2022, the nation spent a total of 956 million EUR on R&D activities. This amount represents a notable increase of 32.4% compared to the previous year, reflecting a strong emphasis on stimulating innovation and development.

A sector-wise breakdown of this expenditure reveals that the largest share, accounting for 54.3%, was dedicated to the business enterprise sector. This indicates a considerable focus on private sector-led innovation, with businesses driving much of the R&D activity in the country. Higher education followed with 27.8%, highlighting the role of academic institutions in advancing research and development. The government and private non-profit sectors contributed 17.9%, showing a balanced approach towards funding across different sectors.

Labor costs constituted the largest portion of R&D expenditure, accounting for 56.7% of the total. This is indicative of a significant investment in human resources, ensuring that skilled professionals are leading these innovative efforts. Other current costs and capital expenditure made up 28.5% and 14.8%, respectively, of the total R&D budget, underlining the allocation of resources to both operational and infrastructural aspects of research.

In terms of funding sources, internal funds were the largest contributors, financing 43.3% of total R&D, followed by central and local government funding, which accounted for 28.8%. This distribution underscores a diverse funding model for R&D in Croatia, combining both internal and public funds. Interestingly, the business enterprise sector predominantly financed R&D through internal funds (71.5%), while the government and private non-profit sector (58.5%), as well as higher education (62.9%), relied more on central and local government funding.

Key actors in Croatia’s R&I system

The Ministry of Science and Education (MSE) and the Ministry of the Economy and Sustainable Development (MESD) are at the forefront of Croatia's R&I system. In the nation's R&I system, the MSE is essential and has a significant impact on a range of academic and scientific fields. The MSE's duties cover a wide range of administrative and developmental obligations that support the establishment of a strong R&I environment in Croatia. A core area of the MSE’s responsibility lies in the realm of education, ranging from preschool to secondary education, both within the country and abroad. The Ministry is instrumental

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in developing the National Curriculum, approving textbooks, and setting regulations and standards for educational work. These efforts are critical for ensuring the quality and consistency of the educational foundation upon which future scientific and technological advancements are built. The MSE also plays a significant role in higher education. It oversees the implementation of national strategies and higher education programs, providing essential support to higher education institutions through funding, facilities, and monitoring their activities. The Ministry's work in evaluating higher education institutions and study programs is vital for maintaining high academic standards and ensuring the relevance and effectiveness of higher education in responding to contemporary scientific and technological challenges.

Figure 2.1 below visualizes PMR values for Croatia (in blue) and OECD average (red) in 2018 (OECD, 2022).

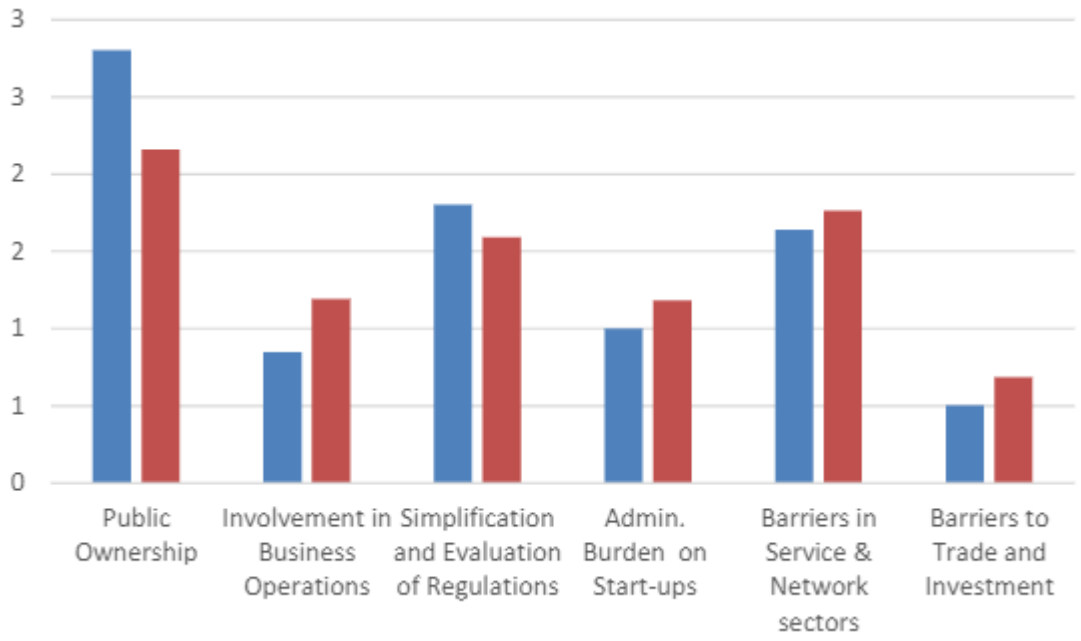

Figure 2.1: Economy-wide PMR values for Croatia (in blue) and OECD average (red) in 2018 (OECD, 2022).

In the sphere of science, technology, and innovation, the MSE is responsible for the development of the science, technology, and innovation system. This encompasses supporting research institutions, applying scientific achievements across various fields, and harmonizing funding programs with research projects. Importantly, the Ministry also focuses on the development and monitoring of intellectual property management policy. This includes harmonizing national legislation on intellectual property rights with the acquis communautaire and developing strategic measures for improving the protection and enforcement of these rights. Such initiatives are key to stimulating technology transfer from research organizations to the business sector and society, thereby enhancing Croatia's technological development. Additionally, the MSE administers the Registry of Researchers and Research Organizations, playing a crucial role in overseeing and establishing scientific, professional, and technological cooperation with foreign countries and international organizations. The Ministry also focuses on enhancing the mobility of Croatian and foreign researchers, offering scholarships, specialization, and practical training based on international, government, business, and other agreements.

The Ministry's participation in the development of programs and projects, including those funded by the EU and other international sources, demonstrates its active involvement in integrating Croatia's R&I system with broader international research and innovation networks. Furthermore, the MSE cooperates

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with other ministries, particularly in matters related to the management and disposal of state property in sectors under its jurisdiction.

MESD is complementing the efforts of the Ministry of Science and Education (MSE) in developing a robust and competitive R&I environment. MESD is tasked with formulating and implementing strategies and plans for sustainable development based on the principles of a green and circular economy. Its goal is to transform Croatia into a prosperous society with a resource-efficient and competitive economy while ensuring climate neutrality and the sustainable use of natural resources. This overarching mission of MESD aligns closely with the objectives of sustainable R&I initiatives, emphasizing the need for innovations that are environmentally sustainable and economically viable.

The Ministry's responsibilities include developing and enhancing the competitiveness of the Croatian economy. It focuses on economic policy instruments and measures, the development of micro, small, and medium-sized enterprises, and industrial policy. Crucially, MESD is also responsible for the policy of applying innovations and new technologies, aligning its efforts with MSE's initiatives in scientific and technological advancements. This includes managing a guarantee fund for industrial advancement, promoting creativity in industry and trade to boost economic competitiveness, and overseeing the application and utilization of intellectual and industrial property rights. These efforts are key to stimulating a climate of innovation and technological development in Croatia.

In addition to these roles, MESD participates in coordinating the strategy for managing state assets, including the restructuring and rehabilitation of legal entities. The Ministry also engages in activities related to internal trade within the European Union, supply and pricing, national coordination for actions within the EU's internal market, and the development of national policies in standardization, accreditation, conformity assessment, and metrology. These activities are critical for ensuring that Croatia's R&I outputs align with EU standards and contribute to the seamless integration of the country's economy within the EU's single market.

Moreover, MESD is instrumental in tasks related to environmental protection and conservation in accordance with Croatia's sustainable development policy. This includes waste management, environmental impact assessments, climate change mitigation and adaptation, water management, and energy-related issues. The Ministry coordinates national-level sustainable development themes and acts as the national coordinator for multilateral environmental agreements and global sustainable development issues. This role is particularly significant in ensuring that R&I activities in Croatia are aligned with global sustainability goals. The Ministry's involvement in the work of European Union bodies in areas within its competence further highlights its role in integrating Croatia's R&I system into the broader European and global context.

The **Croatian Science Foundation (CSF)** plays a crucial role in Croatia's research and innovation system, primarily by funding and supporting scientific, higher education, and technological projects. Central to its mission is the promotion of state-of-the-art research within Croatian scientific institutions, thereby enhancing their ability to compete on an international level. A key function of the CSF is the rigorous evaluation of project proposals through a two-stage process involving peer review by international scientists and panel evaluation by Croatian experts. This approach ensures that only high-quality research projects receive funding, aligning with international standards of scientific excellence. Additionally, the CSF places a strong emphasis on the development of young researchers, particularly doctoral students. By supporting their integration into active research projects and emphasizing the timely completion of their doctoral theses, the CSF cultivates a new generation of scientists equipped to compete globally and pursue advanced post-doctoral opportunities. Moreover, as a member of Science Europe, the CSF engages in international dialogues about science policies, further integrating Croatian

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research into the broader European and global scientific community. This membership underlines the CSF's commitment to upholding and contributing to international research standards and collaborations. Overall, the CSF's role in funding, evaluating, and nurturing research talent significantly contributes to the advancement of Croatia's scientific and technological landscape, positioning the country as a notable participant in the international research arena.

The **Agency for Science and Higher Education (ASHE)** is another important player in Croatia's R&I system. It ensures the quality of higher education and science, primarily through the accreditation and external evaluation of higher education institutions and scientific organizations. This function is essential for maintaining high academic and research standards, aligning Croatian institutions with national and international benchmarks. ASHE is instrumental in integrating Croatia's higher education and science sectors into the European framework, enhancing international collaboration and academic mobility. It manages the Croatian Qualifications Framework and the Registry of Higher Education Institutions and Study Programmes, ensuring that qualifications are relevant and information about institutions and programs is accessible and transparent. Furthermore, ASHE promotes lifelong learning and adult education, adapting to the changing needs of the knowledge economy. It also plays a significant role in aligning Croatian higher education and research with EU priorities, participating in the development and implementation of various EU-funded projects.

Additionally, the **Centre for Industrial Development**, associated with the Croatian Chamber of Commerce, works diligently to enhance the competitiveness of the Croatian business sector. It conducts analytical studies on industrial and innovation policies and offers consultancy services, thereby shaping a more conducive environment for industrial innovation.

The Croatian Agency for Small Business, Innovation, and Investments (HAMAG-BICRO) has a many-sided role in providing financial support, facilitating technology transfer, participating in EU-funded initiatives, and building an innovation-friendly ecosystem, which positions it as a key factor in strengthening Croatia's research and innovation capabilities. Established to promote the development of small and medium-sized enterprises, entrepreneurship, and innovation, HAMAG-BICRO is a key institution in the Croatian R&I landscape. One of the main functions of HAMAG-BICRO is to provide financial support to enterprises at various stages of development, especially in the crucial early stages of innovation. This includes offering a range of financial instruments such as grants, loans, guarantees, and equity investments. These financial tools are designed to address the specific needs of startups and innovative SMEs, which often face challenges in accessing traditional forms of financing. In addition to financial support, HAMAG-BICRO also plays a key role in stimulating the commercialization of research and facilitating the transfer of technology from research institutions to the marketplace. By supporting the collaboration between academia and industry, the agency helps in translating scientific research into market-ready products and services, thus contributing to the national economy and stimulating innovation. HAMAG-BICRO's involvement in various European Union-funded projects and initiatives further amplifies its impact on Croatia's R&I system. Through these projects, the agency not only brings additional funding and support to Croatian enterprises and researchers but also ensures alignment with broader European R&I goals and standards. Moreover, HAMAG-BICRO's efforts extend to building an innovation-friendly ecosystem in Croatia. This involves working with a network of partners, including government bodies, educational institutions, and other agencies, to create a conducive environment for innovation and entrepreneurship. This collaborative approach helps in addressing systemic challenges in the R&I system and ensures a coordinated effort towards achieving national innovation goals.

Strategic coordination in the implementation of Croatia's Smart Specialisation Strategy (S3) is overseen by the **National Innovation Council (NIC)**. The **National Council for Science, Higher Education, and Technology** and the **National Council for Industry - INNOVA** are advisory bodies to the National

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Innovation Council. They bring specialized insights from their respective domains to inform the strategic decisions and policies related to R&I. Supporting the National Innovation Council is an **Inter-ministerial Working Group and Technical Secretariat**. This group's role includes operational tasks, coordination of inter-ministerial activities, and providing technical support for the execution of the innovation strategy.

Beneath these entities is a tier of **Thematic Innovation Councils**, which are focused on specific sectors such as Health & Quality of Life, Energy and Sustainable Development, Transport & Mobility, Security, and Food & Bioeconomics. These councils drive innovation in targeted areas that are crucial for Croatia's socio-economic development. Each of these councils is responsible for advancing innovation within their thematic area, ensuring that initiatives and policies are not only aligned with national strategies but are also responsive to the needs of their respective sectors. In the context of Croatia's R&I system, the relationships among these stakeholders are collaborative, aiming to unify various areas of research and innovation under a coherent national strategy. This integrated approach is designed to create a conducive environment for innovation, leveraging expertise from different sectors to drive progress and competitive advantage in the global landscape. This structure aims to ensure that Croatia's R&I activities are well-coordinated, strategically focused, and effectively contribute to the nation's overall development goals. Thematic councils are vital for stimulating sector-specific advancements, while the advisory bodies ensure that diverse perspectives inform the innovation policy at a national level.

In Croatia, the research and development (R&D) sector is significantly influenced by **higher education institutions and public research institutes**, which are central to the country’s engagement in both basic and applied research activities. These entities have historically been the beneficiaries of substantial funding from European Structural and Investment Funds, yet they face ongoing challenges related to modernization and functional integration. Among the higher education institutions, the University of Zagreb stands as the largest and oldest, with a broad spectrum of disciplines. It's particularly noted for its contributions in a wide range of fields, from natural sciences to humanities. Alongside, the University of Split, with its emphasis on marine sciences and engineering, has developed niche expertise, especially relevant to Croatia’s maritime industries and the Adriatic Sea. Similarly, the University of Rijeka and the University of Osijek each contribute uniquely to the national R&D framework, focusing on biomedicine, biotechnology, sustainable agriculture, and food safety, resonating with the regional needs and strengths. The public research landscape is equally diverse. The Ruđer Bošković Institute in Zagreb is a leading institution in natural and biomedical sciences and is crucial for Croatia's involvement in international scientific projects. Institutes like the Institute for Medical Research and Occupational Health, which focuses on public health and environmental studies, and the Institute of Oceanography and Fisheries in Split, which specializes in marine research, underscore the country’s commitment to addressing both global and local scientific challenges.

In the private sector, a growing number of enterprises are actively engaging in R&D activities. While not always formally recognized as scientific organizations, these enterprises significantly contribute to the innovation ecosystem, particularly in translating research outcomes into market-ready solutions and products.

In conclusion, Croatia's R&I system is marked by a collaborative and multi-layered structure involving public and private entities, each contributing uniquely to the country’s scientific and technological progress. The system, while showing promising development, requires continuous efforts in modernization, integration, and alignment with European standards and practices to fully realize its potential in the global R&I arena.

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Legislative framework of Croatia's R&I system

The legislative framework for Croatia's R&I system is grounded in several national laws that establish the governance, funding, and regulation of scientific research and higher education.

The **Act on Higher Education and Scientific Activity (original name: Zakon o visokom obrazovanju i znanstvenoj djelatnosti, published in national gazette Narodne Novine, 119/2022)**, which entered into force in Croatia in October 2022, was introduced with the main goal of modernizing the system of higher education and scientific activity in the country. The implications of this act for Croatia's R&I system are significant and many-sided. Firstly, the Act simplifies procedures for the admission of teachers, students, and researchers. This is expected to enhance the country's academic profile by attracting talent and facilitating the mobility of researchers both into and out of Croatia. Secondly, the Act addresses ambiguities regarding the founding of new higher education institutions and the launch of new study programs. By establishing clearer regulations, the Act aims to streamline the processes involved in expanding and diversifying the educational offerings in Croatia. The internal organization of universities and research institutes is clarified under this Act, ensuring that governance structures within these entities are efficient and conducive to the goals of R&I. This extends to the changing of status for higher education institutions and research institutes, which could allow for more adaptive and responsive organizational changes in the R&I ecosystem. A critical innovation brought by the Act is the introduction of a new model for the public funding of public higher education institutions and public research institutes. This new model is based on funding agreements and is geared toward enhancing the financial support mechanism for these institutions, aligning them with the performance and results-based approach common in the European Higher Education Area (EHEA), European Education Area (EEA), and the European Research Area (ERA). The Act also contributes to the organizational and functional integration of universities and research institutes, stimulating a dialogue on institutional goals and promoting a collaborative environment conducive to scientific and educational innovation. Additionally, the Act sets out to promote a more effective legal and funding framework for digital transformation in higher education and science. With an emphasis on impactful publications, the number of competitive projects (e.g., Horizon Europe), international cooperation, and partnerships with the economic sector, the Act strives to empower a comprehensive digital transformation of higher education and infrastructure investments, aligning with the goals of a green and digital Europe.

The **Act on the Croatian Science Foundation (original name: Zakon o Hrvatskoj zakladi za znanost, published in national gazette Narodne Novine, 57/2022),** which came into effect in May 2022, reinforces the foundation's role as the central body for funding scientific research across all disciplines in Croatia. It is tasked with providing financial support for fundamental and applied research critical to national interests and nurturing the next generation of scientists at doctoral and post-doctoral levels. The foundation's function includes stimulating scientific excellence and competitiveness in national and international research, as well as encouraging collaborations that contribute to knowledge-based economic and social development. The evaluation of research proposals is required to be transparent and follows rigorous international standards, ensuring the objectivity and impartiality of the process. In essence, the Act enhances the foundation's responsibility in steering Croatia's scientific endeavours and supporting the country's strategic R&I objectives, ensuring a transparent and equitable distribution of resources through public calls.

The **Act on State Aid for Research and Development Projects in Croatia (original name: Zakon o državnoj potpori za istraživačko-razvojne projekte, published in national gazette Narodne Novine, 64/2018)**, effective since July 26, 2018, establishes a legal framework aimed at stimulating private sector investment in R&D. The Act allows beneficiaries to receive an additional deduction from their tax base for eligible R&D costs in all activity sectors and scientific and technological areas. This

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deduction covers fundamental research, industrial research, experimental development, and feasibility studies for R&D projects.

In the context of R&I, it's important to elaborate on the state of Intellectual Property protection. Croatia boasts a contemporary framework for **Intellectual Property Rights (IPR)** that is in complete alignment with the norms and standards set by the European Union. As part of its commitment to international best practices, Croatia is not only a participating member of the European Patent Organization but also a signatory to the major international treaties pertinent to intellectual property. The State Intellectual Property Office (SIPO) of the Republic of Croatia stands as the authoritative body tasked with the issuance of rights and the overall coordination of the national IPR system. The enforcement of these rights is a multi-agency effort involving the police, judicial courts, customs authorities, and the state inspectorate. These bodies work in unison to uphold the integrity of intellectual property laws. Relevant to this framework is Croatia's Patent Act, which underpins the legal protection of IPRs within the country. This act comprehensively addresses the various categories of intellectual property, from patents and trademarks to copyrights and design rights, establishing a robust legal foundation for the protection and commercialization of innovation and creative works. Through this legislation, Croatia ensures that its R&I system is not only legally fortified but also attractive to both domestic and international investors and innovators. The act further facilitates the dynamic exchange and monetization of intellectual capital, positioning Croatia as a competitive player in the global knowledge economy.

Strategic framework of Croatia's R&I system

Unlike Slovenia, Croatia doesn't have a specific strategy steering the development of research and innovation in the country. The strategic direction is based on universal strategies like **National Development Strategy (NDS) until 2030, National Recovery and Resilience Plan 2021–2026 (NRRP), Operational Programme Competitiveness and Cohesion 2021–2027 (OPCC), and Smart Specialisation Strategy 2021–2029 (S3).**

NDS was formulated, aiming to drive Croatia towards being a sustainable and competitive economy. This strategy emphasized reaching a gross expenditure on R&D (GERD) of 3% of GDP, improving Croatia's standing on the Global Competitiveness Index, and enhancing the value of exports relative to GDP. The strategy also encompassed broader economic aspects, such as stimulating innovation and technological advancement, thus indicating a comprehensive approach to national development.

The Smart Specialization Strategy (S3) until 2029 in Croatia is a significant roadmap shaping the research and innovation (R&I) system in the country. This strategy, reflecting a shift from a state-centric policy approach to a more collaborative framework, emphasizes a high level of cooperation between the government, research community, and business sector. It represents a departure from general horizontal innovation policies by focusing on vertical and specific policies that facilitate the creation of a critical mass in a diversified ecosystem. S3 in Croatia, especially in its 2016-2020 cycle, primarily served as a tool for the absorption of European Structural and Investment Funds (ESIF) in R&I. It has been instrumental in identifying research and innovation priorities and has encouraged private investments in these areas. The strategy aimed to define priorities and build comparative advantages by aligning research and innovation strengths with economic needs, responding to new market opportunities while avoiding duplication and fragmentation of efforts. The effectiveness of S3 relies on its ability to transform differentiation and specialization into complementary processes that mutually reinforce each other. This strategy necessitates an interactive discovery process involving stakeholder engagement to identify areas with the potential to develop critical mass activities. It emphasizes the need for transition from imitation or dispersal of available resources into portfolios of connected and complementary projects that create critical mass and synergistic effects.

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The forthcoming S3 strategy until 2029 intends to contribute to achieving the "Smarter Europe" cohesion policy goal through innovations, economic transformation, and modernization, as well as industrial transition of regional economies. This aligns with the strategic goals defined by Croatia's National Development Strategy until 2030.

One of the significant aspects of S3 is the focus on maritime activities, which are crucial for Croatia given its extensive coastline and maritime heritage. This includes developing capacities and opportunities in marine-related research, technology, and innovation, leveraging the country's geographical and historical strengths in this sector.

S3 places a significant emphasis on maritime activities, recognizing the importance of the maritime sector to the nation's economy and heritage. Given Croatia's extensive coastline and rich maritime history, the strategy aims to capitalize on these assets to spur innovation and economic growth in marine-related fields. Maritime activities under the S3 framework encompass a broad spectrum of research, technology, and innovation. This includes, but is not limited to, areas like marine biotechnology, maritime engineering, sustainable fisheries, coastal and maritime tourism, marine energy, and marine environmental protection. The focus is on harnessing the maritime sector's potential to drive economic growth, enhance competitiveness, and ensure sustainability. Key components of the maritime focus in Croatia's S3 strategy involve:

- Strengthening marine and maritime research capacities, including advanced technologies in maritime engineering, naval architecture, and sustainable fisheries management. This aims to position Croatia as a leader in marine science and technology.
- Promoting innovation in traditional and emerging maritime industries. This could include developing new maritime products and services, improving shipbuilding techniques, and innovating in the areas of maritime logistics and transport.
- Emphasizing the importance of sustainability in maritime activities, which includes addressing environmental concerns, promoting the use of renewable energy in maritime operations, and ensuring sustainable fisheries and aquaculture practices.
- Enhancing the coastal and maritime tourism sector through innovative approaches. This might involve developing sustainable tourism models, leveraging Croatia's natural and cultural heritage, and improving tourist services and infrastructure.
- Encouraging collaboration between academic institutions, research organizations, and industry stakeholders. This facilitates the sharing of knowledge, pooling of resources, and development of joint initiatives, further strengthening Croatia’s maritime sector.

Funding of research and innovation

The funding for research and innovation in Croatia, particularly through programs spearheaded by HAMAG-BICRO and CSF, illustrates the nuanced approach taken by the country in advancing its scientific and technological capabilities. This approach is reflective of a strategic alignment with European Union frameworks post Croatia's accession to the EU in 2013, highlighting a significant shift in the funding dynamics from primarily national sources to a more balanced mix of national and EU funding.

HAMAG-BICRO, focusing on small and medium-sized enterprises (SMEs) and innovation activities, implements a range of programs that are instrumental in stimulating a culture of innovation and commercialization in Croatia. Some of its key programs include:

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- The Seed and Startup Program, which aims to encourage the development of new innovative products and services in their early stages. This program is vital in providing the necessary capital for high-risk projects, often in the nascent stages of their development.
- The Proof-of-Concept Program, designed to support the initial stages of turning scientific research into marketable products. This program plays a crucial role in bridging the gap between research and market application, facilitating the transformation of theoretical research into practical solutions.
- The Commercialization of Innovations Program, which targets the later stages of innovation development, helping bring mature projects closer to market readiness. This program is significant in ensuring that innovative ideas do not falter in their final stages due to a lack of resources or commercial expertise.
- The Co-investment Fund for Startups, a venture that reflects the increasing role of venture capital in Croatia's innovation landscape. This fund is key in attracting private investments and stimulating a culture of entrepreneurship and venture capital in Croatia.

Figure 2.2 below is indicating sources of funds for R&D in 2022, in Croatia.

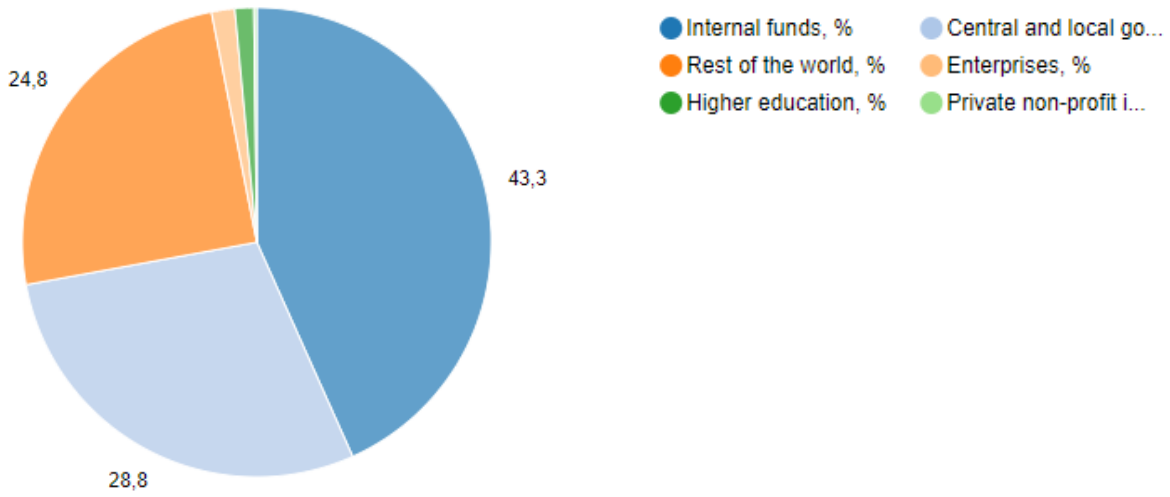

Figure 2.2: G-2 Sources of funds for R&D, 2022 (Croatian Bureau of Statistics, 2023).

On the other hand, the Croatian Science Foundation, primarily supporting fundamental and applied research, administers programs that underpin the scientific research ecosystem in Croatia. Notable among these are:

- The Unity Through Knowledge Fund, which is geared towards connecting the scientific and business communities. This program is central to facilitating collaboration between academia and industry, promoting the transfer of knowledge and innovation.
- The Science for Industry and Society Program, aiming to cultivate research that has direct implications for industry and society. This program underscores the commitment to ensuring that scientific research is not just an academic exercise but has tangible benefits for the broader community.

These programs collectively illustrate the strategic direction of Croatia's research and innovation funding, characterized by a blend of national and EU funding sources. They represent a concerted effort to cover

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the entire spectrum of the innovation cycle, from the early stages of idea generation and proof of concept to the later stages of commercialization and market entry.

Despite these diverse funding mechanisms, Croatia's participation in Horizon 2020-funded programs has been relatively low. This trend is contrasted by a rise in venture capital investments in the country, though these too are largely reliant on public (EU) funding. Such developments indicate a growing dependence on external funding sources for the sustenance and growth of the R&I sector.

However, the current R&I policy mix in Croatia has been identified as suboptimal, necessitating improvements and adjustments. The existing policy, while covering all stages of research and innovation, does not efficiently cater to the varying needs of R&I performers. A notable gap exists in the middle stages of the innovation process, indicating a policy bias towards earlier stages of research and later stages of development. This imbalance poses challenges in developing a cohesive and comprehensive R&I ecosystem that supports all phases of research and innovation equally.

Addressing these challenges, experts recommend a systematic stimulation of public-private cooperation in research and innovation. This involves support for technology transfer, collaborative research with high impact, and applied research and experimental development. Such initiatives are crucial for bridging the existing gaps in the policy mix and ensuring a balanced and effective support system for all stages of innovation and research. Additionally, revising the policy mix to reflect the needs of R&I performers more accurately is seen as an essential step towards the sustainable development of Croatia's research and innovation sector.

Research and innovation by sectors

Croatia's landscape of R&I is a diverse and evolving field, marked by areas of established strength, emerging promise, and sectors where further development is needed.

In the realm of strengths, Croatia is particularly developed in tourism and hospitality. Leveraging its rich cultural heritage and natural beauty, the country has focused on sustainable tourism practices, utilizing digital technologies to enhance visitor experiences, and managing destinations smartly. The emphasis on eco-tourism and cultural richness aligns with global sustainability trends, making this sector a stronghold of Croatian R&I. Another area of traditional strength is the maritime and shipbuilding industry. Croatia's historical maritime prowess has transitioned into modern capabilities, including advanced maritime technologies and specialized ship construction. Croatian shipyards are renowned for their high-quality, custom-built ships, reflecting the country's longstanding maritime tradition. Agriculture and food processing also stand out in Croatia's R&I landscape. With a focus on organic farming and renowned wine production, the sector has seen innovations in agricultural practices and food processing techniques. The integration of biotechnologies and IT solutions in agriculture has further enhanced its competitiveness, positioning Croatia well in these fields.

However, emerging sectors also show significant promise. The Information and Communication Technologies (ICT) sector, for instance, is rapidly gaining momentum. A growing startup ecosystem, supported by a tech-savvy workforce, is propelling advancements in software development and digital solutions. This burgeoning sector reflects Croatia's adaptation to the global digital wave and its potential in ICT. The life sciences and biotechnology sectors are also on the rise, particularly in pharmaceuticals and medical devices. Driven by research institutions and collaborative efforts, this field shows potential for substantial growth, aligning with global health and technological trends. Renewable energy is another emerging area. Croatia's geographical position offers opportunities in solar and wind energy, with R&I

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efforts increasingly focusing on developing sustainable energy technologies. This sector's growth is encouraged by global environmental concerns and EU energy policies.

Despite these strengths and emerging sectors, Croatia faces challenges in certain areas. Advanced manufacturing and robotics, for example, have not reached their full potential compared to other EU countries. Integrating Industry 4.0 technologies and embracing smart manufacturing processes could unlock new opportunities for growth in this sector. Similarly, the aerospace and defence industries, while having latent potential due to Croatia's pool of skilled engineers and historical manufacturing capabilities, require more substantial investment and technological updates to fully realize their potential. Environmental technologies and waste management also present areas for improvement. Despite a growing awareness and commitment to sustainability, Croatia can further develop innovative solutions for effective waste management and environmental conservation, aligning with global environmental standards. Figure 2.3 illustrates R&D performing units, by fields of science.

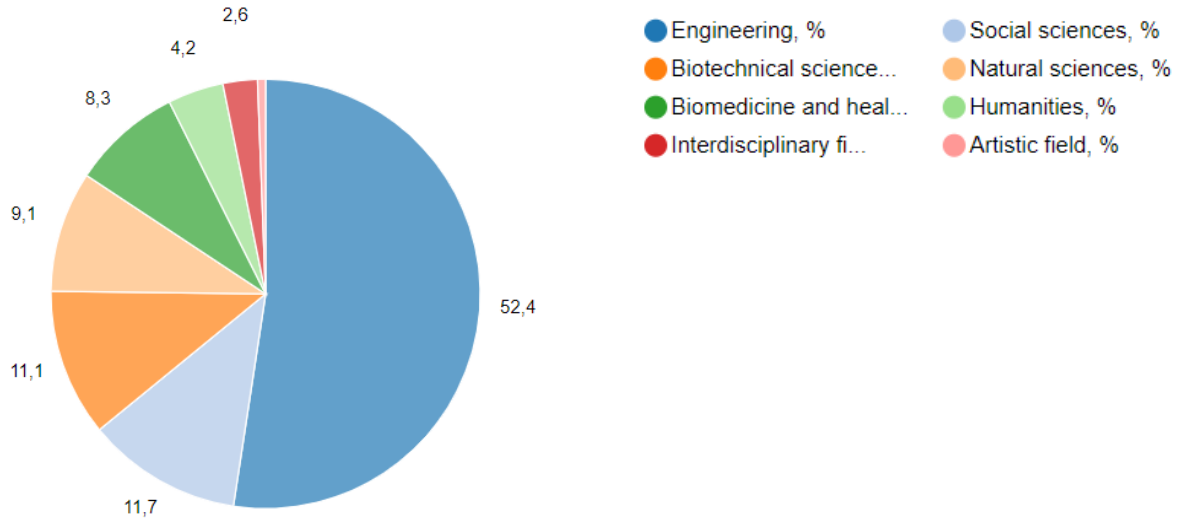

Figure 2.3: G-5 R&D performing units, by fields of science, 2021 (Croatian Bureau of Statistics, 2022).

In summary, Croatia's R&I ecosystem is characterized by a mix of traditional strengths rooted in the country's natural and cultural resources, sectors that are rapidly evolving with technological advancements, and areas that present opportunities for growth through strategic focus and investment. The collaboration of academia, industry, and governmental initiatives, coupled with alignment to European research networks, is key to enhancing Croatia's position in the global R&I arena.

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3 ACTION AND INVESTMENT PLAN

The maritime industry, crucial to both Western Slovenia and Adriatic Croatia, stands on the brink of an innovation-driven transformation. This transformation is guided by the development of an action and investment plan which was stated in 2023 as Commission and Slovenia published an article about enhancing dialogue on Research and Innovation, which aims to nurture a dynamic innovation ecosystem within the maritime sector. The plan recognizes the vast potential for innovation in areas ranging from shipping and logistics to sustainability and safety and seeks to exploit these opportunities to their fullest potential.

There is a keen awareness of the unique R&I systems in Slovenia and Croatia. Both countries boast distinct yet complementary strengths in maritime research and technology development. The Slovenian R&I system, known for its strong technical and engineering prowess, coupled with Croatia's rich maritime heritage and expertise, provides a fertile ground for maritime innovation.

The aim is to create a synergistic environment where these national R&I systems collaborate effectively, stimulating a space where ideas can be exchanged, and innovative solutions can be developed. This collaborative approach will not only bolster regional maritime innovation but also align it with broader European Union strategies, ensuring a sustainable and resilient future for the industry.

Thus, the action and investment plan are more than just a roadmap, it’s a strategic alignment of Slovenia and Croatia’s R&I systems with the industry's needs. It's an invitation to stakeholders across sectors to partake in and contribute to this vision, paving the way for a new era in maritime excellence where innovation leads to sustainable growth and technological advancement.

In shaping the Action and Investment Plan for the INNO2MARE project, one of the paramount components is **Stakeholder Engagement**. This initiative is underpinned by the comprehensive ecosystems' mapping performed as part of Work Package 2, as documented in the INNO2MARE project's Deliverable D2.1. This mapping has been instrumental in identifying and understanding the diverse stakeholders within the Western Slovenian and Adriatic Croatian maritime ecosystems. Stakeholder engagement is key to the success of the INNO2MARE project, with the primary aim of encompassing a broad spectrum of actors from the maritime ecosystem. These stakeholders include, but are not limited to, shipping companies, port authorities, government agencies, research institutions, startups, and investors. Their inclusion in the action plan is critical to ensure a holistic and many-sided approach, addressing the unique challenges and leveraging the varied strengths within these ecosystems. The engagement process acknowledges the complex interplay of various maritime sectors, each bringing distinct perspectives and expertise. This diverse assembly, from logistic specialists to innovators in maritime technology, facilitates a richer, more comprehensive understanding of the ecosystem's needs and aspirations. The inclusion of research institutions and startups is particularly vital in injecting innovation and fresh ideas into the maritime sector, ensuring that the action plan is not only comprehensive but also forward-thinking and aligned with the industry's future trajectory. Furthermore, the mapping process undertaken as part of Work Package 2 has laid a solid foundation for this engagement. It provided an in-depth analysis and visualization of the ecosystem, detailing key stakeholders, their roles, activities, and the collaborative and competitive links within the industry. This has enabled a targeted approach to stakeholder engagement, ensuring that the interactions are meaningful, purpose-driven, and directly relevant to the project's goals. The Action and Investment Plan, therefore, is envisioned as a dynamic, collaborative framework. This collective approach is expected to yield a robust and resilient maritime sector, propelled by shared vision and concerted effort.

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In the pursuit of stimulating a robust maritime innovation ecosystem through the INNO2MARE project, **identification of innovation opportunities** has been a cornerstone of the Action and Investment Plan. This critical component hinges on extensive research and consultations, drawing insights from the dynamic maritime sectors of Western Slovenia and Adriatic Croatia. The aim is to pinpoint and nurture innovation opportunities that could redefine the maritime industry, ranging from the advancement of autonomous shipping technologies to the integration of digital solutions in port operations, the implementation of green shipping initiatives, and the fortification of maritime cybersecurity. The potential for autonomous shipping technologies to revolutionize maritime navigation and operations is immense. These technologies promise enhanced safety, operational efficiency, and a reduction in human error-related incidents, fundamentally transforming the face of shipping. The digitalization of port operations stands as another key innovation opportunity. By embedding digital technologies into the very fabric of port management and logistics, there is a pathway toward streamlined, more efficient operations that can significantly reduce environmental impacts and boost logistical effectiveness. In a world increasingly conscious of environmental impact, these initiatives, which span alternative fuels, energy-efficient ship designs, and sustainable building practices, are crucial for the maritime sector's contribution to global sustainability goals. Furthermore, as maritime operations grow more interconnected and reliant on digital infrastructures, cybersecurity within this sector becomes a pressing concern. Innovations in maritime cybersecurity are vital to safeguard the integrity of maritime operations and protect them against burgeoning cyber threats. By focusing on these specific innovation areas, the INNO2MARE project aligns with the latest technological advancements and market demands, positioning the Western Slovenian and Adriatic Croatian maritime sectors at the forefront of a digitally driven and environmentally conscious maritime future. This strategic approach is designed not only to enhance the efficiency and sustainability of maritime activities but also to bolster their global competitiveness. Thus, these innovation opportunities, identified through collaborative efforts and extensive research, are more than just growth avenues, they represent a leap towards a safer, more efficient, and sustainable maritime industry.

Furthermore, a well-orchestrated **mobilization of resources**, both in terms of finance and human capital is necessary for further development of the innovation ecosystem. At the heart of this initiative is the recognition that a dynamic and resilient innovation environment is fuelled not only by ideas and technologies but also by the requisite investments and expertise to bring these concepts to fruition. As part of the action and investment plan, a key focus is placed on the active pursuit of investments from varied sources. Financial injections are sought both from public entities, such as governmental grants, EU funding programs, and regional development funds, as well as private sector contributions, including venture capital, corporate funding, and private investors. This blend of public and private financing is essential to support a range of activities vital for the maritime innovation ecosystem. These activities include research and development initiatives that push the frontiers of maritime knowledge and technology, incubation programs designed to nurture startup ventures in the maritime domain, and technology demonstration projects that showcase the practical applications of new discoveries and innovations. Additionally, upgrading infrastructure is a key priority. Modern, technologically advanced facilities are fundamental to stimulating an environment where innovation can thrive. Upgrading existing maritime infrastructure and investing in new developments not only facilitates cutting-edge research but also attracts high-profile projects and collaborations, thereby amplifying the ecosystem's capacity for innovation. Beyond financial resources, human capital is the linchpin of any innovation ecosystem. In the context of the INNO2MARE project, considerable effort is devoted to attracting and nurturing top talent in the maritime sector. This involves not only drawing experienced professionals and leading researchers to the region but also investing in the next generation of maritime innovators through education, training, and mentorship programs. By creating opportunities for learning and development, the project aims to cultivate a rich talent pool that can drive future innovations in the maritime sector.

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Building an innovative and entrepreneurial culture is an additional facet of the human resource strategy. This entails stimulating an atmosphere where taking risks is welcomed, innovation is promoted, and teamwork is expected. This kind of culture not only draws bright people to the maritime industry, but it also pushes them to create and execute novel concepts, which feeds the ecosystem of maritime innovation's ongoing development. The action plan for the INNO2MARE project's resource mobilization section employs a thorough strategy that combines financial investment with the development of human capital. Through attracting top personnel and getting finance from various sources for necessary projects and infrastructure upgrades, the project establishes the foundation for a thriving, inventive, and entrepreneurial maritime sector in Western Slovenia and Adriatic Croatia.

As the cornerstone of its action and investment plan, the INNO2MARE project prioritizes the integration of a strong policy and regulatory framework with the goal of encouraging innovation in the marine industry of Western Slovenia and Adriatic Croatia. This strategic approach acknowledges that in addition to significant financial and human capital investments, a supportive regulatory framework is critical to optimizing their effectiveness. To create responsive policies that meet the changing requirements of marine technology and business models, the project prioritizes communication with policymakers and regulatory bodies across several administrative levels, including local and EU-wide.

This program entails putting specific measures into place with the goal of creating a policy environment that not only accepts but actively promotes innovation. The creation of adaptable regulatory frameworks that can accommodate cutting-edge technology like sophisticated energy systems, digital logistics solutions, and autonomous vessels is essential to this quest. Over the next ten years, these technologies are expected to uphold strict safety and environmental sustainability criteria while making a major contribution to significant gains in operating efficiency, estimated at up to 20% within the maritime sector.

Additionally, the plan calls for actions to simplify bureaucratic procedures that frequently obstruct the development and testing of innovative technology, which is especially advantageous for startups and small businesses. It is projected that by streamlining these processes, innovations will have a 30% shorter time to market, which will hasten their adoption in the maritime sector.

One important area of concentration is lobbying for laws that assist research and development in the marine industry, which is in line with the larger goals of the INNO2MARE initiative. The goals are to protect intellectual property rights, make financial opportunities easier to access, and provide incentives for innovative and sustainable maritime solutions. Over the course of the project, it is anticipated that these rules will make it easier to obtain an additional €15 million in funding, creating an atmosphere that is favourable to growth driven by innovation.

To put it simply, the INNO2MARE project's action and investment plan's Policy and Regulatory Framework component is a critical first step in stimulating an atmosphere that cultivates maritime innovation. The project not only strives to improve economic and technological progress in Western Slovenia and Adriatic Croatia, but also makes sure that this progress is safe, secure, and sustainable by aligning policy and regulation with the strategic imperatives of marine innovation. This strategic alignment highlights how crucial it is for the innovation and regulatory domains to work together harmoniously, as this is necessary for the marine industry to remain successful and competitive in the modern day.

3.1 Action 1: Creation of a Virtual Site for Maritime Ecosystem Actors

Below is the table 3.1, describing in detail the first action of the Action and Investment Plan.

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Table 3.1: Virtual site for maritime ecosystem Actors.

Objective	Bridging communication gaps between stakeholders through interoperable digital hubs in Slovenia and Croatia.
Key Features	Stakeholder directory, matchmaking tools, repositories, multilingual access, EU platform integration
Timeline	Design: Q3 2025 – Q4 2026, Launch: Q2 2027
Funding	Digital Europe Programme, EDIH funding, regional funds
ESG	Carbon tracking, accessibility standards, etc.
Expected Results	Establishment of dedicated online hubs that serve as central points for maritime ecosystem actors, providing resources, facilitating networking, and offering e-learning opportunities. This will enhance connectivity and knowledge sharing within the ecosystem, ensuring all identified stakeholders become part of these hubs through a membership declaration. Quarterly meetings will be organized to ensure regular engagement and collaboration.
Responsible Parties	BSC (Slovenia), PRIGODA (Croatia), maritime associations

The action of creating a Virtual Site for Maritime Ecosystem Actors directly addresses a critical gap identified within Work Package 2 in the Croatian and Slovenian maritime ecosystems - the need for systemic and continuous communication among all stakeholders. Currently, the maritime sectors in Croatia and Slovenia face challenges in maintaining a consistent and structured dialogue between its key players, notably companies, academia, research institutions, and the public sector. The smooth flow of information, teamwork on innovative prospects, and the efficient transfer of knowledge and technology are all hampered by this communication gap.

This initiative seeks to close these gaps in communication by creating specialized virtual hubs run by PRIGODA for Adriatic Croatia and BSC for Western Slovenia. This will allow for a more cohesive and cooperative environment. In addition to promoting continued communication, these hubs will strengthen alliances and collaborate on projects, all of which are essential for the development and long-term viability of the maritime industries in both nations.

Improving cooperation and communication between the Croatian and Slovenian marine systems is equally crucial. The establishment of Virtual Sites for Maritime Ecosystem Actors breaks down geographical boundaries by offering cohesive hubs that facilitate seamless interaction between Slovenian and Croatian stakeholders. These online centers will play a critical role in coordinating the activities and endeavors of both ecosystems. Through the provision of access to common resources, research outcomes, and technology advancements, the hubs will guarantee that interested parties in both nations are not only aware of developments but also actively involved in cooperative endeavors.

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By providing integrated, interactive, and user-friendly interfaces, the hubs will streamline communication, making it more efficient and effective. In essence, these virtual sites will not only bridge gaps within the Croatian and Slovenian maritime ecosystems but also pave the way for a more cohesive and synergistic relationship. The result will be enhanced ecosystems where innovation, collaboration, and shared growth are not just possibilities but realities.

The Virtual Sites for Maritime Ecosystem Actors must be equipped with key functionalities to serve their purpose effectively. Primarily, they should host comprehensive repositories of training materials developed for the maritime ecosystem. These repositories would be centralized knowledge bases, offering easy access to educational resources, best practices, case studies, and research findings, crucial for upskilling and continuous learning.

The Virtual Sites for Maritime Ecosystem Actors are much more than just information repositories thanks in large part to the addition of real-time communication and collaboration facilities. The sites become dynamic platforms for stakeholder interaction when they incorporate features like video conferencing and forums. These instruments are essential for bridging geographic divides and facilitating easy communication and cooperation between Slovenian and Croatian participants in the maritime ecosystem.

The websites should also have databases of interested parties that list important participants in Slovenian and Croatian maritime ecosystems together with thorough biographies and areas of specialization. Finding possible mentors, collaborators, and partners would be made easier by doing this. Furthermore, the sites should offer news and updates sections, providing the latest information on maritime trends, policy changes, funding opportunities, and upcoming events. This will ensure all stakeholders are well-informed and can take timely advantage of emerging opportunities.

The planning and execution of roundtables, stakeholder consultations, and conferences centered on marine innovation is a significant usage for these capabilities. These online gatherings become far more inclusive and approachable, enabling increased involvement from different marine community sectors. Stakeholders can actively participate in these events and offer their knowledge and ideas, even if they would otherwise be limited by geography or resources. These tools also make it possible for events to be streamed live, which promotes participation in real time and prompt feedback—two things that are crucial for creating an environment that is responsive and collaborative for innovation.

All materials can be submitted straight to the websites after the event, including presentations, video recordings, discussion summaries, and any other resources. This guarantees that the information is easily available to all parties involved and produces an archived version of the event that can be used for research and analysis in the future. The sites guarantee stakeholder alignment and facilitate the sharing of best practices, policy updates, and creative breakthroughs in the marine industry by making this information easily accessible on the hubs. As stakeholders may review materials at their convenience and start follow-up conversations or partnerships based on the insights gleaned, it also encourages ongoing involvement and debate after the event.

Costs

Establishing and maintaining the Virtual Sites for Maritime Ecosystem Actors involves key cost items, including the initial costs for website design, development, software licensing, content creation, server hosting, domain registration, and cybersecurity measures. Ongoing costs encompass web hosting renewals, software maintenance, content management, technical support, user engagement, and organization of quarterly meetings for stakeholders.

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3.2 Action 2: Designing Training Programmes for Maritime Ecosystem Stakeholders

Below is the table 3.2, describing in detail the second action of the Action and Investment Plan.

Table 3.2: Training programmes for maritime ecosystem stakeholders.

Objective	Deliver modular training aligned with green, digital, and entrepreneurial needs.
Key Features	Micro-credentials, hybrid delivery, EU-aligned certification, mentorship
Timeline	Dev: Q1 2026, Pilot: Q2 2026, Rollout: Q1 2027
Funding	Erasmus+, private co-financing, innovation grants, government educational programs, private sector sponsorship, industry contributions, educational grants, and corporate sponsorships.
ESG	Diversity metrics, low-carbon delivery, ?
Expected Results	The anticipated outcome is a many-sided, skilled workforce adapted in modern maritime technologies and practices. This includes proficiency in digital and green technologies, a deep understanding of sustainable practices in maritime contexts, and enhanced skills in entrepreneurship and leadership. Such training programs aim to elevate the overall standard of the maritime industry, stimulating innovation and sustainability.
Responsible Parties	Maritime universities, training centers, UNIRI, UL, ZOTKS, CTK RIJEKA

The action to develop training programs for maritime ecosystem stakeholders in Slovenia and Croatia is set to bridge a significant gap in the current workforce's competencies, while simultaneously preparing the next wave of professionals entering the field. This gap lies in the existing misalignment between the current workforce's skill set and the rapidly evolving technological and environmental demands of the maritime industry. Despite having a foundation in traditional maritime operations, the current workforce may not be fully equipped with the latest digital proficiencies or green practices that are becoming increasingly integral to modern maritime business models. As such, there is an imperative to not only modernize educational institutions for upcoming professionals but also to provide upskilling and retraining opportunities for those already within the maritime sector. This action of crafting targeted training programs aims to create pathways for continuous professional development, allowing the existing workforce to adapt to and adopt new technologies and sustainable practices. These programs will serve as a conduit for ongoing education, offering modules on the latest advancements in digitalization, automation, and eco-friendly maritime operations. The initiative is not only about enhancing the technical know-how of the workforce but also about stimulating a culture of lifelong learning within the maritime industry. By investing in the development of a skilled workforce that is attuned to the current and emerging trends, Slovenia and Croatia can ensure that their maritime sectors

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remain competitive, innovative, and sustainable. The expected outcome is a holistic elevation of the entire maritime ecosystem, characterized by a workforce that is proficient, adaptable, and forward-looking.

Workforce Training in Digital and Green Technologies

Workforce Training in Digital and Green Technologies is a critical action that aims to equip various stakeholders within the maritime industry with the necessary skills to navigate the burgeoning demands of the sector. This training should encompass a broad spectrum of participants, including but not limited to, operational staff, engineers, management teams, policymakers, and even members of the logistics and supply chain networks associated with maritime operations.

The subjects of these trainings should be comprehensive and future-oriented, covering areas such as advanced automation, AI and data analytics, IoT for maritime applications, green propulsion technologies, energy efficiency, waste management, and the implementation of international environmental regulations like MARPOL Annex VI. Other crucial topics may include digital security practices, emergency response to maritime incidents, and understanding the global trends towards decarbonization.

Regarding the frequency and delivery format of these trainings, it would be prudent to organize them in a staggered and continuous manner to ensure the workforce can integrate new knowledge without significant downtime. Quarterly training sessions could provide a balance between knowledge acquisition and practical application. To accommodate the varied schedules and locations of participants, a hybrid model that combines online learning with in-person workshops should be considered. Online modules offer flexibility and scalability, while in-person sessions can facilitate hands-on experience and cultivate teamwork.

A curriculum might be broken down into several modules, each focusing on specific skills and competencies. For example, a foundational module could cover the basics of maritime digital technologies, followed by intermediate modules on specific applications, and advanced modules focusing on integration and innovation in maritime processes.

Maritime Entrepreneurship, Leadership and End users of new technologies Training Programs

Maritime Entrepreneurship and other Training Programs are essential to nurturing the innovative spirit and guiding vision that will propel the maritime sector into the future. These programs are designed to be inclusive, targeting a wide range of stakeholders who are in positions to influence and drive change within the industry. Participants should include emerging entrepreneurs in the maritime industry, mid-level managers, executives at shipping companies, port authorities, logistics and supply chain managers, as well as policymakers who can shape the future of maritime regulations.

The curriculum for these trainings should be diverse, encapsulating core concepts of entrepreneurship such as opportunity recognition, business plan development, startup financing, and scaling businesses. Leadership modules should focus on strategic decision-making, change management, team building, cross-cultural communication, and ethics in leadership. Given the unique challenges of the maritime sector, a specialized focus on maritime law, international regulations, and the global economic impact of maritime trade would be highly beneficial.

In terms of frequency and mode of delivery, the training should be structured to allow for regular intervals, potentially semi-annually or annually, to keep pace with the fast-evolving maritime sector. The modality of the training could be hybrid, making use of both online modules for theoretical learning and

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in-person sessions for practical, interactive workshops. This blend would cater to a geographically dispersed workforce and leverage the benefits of face-to-face networking and collaboration.

Mentorship could be a key component of these programs, with seasoned industry veterans and successful maritime entrepreneurs providing guidance, sharing experiences, and facilitating connections. These mentors can play a key role in helping participants navigate the complexities of the maritime industry and in encouraging the practical application of their learning.

The training might be structured into a series of modules, beginning with foundational entrepreneurship and leadership concepts before moving into more advanced, maritime-specific topics. Each module could span several weeks, with participants engaging in case studies, group discussions, and project work that culminates in a presentation or capstone project.

Post-training activities

Each training session should culminate in a certification or credential that recognizes the participant's newly acquired skills, incentivizing the learning process and providing a tangible benefit to their professional development. To further encourage participation, these training programs could be recognized as part of mandatory professional development requirements where applicable.

Continual assessment and evolution of the training content are essential to ensure relevance and effectiveness. Feedback mechanisms should be implemented to gather participant input, which can be used to refine and update the training modules.

Costs

Organizing training programs in Maritime Entrepreneurship, Leadership, and Green Technologies requires careful financial planning to cover essential expenses. These include developing up-to-date curriculums, securing expert instructors and mentors, and setting up reliable digital hubs for online learning. Physical training sessions necessitate venue hire, while equipment costs ensure interactive and engaging sessions. Marketing initiatives are crucial for attracting a wide range of participants. Administrative efforts underpin the smooth enrolment and management of the courses. For trainers and attendees who need to travel, appropriate provisions for travel and accommodations are made.

3.3 Action 3: Cross-Border Maritime R&I Collaborative Projects

Below is the table 3.3, describing in detail the third action of the Action and Investment Plan.

Table 3.3: Cross-Border Maritime R&I Collaborative Projects.

Objective	Establish cross-border R&I labs for applied innovation in green and digital tech.
Key Features	Joint teams, shared IP, pilots, SME R&D calls
Timeline	Set-Up: Q2–Q4 2026, 1st Pilot: Q2 2027

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Funding	Horizon Europe, Digital Europe programme, Interreg, industry match-funding…
ESG	Sustainability impact assessments
Expected Results:	Enhanced cross-border collaboration, joint maritime R&I projects.
Responsible Parties	Universities, innovation agencies, SMEs

In the context of the development of the maritime innovation ecosystem, initiating Cross-Border Maritime R&I Collaborative Projects between Croatian and Slovenian stakeholders is a strategic action of considerable importance. This initiative stands as a catalyst for enhancing regional cooperation, pooling resources, and harmonizing maritime R&I efforts across the Adriatic border.

The significance of this action lies in its potential to drive synergies and innovations that are greater than the sum of individual national efforts. Collaborative projects offer a hub for sharing unique expertise, insights, and technologies between Croatia and Slovenia, stimulating a unified approach to maritime challenges. These collaborations can address a wide range of issues from environmental sustainability, digital transformation in maritime logistics, to advancements in shipbuilding technology and maritime safety protocols.

To initiate these cross-border R&I projects, the first necessary step is the establishment of a formal framework for collaboration. This framework should outline the scope, objectives, and governance structure of the collaborative efforts, ensuring clear understanding and agreement among all parties involved. Building on this framework, an effective communication channel needs to be established to facilitate regular interaction and coordination between Croatian and Slovenian maritime stakeholders.

Another key action is the identification and prioritization of research areas and projects that hold mutual interest and promise significant impact for both countries. This might involve joint workshops and brainstorming sessions to identify pressing maritime challenges and potential innovative solutions.

Engagement with existing EU funding mechanisms is crucial for the realization of these collaborative projects. Programs like Horizon Europe, particularly the clusters relevant to maritime research and innovation, present ideal opportunities for funding these cross-border initiatives. Other EU initiatives like INTERREG and the European Maritime and Fisheries Fund (EMFF) could also be instrumental in supporting such projects.

In addition, setting up a joint project management team with representatives from both countries can ensure balanced participation and effective oversight. This team would be responsible for project planning, execution, monitoring, and dissemination of results.

Moreover, establishing a framework for intellectual property rights and data sharing is vital to encourage openness and protect the interests of all parties involved. This framework should address issues related to joint ownership, use, and dissemination of research outcomes.

To maximize impact, these collaborative projects should not only focus on technological innovations but also consider the socio-economic aspects of the maritime industry, including workforce development, policy implications, and environmental sustainability.

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In summary, Cross-Border Maritime R&I Collaborative Projects between Croatian and Slovenian stakeholders represent a strategic and impactful action within the INNO2MARE project. By stimulating regional cooperation, harmonizing R&I efforts, and leveraging EU funding opportunities, these projects can significantly contribute to the advancement of the maritime sector, benefiting both nations and aligning with broader European maritime goals.

Costs

The action of Cross-Border Maritime R&I Collaborative Projects involves financial considerations such as the facilitation of joint research activities, which requires funding for research personnel, technical resources, and materials. There are also administrative costs for project coordination and management across different regions and organizations. Significant investment is needed for the development of shared technology hubs or laboratory spaces, as well as travel and accommodations to enable face-to-face meetings and workshops for project teams. Moreover, dissemination of research findings through conferences, publications, and intellectual property management can incur additional expenses.

3.4 Action 4: Maritime Industry and Academic Exchange Programs

Below is the table 3.4, describing in detail the fourth action of the Action and Investment Plan.

Table 3.4: Maritime Industry and Academic Exchange Programs.

Objective	Enable research residencies and reciprocal knowledge exchange between academia and industry.
Key Features	Placements, reverse mobility, memorandum of understanding
Timeline	Design: Q3 2026, Launch: Q1 2027, Framework: Q3 2027
Funding	EU funding programs, such as: European Social Fund, Erasmus+
ESG	Gender/nationality equity, offsetting mobility emissions
Expected Results	Increased industry-academia collaboration, knowledge, and technology transfer.
Responsible Parties	UNIRI, UL, companies, hubs

The action of establishing Maritime Industry and Academic Exchange Programs is geared toward addressing a multi-layered gap in the innovation lifecycle within the maritime sector of Slovenia and Croatia. Despite active research and development efforts, there exists a notable divide between the conceptual phase of maritime sciences and the actual deployment and commercialization of these innovations in the market. Currently, a chasm often exists following the pilot phase of a project, where promising innovations face the challenge of scaling up and achieving market viability. This hurdle can be attributed to a lack of seamless integration between the research capabilities of universities, the business

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acumen of companies, and the support structures provided by incubators. Maritime Industry and Academic Exchange Programs aim to bridge this gap by stimulating a stronger, more organic collaboration between academia and the maritime industry. By encouraging a symbiotic exchange of knowledge, resources, and expertise, these programs can help ensure that R&D efforts are not only theoretically sound but are also practically applicable and market ready. Such exchange programs can provide researchers and academics with insights into the commercial challenges and operational constraints faced by the maritime industry, thereby directing research efforts towards tangible, market-driven solutions. Conversely, maritime companies can benefit from access to cutting-edge research, innovative methodologies, and fresh perspectives from the academic world.

Maritime Industry and Academic Exchange Programs cultivate a more integrated maritime innovation ecosystem. The essence of these exchange programs lies in their potential to forge strong, mutually beneficial partnerships between academic institutions and the maritime industry. To facilitate this, the programs should be designed with a focus on practical experience and knowledge sharing, allowing for the immersion of participants in both the theoretical underpinnings of maritime sciences and the practical realities of the industry.

For academic participants, this could include internships at maritime companies, engaging in hands-on project work, and attending industry-led seminars and workshops. For industry professionals, the exchange could involve attending specialized courses at academic institutions, participating in research projects, or engaging in collaborative R&D initiatives hosted by universities.

Incorporating the industry into these programs is critical. This could be achieved through partnerships where companies provide real-world problems for academic research, host academic personnel within their operations, and co-develop training modules that reflect the current industry needs. In turn, academic institutions could offer bespoke courses tailored to the industry's emerging trends and technologies and provide research insights that can drive innovation within the companies.

Key institutions and organizations to be included are maritime universities and faculties, such as the University of Rijeka's Maritime Faculty and the University of Ljubljana, as well as industry associations like the Croatian Shipbuilders Association and prominent maritime companies within both countries. Moreover, innovation hubs and incubators should play a part in facilitating the translation of research into market-ready solutions.

Funding for these exchange programs could be sourced from the academic institutions' own budgets dedicated to industry collaboration, as well as from industry sponsorships that view these exchanges as investments in future innovation. These programs are expected to result in increased industry-academia collaboration, with a vibrant transfer of knowledge and technology, equipping both sectors with the insights and tools necessary for pioneering advancements in the maritime domain.

Ultimately, the success of these Maritime Industry and Academic Exchange Programs will depend on their ability to address the specific needs of both the academic and industrial partners, bridging the gap between research and practical application, and establishing a steady flow of innovative solutions into the maritime market.

Costs

The costs associated with Maritime Industry and Academic Exchange Programs encompass the design and administration of the program, which includes planning, coordination, and management by dedicated teams. Funding is also required for the logistics of the exchange, such as travel,

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accommodation, and living expenses for participants. There is the need for resources to develop tailored training materials and modules that reflect the current industry needs, and potentially, costs for special events like workshops, seminars, and networking functions that facilitate direct interaction between industry and academic participants. Additionally, investment into marketing the program to ensure maximum participation and impact, as well as monitoring and evaluation mechanisms to assess the program's effectiveness and adapt for future iterations, are essential.

3.5 Action 5: Public Awareness Campaigns on Maritime Sustainability

Below is the table 3.5, describing in detail the fifth action of the Action and Investment Plan.

Table 3.5: Public Awareness Campaigns on Maritime Sustainability.

Objective	Run public campaigns to increase maritime sustainability awareness.
Key Features	Docs, exhibitions, youth outreach, awards
Timeline	Start: Q4 2027 Annual Themes by 2030
Funding	LIFE Programme, public education funds
ESG	Awareness KPIs, youth engagement
Expected Results:	Enhanced public awareness of maritime sustainability issues, increased community engagement.
Responsible Parties	ZOTKS, BSC, PRIGODA

Public Awareness Campaigns on Maritime Sustainability play a crucial role in educating and engaging communities about the importance of preserving marine ecosystems and promoting sustainable practices within the maritime industry. These campaigns offer numerous benefits, including raising public consciousness about the environmental challenges facing oceans, stimulating a sense of responsibility and stewardship among citizens, and empowering individuals to act towards marine conservation.

The campaigns will include a variety of outreach activities designed to reach diverse audiences. This may involve educational workshops and seminars in schools and community centres, where participants can learn about marine biodiversity, pollution, overfishing, and other pressing issues. Interactive exhibitions and public events held at coastal areas or maritime festivals can further amplify the message, allowing people to directly engage with experts, view demonstrations, and participate in hands-on activities.

In addition to offline initiatives, digital hubs will be leveraged to extend the campaign's reach. Social media campaigns, online webinars, and educational videos can disseminate information widely, engaging younger audiences and those who may not have access to traditional outreach channels. Collaborations with media outlets, influencers, and maritime-related organizations can help amplify the campaign's message and reach a broader audience.

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The frequency and duration of the campaigns will vary depending on the specific objectives and resources available. However, regular, and sustained efforts are essential to maintain momentum and drive lasting behavioural change. Initial campaigns may be launched as part of broader awareness-raising initiatives, with follow-up activities scheduled periodically to reinforce key messages and track progress towards behavioural shifts.

To ensure the success of these campaigns, robust planning and coordination are necessary. This includes developing engaging and culturally relevant campaign materials, training outreach teams to effectively communicate with diverse audiences, and securing collaborations with media partners to maximize visibility. Furthermore, ongoing evaluation and feedback mechanisms will be implemented to assess the campaigns' impact, refine messaging strategies, and adapt approaches based on community feedback and evolving sustainability priorities.

Overall, Public Awareness Campaigns on Maritime Sustainability serve as powerful tools for stimulating a collective sense of responsibility and inspiring actionable change towards a more sustainable future for our oceans and coastal communities.

Costs

The costs related to Public Awareness Campaigns on Maritime Sustainability include expenses for campaign materials such as brochures, posters, and educational resources, as well as for hiring outreach teams and collaborating with media outlets. Other costs may include venue rentals for workshops and events, travel expenses for outreach teams, and fees for digital advertising and social media promotion. Additionally, funds may be allocated for the development and maintenance of campaign websites or online hubs.

3.6 Action 6: Innovation Competitions and Hackathons

Below is the table 3.6, describing in detail the sixth action of the Action and Investment Plan.

Table 3.6: Innovation Competitions and Hackathons.

Objective	Conduct challenge-driven sprints to generate solutions for pressing maritime issues.
Key Features	Bootcamps, mentoring, EU exposure for winners
Timeline	Cycle 1: Q1 2028, Cycle 2: Q3 2029
Funding	Innovation Norway, sponsors, BlueInvest
ESG	Green innovation judging criteria
Expected Results:	Generation of innovative ideas and solutions, engagement of the tech community.
Responsible Parties	Digital hubs, accelerators, EDIHs, clusters

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Innovation Competitions and Hackathons will be meticulously organized events, typically spanning a defined timeframe, ranging from a few days to several weeks, depending on the complexity of the challenges being addressed. These events will be hosted in collaboration with tech companies, universities, and innovation hubs, serving as focal points for bringing together a diverse array of participants, including software developers, engineers, designers, entrepreneurs, and domain experts from the maritime industry.

The format of these competitions and hackathons will vary based on the objectives and scope of the challenges being tackled. Participants may work individually or in teams, with access to cutting-edge technology hubs, development tools, and data sets relevant to the maritime domain. The events may kick off with keynote presentations or workshops, providing participants with insights into the specific challenges and opportunities within the maritime sector. Throughout the event, mentors and subject matter experts will be available to provide guidance, feedback, and technical support to the participants as they develop their solutions.

Participants will be tasked with addressing real-world challenges faced by the maritime industry, spanning a wide range of areas such as maritime logistics optimization, environmental sustainability, safety and security, digitalization, and emerging technologies like autonomous vessels and renewable energy integration. The solutions developed during these competitions may take the form of software applications, hardware prototypes, data analytics algorithms, or innovative business models.

The results of Innovation Competitions and Hackathons will be many-sided. Firstly, participants will present their solutions to a panel of judges composed of industry experts, academics, and corporate sponsors, who will evaluate the projects based on criteria such as innovation, feasibility, scalability, and potential impact. Winning teams or individuals may receive prizes, recognition, and opportunities for further development and implementation of their ideas.

Moreover, these events serve as catalysts for stimulating collaboration, networking, and knowledge exchange among participants, enabling them to learn from each other's experiences, explore new technologies and methodologies, and forge partnerships that extend beyond the duration of the event. The solutions developed during Innovation Competitions and Hackathons have the potential to drive tangible improvements within the maritime industry, ranging from optimizing operational efficiencies and reducing environmental footprints to unlocking new business opportunities and enhancing safety and security standards. Overall, these events play a vital role in energizing the innovation ecosystem, inspiring creativity, and accelerating progress towards a more sustainable and technologically advanced maritime sector.

Costs

The costs related to Innovation Competitions and Hackathons include expenses for event organization, venue rental, technical infrastructure such as software development tools and data access, prizes and incentives for participants, and staffing costs for organizing teams, mentors, and judges. Additionally, marketing, and promotional expenses to attract participants and sponsors, as well as catering and logistics costs for the duration of the event, may also be incurred.

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4 ESTABLISHING THE MONITORING

4.1 Objectives and Goals

The primary objective of establishing a monitoring framework for the maritime innovation ecosystems in Slovenia and Croatia is to create a systematic and comprehensive approach to track, evaluate, and enhance the performance and impact of various strategic initiatives within these sectors. This involves the establishment of clear, measurable, and achievable goals that align with the overarching aim of stimulating innovation, sustainability, and competitiveness in the maritime and nautical industries.

It is seen from the Green Deal adopted by the European Commission that one of the foremost goals of this monitoring framework is to promote the widespread adoption of advanced digital and green technologies. As the maritime industry evolves, integrating digital solutions such as automation, big data analytics, and Internet of Things (IoT) technologies will be crucial for optimizing operations, enhancing safety, and improving overall efficiency. Similarly, adopting green technologies, such as hybrid and electric propulsion systems, energy-efficient designs, and renewable energy sources, is also essential for reducing the environmental footprint of maritime activities, as seen from IMO Strategy on reduction of GHG emissions from ships. The framework aims to closely monitor the progress of these technological transitions, ensuring that both Slovenia and Croatia not only meet their sustainability targets but also enhance their competitiveness in the global maritime market.

The monitoring framework's continued cross-border cooperation between Slovenian and Croatian marine stakeholders is another essential objective. Through the development of a unified and integrated innovation ecosystem, the framework seeks to capitalize on the distinct advantages and skills of both countries. This entails fostering knowledge sharing, facilitating cooperative research and development (R&D) projects, and establishing connections between research centres, academic institutions, and the maritime industry. The framework aims to foster an innovative culture that benefits the entire region and propel technological progress through these cooperative efforts.

The monitoring framework is also committed to helping the maritime industry build a highly skilled workforce. The demand for experts with knowledge of digital technology, sustainable business practices, and innovative manufacturing procedures is rising as the industry develops. The framework's objective is to track how well different workshops and training courses that improve these abilities are working to prepare the workforce for the needs of an industry that is changing quickly. This entails monitoring participation rates, rating skill development, and analysing the total effect of these training programs on industry performance and worker preparedness.

Apart from these principal objectives, the framework for monitoring also aims to guarantee the ongoing enhancement and flexibility of the strategic endeavours. This entails frequent evaluations and modifications in response to input, new trends, and changing market demands. The framework can guarantee that the implemented plans stay pertinent, efficient, and in line with regional and national priorities by upholding a flexible and adaptable approach.

The goal of creating a strong monitoring framework is to lay the groundwork for Slovenia and Croatia's maritime and nautical industry to continue growing and developing. Both nations can strengthen their leadership roles in the international marine industry and promote innovation, economic growth, and sustainable development in their respective regions by firmly establishing and pursuing these objectives and goals. The maritime industries benefit greatly from this strategic focus, which also greatly advances

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the larger economic and environmental objectives of the European Union and the international community.

4.2 Key Performance Indicators

To properly monitor and assess the development and effects of projects within the Slovenian and Croatian marine innovation ecosystems, Key Performance Indicators (KPIs) must be identified. KPIs are quantifiable benchmarks that offer insightful information about how different strategic initiatives are doing. This information helps stakeholders make decisions and modifications to maximize results. The main KPIs that will be used to monitor the growth and prosperity of the maritime and nautical sectors in both nations are described in this section.

The adoption and integration of cutting-edge digital technology in the maritime industry is the subject of one main group of KPIs. These metrics include the quantity of data analytics used, the number of digital solutions put into practice, the level of automation in operations, and the incorporation of Internet of Things (IoT) technology. By keeping an eye on these KPIs, you may gain insights into how the sector is changing digitally, highlighting areas of success, and pointing out any gaps that could need more work. Furthermore, monitoring the amounts spent on technological advancements and digital infrastructure would make it easier to gauge how committed players are to creating a digitalized maritime environment.

Another crucial area of attention is environmental sustainability, and the KPIs pertaining to green practices and technology are essential for tracking advancements in this field. Crucial metrics encompass the decline in carbon emissions resulting from marine operations, the proportion of ships equipped with electric or hybrid propulsion systems, and the pace at which renewable energy sources are integrated into port operations. Moreover, observing waste management procedures, energy efficiency enhancements, and adherence to global environmental norms will offer a thorough understanding of the industry's environmental performance. These KPIs are crucial for ensuring that Slovenia and Croatia are actively reducing their environmental footprint and in line with global sustainability targets.

The strategic objectives of the maritime industries in both nations are centred on cooperation and innovation. KPIs in this domain include the quantity of cooperation agreements between industry and academics, the number of joint research and development (R&D) projects that are started, and the scope of knowledge exchange programs. Monitoring these metrics will demonstrate the efficacy of initiatives to foster a cooperative innovation ecosystem, highlighting fruitful collaborations and pinpointing chances for additional cooperation. Furthermore, quantifying the results of research and development (R&D) endeavours, including the quantity of patent applications, novelties created, and technologies brought to market, would offer a precise image of the innovation environment in the maritime sectors. The table 4.1 below indicated KPIs for Monitoring Maritime Innovations.

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Table 4.1: Key Performance Indicators (KPIs) for Monitoring Maritime Innovations.

KPI	Indicator	Monitoring Method
Digital Technology Adoption	Number of digital solutions implemented	Survey among industry stakeholders
Environmental Sustainability	Reduction in CO2 emissions	Measurement of emissions in ports
Innovation and Collaboration	Number of patents and joint projects	Review of research reports and patents
Workforce Development	Number of training programs and workshops	Survey on satisfaction and success rates

Workforce development is another crucial aspect monitored through specific KPIs. These due to the European Maritime Safety Agency (EMSA) include the number of training programs conducted, participation rates in skill development workshops, and the levels of skill acquisition among maritime professionals. Assessing the impact of these educational initiatives on workforce readiness, job satisfaction, and career advancement opportunities will ensure that the industry is equipped with a skilled and adaptable workforce. Furthermore, tracking employment rates, job creation statistics, and career progression within the maritime sectors will provide valuable insights into the socio-economic benefits of these initiatives.

Economic performance indicators are also vital for evaluating the overall impact of the maritime and nautical industries on the national economies of Slovenia and Croatia. Key economic KPIs include the contribution of the maritime sector to Gross Domestic Product (GDP), the value of maritime exports and imports, and the levels of investment attracted to the sector. Additionally, monitoring the growth of maritime-related businesses, the volume of cargo handled by ports, and the performance of nautical tourism will offer a comprehensive view of the economic health and growth prospects of these industries.

In summary, the identification and monitoring of Key Performance Indicators are fundamental to the success of the maritime innovation ecosystems in Slovenia and Croatia. By tracking progress across digital adoption, environmental sustainability, collaboration and innovation, workforce development, and economic performance, stakeholders can ensure that strategic initiatives are effectively implemented and yield the desired outcomes. These KPIs will serve as critical tools for guiding decision-making, optimizing resource allocation, and driving continuous improvement, ultimately enhancing the competitiveness and sustainability of the maritime and nautical industries in both countries.

4.3 Alignment with Strategies

Ensuring that the monitoring framework aligns with European Union (EU), regional, and national strategies is crucial for the success of the maritime innovation ecosystems in Slovenia and Croatia. This alignment guarantees that the initiatives undertaken are in harmony with broader policy goals, thereby maximizing the impact and sustainability of the projects. This section outlines the key aspects of alignment with various strategies, detailing how the maritime innovation efforts are integrated with EU policies, regional development plans, and national strategic frameworks.

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Adherence to the European Green Deal is crucial at the EU level. The European Green Deal establishes aggressive goals for cutting greenhouse gas emissions, improving energy efficiency, and encouraging environmentally friendly practices in all industries, including the maritime one. KPIs that track the development of these goals—such as the decrease in carbon emissions from marine operations, the integration of green technology in port operations and shipbuilding, and the deployment of environmentally friendly maritime transportation options—will be included in the monitoring framework. Slovenia and Croatia may guarantee that their maritime sectors support the EU's broad objectives of climate neutrality and environmental sustainability by joining the European Green Deal.

Additionally, promoting a contemporary, competitive marine industry depends on connection with the EU's Digital Strategy. Through improving connectivity, developing digital skills, and integrating digital technology across a range of industries, the Digital Strategy seeks to advance digital transformation throughout Europe. Indicators pertaining to the uptake of digital solutions, the application of automation and data analytics in maritime operations, and the growth of digital infrastructure at ports will all be monitored by the framework. By enhancing efficiency and competitiveness in respective maritime industries, this alignment will assist Slovenia and Croatia in maintaining their leadership positions in digital innovation.

Regional development strategies also play a critical role in shaping the maritime innovation ecosystems. Both countries are part of the EU's Adriatic-Ionian Initiative, which aims to promote economic growth and regional cooperation in the Adriatic-Ionian region. The monitoring framework will include KPIs that measure the success of cross-border collaborations, joint research and development projects, and regional investment initiatives. By aligning with regional strategies, Slovenia and Croatia can leverage synergies with neighbouring countries, enhancing the impact of their innovation efforts, and stimulating a more integrated regional maritime economy.

At the national level, the alignment with Slovenia's and Croatia's respective maritime strategies is crucial. Slovenia's National Maritime Strategy and Croatia's Maritime Development and Integrated Maritime Policy provide comprehensive frameworks for the sustainable development of their maritime sectors. The monitoring framework will track progress in areas such as maritime safety, infrastructure development, environmental protection, and workforce training, ensuring that national priorities are addressed. This alignment will support the effective implementation of national policies, driving sustainable growth and innovation in the maritime industries.

Moreover, alignment with national innovation strategies is essential for developing a robust innovation ecosystem. Both Slovenia and Croatia have national innovation strategies that emphasize the importance of research and development, technology transfer, and collaboration between academia and industry. The monitoring framework will include indicators that measure the effectiveness of innovation initiatives, the level of investment in research and development, and the success of technology commercialization efforts. By aligning with national innovation strategies, the maritime sectors in both countries can enhance their capacity for innovation, driving long-term growth and competitiveness.

For Slovenia's and Croatia's marine innovation ecosystems to succeed, the monitoring framework must be in line with national, regional, and EU policies. This alignment increases the programs' impact and sustainability by ensuring that they are in line with more general policy objectives. Slovenia and Croatia can guarantee that their maritime sectors contribute to the accomplishment of important policy goals, fostering sustainable growth and innovation in the region, by adding pertinent KPIs and monitoring progress towards strategic objectives. In the end, this strategic alignment will help both nations' maritime industry grow to be vibrant, competitive, and sustainable.

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4.4 Data Sources

Identifying relevant data sources for monitoring the progress and impact of maritime innovation initiatives is a critical step in establishing a strong monitoring framework. Effective data collection requires a comprehensive understanding of the various sources that provide accurate and timely information about the maritime and nautical industries in Slovenia and Croatia. This section explores the primary data sources that will be utilized to track key performance indicators (KPIs) and monitor the success of the strategies implemented. The table 4.2 below indicates key data sources for monitoring maritime innovation initiatives.

Table 4.2: Key Data Sources for Monitoring Maritime Innovation Initiatives.

Data Source	Type of Data	Collection Frequency
Government Agencies and Regulators	Statistical data, traffic and safety reports	Annually, quarterly
Port Authorities	Traffic data, environmental impacts	Monthly, quarterly
Industry Associations	Market trends, innovation activities	Annually
Academic and Research Institutions	Research data, technology studies	Continuously
International Organizations	Global and regional data	Annually, as needed
Digital Platforms	Real-time operational and environmental data	Continuously

Government agencies and regulatory bodies are fundamental sources of data, providing official statistics, reports, and updates on maritime activities. In Slovenia, the Ministry of Infrastructure, particularly its Maritime Administration, collects and publishes data on maritime traffic, port activities, and safety standards. Similarly, in Croatia, the Ministry of the Sea, Transport, and Infrastructure plays an essential role in gathering data related to maritime transport, port operations, and shipbuilding activities. These agencies provide reliable and authoritative data, essential for tracking industry trends and regulatory compliance.

Ports are another crucial source of data, as they are the hubs of maritime activity. The Port of Koper in Slovenia and major Croatian ports such as Rijeka, Split, and Ploče maintain detailed records of cargo volumes, vessel traffic, and operational performance. These ports also collect data on environmental impacts, such as emissions and waste management practices, which are vital for monitoring sustainability initiatives. Collaboration with port authorities ensures access to real-time data, facilitating effective monitoring and decision-making.

Industry associations and organizations provide valuable data and insights into the maritime and nautical sectors. In Slovenia, the Slovenian Maritime Cluster brings together various stakeholders, including shipyards, shipping companies, and research institutions, to promote industry development. Similarly, in Croatia, the Croatian Chamber of Economy and the Croatian Shipbuilding Corporation are key industry bodies that gather and disseminate data on market trends, industry performance, and innovation

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activities. These organizations serve as important hubs for data sharing and collaboration among industry stakeholders.

Academic and research institutions are essential partners in data collection and analysis. Universities and research centres in both countries conduct studies and projects that generate valuable data on maritime technologies, environmental impacts, and economic performance. For instance, the University of Ljubljana in Slovenia and the University of Split in Croatia have dedicated maritime research departments that contribute to the understanding of industry dynamics and innovation potential. Engaging with these institutions ensures access to cutting-edge research and empirical data.

Private sector companies, particularly those involved in shipbuilding, maritime transport, and nautical tourism, are key sources of operational and market data. These companies maintain records on production volumes, financial performance, customer preferences, and technological adoption. Collaborating with leading industry players, such as shipyards like Uljanik and Brodosplit in Croatia, can provide granular data that enhances the monitoring framework's accuracy and relevance.

International organizations and databases offer comparative data and benchmarks that are useful for contextualizing national performance. Organizations such as the International Maritime Organization (IMO), the European Maritime Safety Agency (EMSA), the Organisation for Economic Co-operation and Development (OECD) and European Environment Agency (EFRAG) provide global and regional data on maritime safety, environmental standards, and industry trends. Utilizing these sources allows for benchmarking Slovenia's and Croatia's maritime sectors against international standards and best practices.

Digital hubs and technology solutions are increasingly important for data collection in the maritime sector. The use of sensors, GPS tracking, and automated reporting systems on vessels and in ports generates real-time data on operations, environmental conditions, and logistics. These digital tools enhance the precision and timeliness of data, supporting more dynamic and responsive monitoring processes.

In summary, the effective monitoring of maritime innovation initiatives in Slovenia and Croatia relies on diverse and reliable data sources. Government agencies, port authorities, industry associations, academic institutions, private companies, international organizations, and digital hubs all contribute valuable data that underpins the monitoring framework. The framework can offer thorough and precise insights on the development and significance of the maritime and nautical industries in both nations by utilizing various sources. The utilization of a multifaceted approach to data collecting guarantees comprehensive coverage of the maritime ecosystem, hence promoting informed decision-making and ongoing enhancement of the innovation methods put into practice. Achieving the strategic goals and promoting a competitive, sustainable marine industry in Slovenia and Croatia will require forging solid alliances with these data sources and incorporating their contributions into the monitoring framework.

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5 DATA COLLECTION AND ANALYSIS

5.1 Data Collection Methods

Effective data collection methods are crucial for acquiring accurate and comprehensive information necessary for monitoring the progress and impact of maritime innovation initiatives. This section outlines the various methods that will be employed to gather data from the identified sources in Slovenia and Croatia, ensuring robust and reliable insights into the maritime and nautical industries.

Surveys and questionnaires are versatile tools for collecting quantitative and qualitative data from a wide range of stakeholders, including industry professionals, government officials, and researchers. These tools will be designed to capture detailed information on various aspects of the maritime industry, such as technological adoption, operational challenges, and innovation activities. Surveys can be administered online, via email, or through face-to-face interviews to maximize response rates and ensure diverse participation.

In-depth interviews and focus groups provide qualitative insights that are often not captured through surveys. Interviews with key stakeholders, such as industry leaders, policymakers, and academic experts, offer nuanced perspectives on strategic priorities, innovation challenges, and collaboration opportunities. Focus groups facilitate interactive discussions among stakeholders, generating rich data on shared experiences, perceptions, and potential solutions to common issues.

Case studies are particularly useful for exploring best practices and successful innovation initiatives within the maritime industry. By examining specific examples of innovation projects, technological implementations, or strategic collaborations, case studies provide detailed insights into what works, why it works, and how similar successes can be replicated or scaled.

Secondary data analysis involves the review and synthesis of existing data from various sources, including government reports, academic studies, and industry publications. This method leverages already available data to identify trends, benchmark performance, and inform strategic decisions. Secondary data analysis is cost-effective and can provide a broad context for primary data findings.

Direct observation and field visits to ports, shipyards, and maritime research centers enable the collection of first-hand data on operational practices, technological infrastructure, and innovation activities. These visits provide an opportunity to validate data collected through other methods and to gain a deeper understanding of the practical challenges and opportunities within the maritime industry.

5.2 Data Analysis Techniques

Analyzing collected data is crucial for monitoring progress, identifying trends, and measuring the impact of innovation initiatives. This section outlines the data analysis techniques that will be employed to ensure rigorous and insightful analysis.

Descriptive analysis involves summarizing and describing the main features of the collected data. This includes the use of statistical measures such as mean, median, mode, and standard deviation to provide a comprehensive overview of the data. Descriptive analysis helps in understanding the basic

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characteristics of the maritime industry, such as the average size of shipyards, typical levels of technological adoption, and common challenges faced by stakeholders.

Comparative analysis involves comparing data across different groups, regions, or time periods to identify differences and similarities. This technique is useful for benchmarking performance, assessing the impact of policy changes, and evaluating the effectiveness of different innovation strategies. For instance, comparing the innovation activities of Croatian and Slovenian shipyards can highlight best practices and areas for improvement.

Trend analysis focuses on identifying patterns and trends over time. This technique is essential for understanding the evolution of the maritime industry and predicting future developments. Trend analysis can be applied to various data points, such as the adoption of green technologies, changes in employment levels, or shifts in market demand. By identifying trends, stakeholders can make informed decisions and develop proactive strategies.

Regression analysis is a powerful statistical technique used to examine the relationships between variables. This method helps in identifying factors that significantly influence outcomes, such as the impact of digitalization on operational efficiency or the effect of policy incentives on innovation activities. Regression analysis provides insights into causal relationships and helps in developing evidence-based strategies.

Qualitative analysis involves interpreting non-numeric data, such as interview transcripts, focus group discussions, and case study narratives. Techniques such as thematic analysis, content analysis, and narrative analysis are used to identify key themes, patterns, and insights from qualitative data. This approach provides a deeper understanding of stakeholders' perspectives, motivations, and experiences, complementing the findings from quantitative analysis.

Network analysis examines the relationships and interactions between different stakeholders within the maritime innovation ecosystem. By mapping the connections between shipyards, research institutions, government agencies, and other actors, network analysis helps in understanding the structure and dynamics of the ecosystem. This technique is useful for identifying key influencers, collaboration opportunities, and potential barriers to innovation.

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6 MONITORING PROCESS

6.1 Baseline Assessment

A basic stage in the monitoring process is setting a baseline for each Key Performance Indicator (KPI). The baseline ensures that any changes in the performance of the Croatian and Slovenian maritime innovation ecosystems are precisely monitored by offering a standard by which progress can be evaluated. This entails gathering preliminary data on every KPI prior to putting any strategic actions into action. All pertinent facets of the maritime and nautical industries, such as the state of innovation, the uptake of new technologies, the influence on the economy, and the sustainability of the environment, should be included in the baseline assessment.

Engaging with a wide range of stakeholders, such as shipyards, maritime transport firms, operators of nautical tourism, research institutions, government agencies, and environmental organizations, is essential to conducting a thorough baseline assessment. Compiling information from these several sources guarantees a comprehensive picture of the industry's current situation. The current infrastructure, the technological prowess of maritime and nautical businesses, the skill and training levels of the workforce, the volume and character of maritime trade and tourism activities, and the environmental practices in use should all be major areas of concern. Figure 6.1 below indicates primary components of an M&E System.

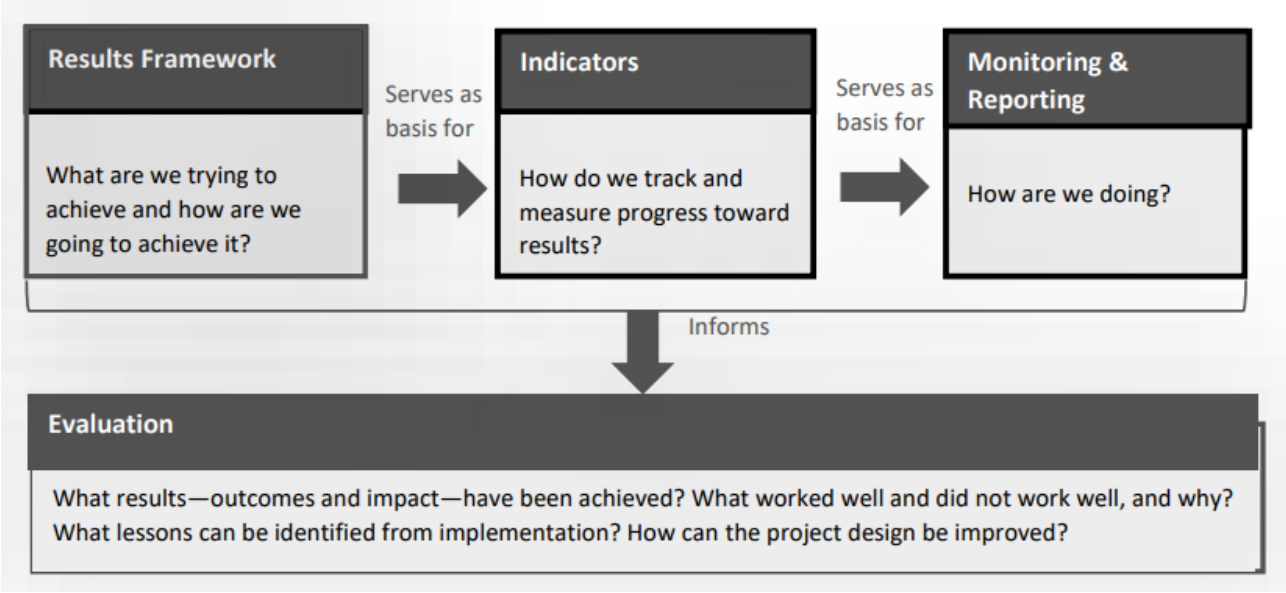

Figure 6.1: Primary Components of an M&E System (Wiliams, 2016).

A detailed examination of current laws and policies that influence the maritime industries in both nations should also be part of the baseline evaluation. This entails being aware of the regulatory landscape, figuring out what systems are in place to encourage innovation and sustainability, and spotting any roadblocks. Stakeholders can gain a better understanding of how the existing policy landscape affects industry practices and outcomes by outlining it.

To create a baseline, a reliable mechanism for gathering data must be put in place. It is imperative that this system can consistently collect, store, and evaluate data to guarantee smooth and efficient

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continuous monitoring. To effectively evaluate the baseline data and identify important trends and insights that can guide strategic decision-making, advanced data analytics tools and techniques should be used.

The monitoring and evaluation system is built upon the baseline assessment. Stakeholders can use it to set reasonable goals, monitor their progress over time, and modify methods and interventions as needed. Slovenia and Croatia can effectively drive the transformation of their maritime and nautical industries, ensure sustainable growth, and improve global competitiveness by having a thorough awareness of the starting conditions.

6.2 Regular Monitoring

Regular monitoring is essential to ensure that the maritime innovation strategies in Slovenia and Croatia are on track and achieving the desired outcomes. This involves systematically collecting data at predefined intervals to track the progress of each Key Performance Indicator (KPI). The monitoring schedule should be meticulously aligned with the overall project timeline and key milestones, ensuring that progress is continuously assessed, and adjustments can be made as necessary. Monitoring activities and data sources are described in the table 6.1 below.

Table 6.1: Regular Monitoring Activities and Data Sources.

Monitoring Activity	Data Source	Frequency	Purpose
Surveys	Maritime businesses, research institutions	Quarterly	Gauge progress and effectiveness
Interviews	Industry leaders, policymakers, academic experts	Bi-annually	Obtain detailed feedback and insights
Site Visits	Shipyards, ports, marinas	Annually	Verify data accuracy and assess challenges
Documentation Review	Reports, financial statements	Annually	Ensure compliance and validate data
Stakeholder Meetings	All stakeholders	Quarterly	Keep stakeholders informed and engaged

The regular monitoring process includes a variety of activities to gather comprehensive and accurate data. These activities encompass surveys, interviews, site visits, and reviews of relevant documentation. Surveys can be conducted among a broad range of stakeholders, including maritime businesses, research institutions, and governmental bodies, to gauge their perspectives on the progress and effectiveness of implemented strategies. Interviews provide deeper insights, allowing for more detailed feedback on specific issues or successes encountered during the implementation phase.

Site visits are another crucial component of regular monitoring. They allow for firsthand observation of the operations and conditions at various maritime facilities, such as shipyards, ports, and marinas. These visits enable evaluators to verify the accuracy of reported data and to understand the practical challenges

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and advancements occurring on the ground. During site visits, evaluators can assess the implementation of new technologies, the condition of infrastructure, and the operational efficiency of maritime activities.

The European Commission established that reviews of relevant documentation are also essential in the regular monitoring process that is why they are included in FAQ - Monitoring, reporting and verification of maritime transport emissions adopted by the European Commission. These relevant reviews include analyzing reports, financial statements, project plans, and other pertinent documents to ensure compliance with strategic objectives and to validate the data collected through other means. Document reviews help in identifying trends, assessing the effectiveness of policies, and ensuring that financial resources are being used appropriately and efficiently.

To enhance the effectiveness of regular monitoring, continuous engagement with stakeholders is vital. This engagement ensures that the data collected is relevant, comprehensive, and reflective of on-ground realities. Regular meetings and communication channels should be established to keep all stakeholders informed about the monitoring process and findings. This continuous dialogue not only builds trust but also encourages stakeholders to actively contribute to the data collection and to address any issues promptly.

Utilizing advanced data analytics tools and techniques can significantly enhance the monitoring process. These tools can help in analyzing large volumes of data, identifying patterns, and providing actionable insights. Real-time data collection and analysis can enable more responsive and dynamic management of maritime innovation strategies.

6.3 Reporting Mechanism

Developing an effective reporting mechanism is crucial for the transparency, accountability, and success of the maritime innovation strategies in Slovenia and Croatia. A robust reporting structure ensures that all stakeholders are kept informed about the progress, challenges, and outcomes of the initiatives being implemented. This section outlines the key components and processes involved in establishing a comprehensive reporting mechanism taking into account the main findings of the Operational Guidance for Monitoring and Evaluation (M&E) in Climate and Disaster Resilience-Building Operations prepared by the World Bank.

Structure and Frequency of Reports

The reporting mechanism should include both periodic and ad-hoc reports to provide timely updates and address specific issues as they arise. Regular reports, such as quarterly and annual reports, should be scheduled to align with the overall project timeline and key milestones. These reports should provide a detailed account of the progress made towards achieving the objectives and goals set out in the maritime innovation strategies. Additionally, ad-hoc reports may be required to address urgent matters, significant deviations, or unexpected challenges that require immediate attention.

Content of Reports

Each report should follow a standardized format to ensure consistency and comprehensiveness. The key sections of the reports should include:

- Executive Summary: A concise overview of the key findings, progress, and any critical issues identified during the reporting period.

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- Progress Overview: Detailed information on the progress of each Key Performance Indicator (KPI), including data collected, analysis, and comparisons with baseline values and targets.
- Activities and Milestones: A summary of the activities conducted during the reporting period, including surveys, interviews, site visits, and stakeholder meetings. This section should also highlight any key milestones achieved.
- Challenges and Deviations: Identification and analysis of any challenges encountered or deviations from the planned objectives. This should include an assessment of the causes and potential impacts of these challenges.
- Corrective Actions: Recommendations for corrective actions to address any issues identified. This should include specific steps to be taken, responsible parties, and timelines for implementation.
- Stakeholder Feedback: Insights and feedback from stakeholders collected during the reporting period. This ensures that the perspectives of all relevant parties are considered in the assessment.
- Financial Overview: A summary of the financial status, including expenditures, budget utilization, and any financial challenges or adjustments needed.
- Future: An outline of the planned activities and focus areas for the next reporting period, ensuring continuity and proactive management of the strategies.

Reporting Process

The reporting process should be clearly defined to ensure efficiency and accuracy. The steps involved include:

- Data Collection and Compilation: Collecting data from various sources, including surveys, interviews, site visits, and documentation reviews. This data should be compiled and organized systematically.
- Data Analysis: Analyzing the collected data to assess progress, identify trends, and highlight any issues. Advanced data analytics tools can be employed to enhance the accuracy and depth of the analysis.
- Drafting the Report: Preparing the draft report based on the standardized format. This involves summarizing the findings, providing detailed analysis, and including visual aids such as charts and graphs to illustrate key points.
- Stakeholder Review: Sharing the draft report with key stakeholders for review and feedback. This step ensures that the report reflects a comprehensive and accurate assessment and incorporates stakeholder perspectives.
- Finalization and Approval: Revising the draft report based on stakeholder feedback and obtaining the necessary approvals from relevant authorities or committees.
- Distribution and Communication: Distributing the final report to all stakeholders, including government agencies, industry partners, research institutions, and the public. Utilizing various communication channels, such as email, online portals, and meetings, ensures broad and effective dissemination.

To enhance the effectiveness of the reporting mechanism, continuous improvement practices should be implemented. This involves regularly reviewing and refining the reporting process based on feedback from stakeholders and lessons learned from previous reporting cycles. Incorporating innovative reporting tools and technologies can also streamline the process and improve the quality of the reports.

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7 QUALITATIVE ASSESSMENTS

7.1 Best Practices Documentation

Documenting and analyzing best practices are crucial for the advancement of the maritime innovation ecosystems in Slovenia and Croatia. This process involves a detailed examination of successful strategies and initiatives within the Flemish ecosystem, known for its exemplary maritime practices. By studying these best practices, stakeholders can gain insights into effective methods for stimulating innovation, sustainability, and competitiveness. This documentation process should include case studies, interviews with key stakeholders, and analysis of specific projects that have led to significant improvements in the Flemish maritime industry. The findings from this analysis can then be adapted and applied to the Slovenian and Croatian contexts, ensuring that the most effective practices are implemented to enhance their maritime sectors. Table 7.1 below is indicating best practices from the Flemish Maritime Ecosystem, while table 7.2 identifies challenges and interventions.

Table 7.1: Documented Best Practices from the Flemish Maritime Ecosystem.

Best Practice	Description	Key Benefits	Applicability to Slovenia and Croatia
Green Port Initiative	Implementation of sustainable port operations	Reduced environmental footprint	High
Digitalization of Shipping	Use of IoT and big data for efficient shipping	Enhanced operational efficiency	Medium
Public-Private Partnerships	Collaborative R&D projects	Accelerated innovation	High

Identifying and addressing challenges within the maritime innovation ecosystems of Slovenia and Croatia is essential for achieving long-term success. This process begins with a thorough analysis of the barriers and obstacles that hinder progress and limit the potential for innovation. Key challenges often include regulatory constraints that create bureaucratic hurdles, lack of adequate funding to support research and development, and limited access to cutting-edge technologies that are crucial for advancing the industry.

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Table 7.2: Identified Challenges and Proposed Interventions.

Challenge	Description	Proposed Intervention	Expected Outcome
Regulatory Constraints	Bureaucratic hurdles affecting operations	Streamline regulatory processes	Reduced administrative burden
Lack of Funding	Insufficient funds for R&D	Leverage national and EU funding	Increased investment in innovation
Limited Access to Technologies	Difficulty accessing cutting-edge technologies	Promote industry-research collaboration	Enhanced technological adoption

In order to gain a comprehensive understanding of these challenges, stakeholders should adopt a multifaceted approach. This involves conducting surveys to collect quantitative data on the experiences and perceptions of industry participants. Utilizing focus groups can offer valuable qualitative insights and foster in-depth discussions regarding issues impacting various segments of the maritime industry. Conducting thorough interviews with important stakeholders, including business leaders, policymakers, and researchers, is crucial for gaining valuable insights and pinpointing underlying issues that may not be obvious at first glance.

Once the challenges have been identified, the next step is to strategically tackle them through focused interventions. For example, it may be necessary to make policy adjustments to streamline regulatory processes and alleviate administrative burdens on businesses. One possible approach is to streamline permitting procedures, harmonize national regulations with EU standards, and establish regulatory environments that are more transparent and predictable. To address the funding gap, it is important to strategically allocate resources, make use of national and EU funding mechanisms, and foster public-private partnerships to attract investment into the maritime sector.

Improving access to advanced technologies can be achieved by fostering stronger collaboration between industry and research institutions, facilitating the transfer of technology, and providing support for the growth of innovation hubs and clusters. By providing valuable insights and expertise, this can facilitate the integration of cutting-edge technology into maritime businesses in Slovenia and Croatia, bridging the divide between research and practical implementation.

In addition, it is crucial to tackle challenges related to the workforce. We prioritize investments in education and training programs to foster the development of essential skills for the maritime industry. Our focus lies in areas like digitalization, automation, and sustainable practices. Encouraging young professionals to join the maritime sector and offering ongoing professional development opportunities can contribute to the development of a highly skilled and flexible workforce. Figure 7.1. below is showing a concept map of digital strategies.

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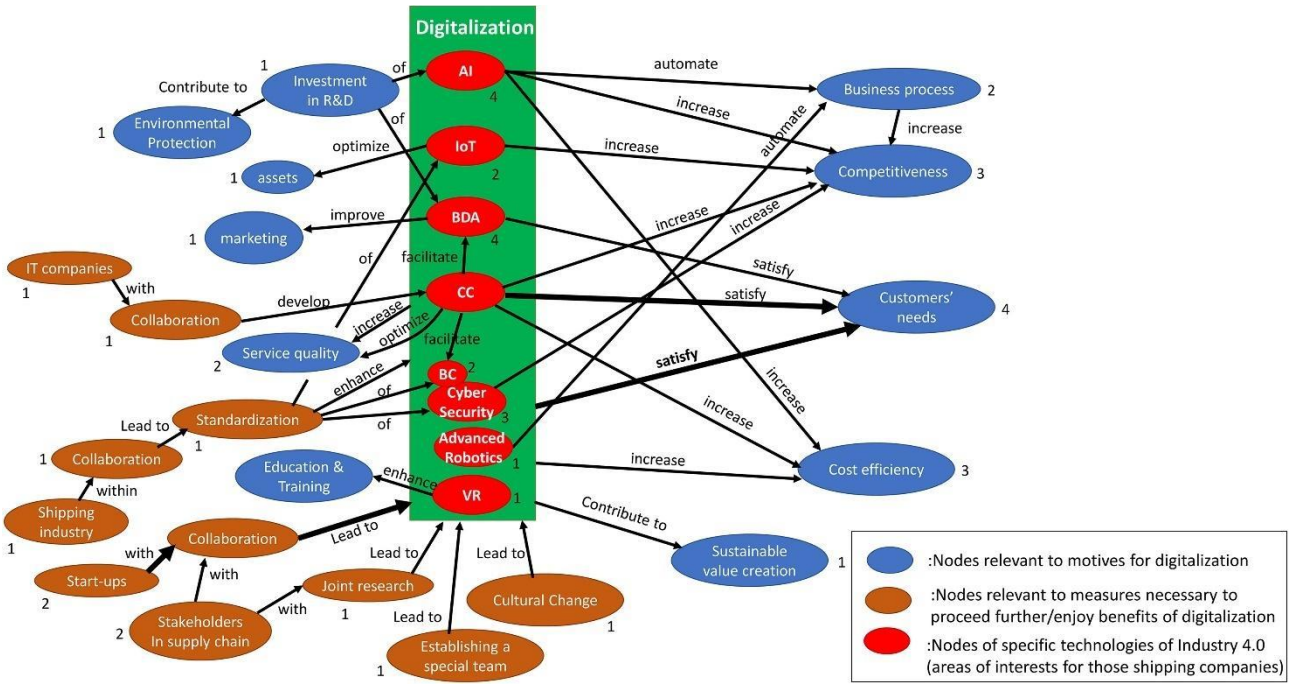

Figure 7.1: Concept map of the digital strategies (Yuki Ichimura, Dimitrios Dalaklis, Momoko Kitada, Anastasia Christodoulou, 2022).

7.2 Needs Analysis

Conducting a thorough needs analysis is a critical component of ensuring continuous improvement in the maritime innovation ecosystems of Slovenia and Croatia. This involves assessing the current and future needs of the industry, including technological advancements, skill development, infrastructure upgrades, and policy support. The needs analysis should be based on data collected from various stakeholders, including industry leaders, academic institutions, and government agencies. By understanding the specific needs of the maritime sector, stakeholders can prioritize initiatives that address the most pressing issues and opportunities. This proactive approach helps to ensure that the maritime innovation ecosystems remain dynamic, resilient, and capable of adapting to changing market conditions and technological advancements.

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8 ANNUAL MONITORING REPORTS

8.1 Progress Tracking

Progress tracking is a critical component of the annual monitoring reports, focusing on the state of progress on actions defined in the action plan for the maritime innovation ecosystems of Slovenia and Croatia. This involves a systematic review of the initiatives and activities that have been implemented over the year, providing a comprehensive overview of the accomplishments and areas needing attention.

The process begins with collecting data from various sources, including detailed project reports, stakeholder feedback, performance metrics, and regular updates from project leads and coordinators. These sources offer a wealth of information that must be meticulously compiled and analyzed to ensure a clear understanding of the progress made.

To accurately assess each action, predefined milestones and timelines established in the action plan serve as benchmarks. Each initiative is evaluated against these benchmarks to determine whether the objectives are being met as planned. This involves a thorough examination of the following aspects:

Completion Status: Reviewing whether the actions have been fully implemented, partially completed, or are still in progress. This helps in identifying which initiatives are on track and which are lagging.

Performance Metrics: Analyzing key performance indicators (KPIs) specific to each action. These metrics could include quantitative measures such as the number of new technologies adopted, the amount of investment attracted, or the increase in research and development activities.

Stakeholder Feedback: Gathering insights from stakeholders through surveys, interviews, and focus groups to gauge the perceived effectiveness and impact of the initiatives. This qualitative data provides a deeper understanding of the practical implications and reception of the actions taken.

Resource Utilization: Assessing how efficiently resources such as funding, personnel, and infrastructure have been used. This includes evaluating whether the resources allocated have been sufficient and effectively utilized to achieve the desired outcomes.

Challenges and Barriers: Identifying any obstacles or issues that have hindered progress. This could range from regulatory hurdles and funding shortages to technological limitations and stakeholder resistance. Regular updates and status reports from project leads and coordinators are essential for maintaining an accurate picture of progress. These updates should include detailed accounts of activities carried out, challenges encountered, and any adjustments made to the original plans. This ongoing documentation is crucial for keeping all stakeholders informed and aligned.

Visual tools such as Gantt charts, dashboards, and progress maps can be highly effective in presenting this data. Gantt charts illustrate the timeline of activities, showing the start and end dates, as well as dependencies between different tasks. Dashboards provide real-time data visualization, offering an at-a-glance view of key metrics and progress indicators. Progress maps can highlight geographical areas of focus and the spread of various initiatives across regions.

These tools not only facilitate a clear and concise representation of progress but also help in identifying trends, bottlenecks, and areas requiring immediate attention. By making the information accessible and understandable, stakeholders can more effectively participate in decision-making and strategic planning.

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Additionally, it is important to establish a feedback loop where insights gained from progress tracking are used to refine and adjust the action plan. This iterative process ensures that the strategy remains dynamic and responsive to changing conditions and emerging opportunities. Regular reviews and consultations with stakeholders help in validating findings and making necessary course corrections.

8.2 Investment Tracking

Investment tracking is a vital aspect of the annual monitoring reports, ensuring that financial resources are effectively mobilized and utilized within the maritime innovation ecosystems of Slovenia and Croatia. This process involves monitoring both the negotiation stages and the actual realization of investments, which are crucial for driving innovation, infrastructure development, and overall industry growth. Table 8.1 represents investment tracking summary.

Table 8.1: Investment Tracking Summary.

Investment Stage	Activities	Metrics	Stakeholder Feedback	Challenges and Mitigation
Negotiation	Identifying and engaging investors	Number of proposals, meetings held	Positive interest, concerns about ROI	Regulatory hurdles, economic risks
Realization	Disbursing and utilizing funds	Amount of funds disbursed, projects initiated	Effective fund use, need for more transparency	Timely fund release, project delays
Impact Assessment	Measuring outcomes and ROI	Technological advancements, job creation	High satisfaction with outcomes	Ensuring long-term sustainability

8.2.1 Monitoring Investment Negotiations

The initial step in investment tracking focuses on the negotiation phase. This involves:

Identification of Potential Investors: Cataloguing potential domestic and international investors, including venture capitalists, private equity firms, governmental funding bodies, and international financial institutions.

Tracking Negotiation Progress: Documenting the stages of negotiation with these investors, including initial contacts, proposals submitted, meetings held, and agreements reached. This can be done through regular updates from investment officers, minutes of meetings, and formal communication records.

Assessment of Investment Proposals: Evaluating investment proposals based on criteria such as alignment with strategic goals, potential for innovation, financial stability, and expected impact on the maritime ecosystem. This involves a thorough due diligence process to ensure that only viable and beneficial investments are pursued.

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Engagement with Stakeholders: Maintaining an open line of communication with all relevant stakeholders, including government agencies, industry leaders, and community representatives, to ensure transparency and consensus on investment priorities.

8.2.2 Tracking Realized Investments

Once investments move beyond the negotiation phase and are realized, it is crucial to track their implementation and impact.

Financial Disbursement Monitoring: Ensuring that the funds are disbursed as per the agreed timelines and milestones. This involves tracking the release of funds from investors to the relevant projects or companies, ensuring compliance with contractual agreements.

Utilization of Funds: Monitoring how the received investments are utilized. This includes tracking expenditure on various components such as infrastructure development, research and development, technology adoption, human resource development, and operational expenses. Regular financial reports and audits can provide insights into the effective use of funds.

Impact Assessment: Evaluating the impact of investments on the maritime innovation ecosystem. This involves measuring improvements in key performance indicators such as technological advancements, increase in research outputs, job creation, enhancement in operational efficiencies, and overall economic growth.

Project Progress and Milestones: Keeping track of the progress of funded projects against their planned milestones. Regular project status reports, site visits, and progress reviews ensure that projects stay on track and any deviations are promptly addressed.

Return on Investment (ROI): Analyzing the return on investment for both investors and the broader maritime ecosystem. This includes financial returns for investors and broader economic and social returns such as enhanced competitiveness, increased sustainability, and long-term growth of the maritime industry.

8.2.3 Reporting and Communication

Regular Updates: Providing regular updates to all stakeholders on the status of investment negotiations and realized investments. This can be done through quarterly reports, newsletters, and stakeholder meetings.

Transparent Reporting: Ensuring that all reports are transparent, detailed, and accessible. Reports should include comprehensive data on financial disbursements, fund utilization, project progress, and impact assessments.

Feedback Mechanisms: Establishing mechanisms for stakeholders to provide feedback on investment processes and outcomes. This helps in refining investment strategies and ensuring continuous improvement.

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8.2.4 Challenges and Risk Management

Identifying Challenges: Recognizing potential challenges in the investment process, such as regulatory hurdles, economic downturns, and technological risks. This involves ongoing risk assessment and management.

Mitigation Strategies: Developing and implementing strategies to mitigate identified risks. This can include securing alternative funding sources, adjusting project timelines, and enhancing stakeholder engagement to ensure continued support.

8.2.5 Continuous Improvement

Learning and Adaptation: Using the insights gained from investment tracking to inform future investment strategies. This involves learning from both successes and failures, adapting approaches as necessary, and continuously seeking to improve the investment environment within the maritime innovation ecosystems.

8.3 Skills and Knowledge Assessment

Skills and knowledge assessment is a crucial component of the annual monitoring reports for the maritime innovation ecosystems of Slovenia and Croatia. This assessment focuses on evaluating the acquisition and development of skills and knowledge among stakeholders within these ecosystems, ensuring that the workforce is well-equipped to drive innovation and maintain competitive advantage.

To begin with, it is essential to identify the key skills and knowledge areas required in the maritime industry. Core competencies such as technical skills in shipbuilding, maritime logistics, nautical engineering, and marine technology form the backbone of the industry. In addition to these foundational skills, there is a growing need for expertise in emerging areas driven by advancements in digitalization, automation, and green technologies. This includes proficiency in digital tools, data analytics, sustainable practices, and new propulsion systems. Furthermore, the importance of soft skills such as project management, leadership, communication, and problem-solving cannot be overstated, as these are critical for effective collaboration and innovation.

Assessing skills and knowledge requires utilizing a range of methods to collect thorough data. Regularly, surveys and questionnaires are conducted among industry professionals, academic institutions, and training centers to gather quantitative data on existing skills and identify gaps. These tools offer valuable insights into the current skill levels and training requirements. Conducting in-depth interviews and focus groups with key stakeholders, such as employers, employees, educators, and industry experts, provides valuable qualitative insights into the unique challenges and needs of the workforce. In addition, it is important to review training records and certifications to keep track of participation and completion of relevant training programs. Feedback from performance reviews conducted by employers can also provide valuable insights into the practical application of acquired skills in the workplace.

Developing and implementing effective training and development programs is crucial for addressing identified skills gaps. An in-depth needs analysis is performed to identify precise training requirements, considering the assessment of skills and knowledge. Our training programs are carefully tailored to address your specific needs, encompassing both technical expertise and essential interpersonal skills that align with the ever-evolving demands of your industry. Working closely with universities, technical

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schools, and training centers is crucial to maintain training content that is current and in line with industry standards. Experienced professionals are always there to provide guidance and support to less experienced employees, promoting on-the-job training and mentorship programs for practical learning and knowledge transfer.

Assessing the efficiency of training programs is a continuous endeavor. Implementing pre- and post-training assessments allows for the measurement of improvements in skills and knowledge. This evaluation process helps to determine the effectiveness of the training and identify any areas that may still need improvement. Feedback mechanisms are put in place to collect input from participants about the quality and relevance of the training programs, guaranteeing ongoing improvement. Examining the career development of individuals who have taken part in training programs offers valuable insights into the lasting effects of training on personal growth and overall organizational success.

Regular reporting on the outcomes of skills and knowledge assessments is crucial for maintaining transparency and accountability. These reports provide in-depth analysis, important findings, and suggestions for future steps. Assessing the skills and knowledge levels within the maritime ecosystems of Slovenia and Croatia in comparison to international standards and best practices allows for the identification of strengths and areas that can be improved upon. With a focus on continuous improvement and a commitment to staying ahead of the curve, Slovenia and Croatia can cultivate a workforce that is well-equipped to drive innovation in their maritime industries. By leveraging the valuable insights gained from assessments, they can refine their training programs and initiatives to ensure that their maritime innovation ecosystems thrive. This strategy fosters long-term growth and a competitive edge in the maritime industry, establishing both countries as frontrunners in maritime innovation and progress.

8.4 Business Growth Tracking

Business growth tracking is a vital aspect of the annual monitoring reports for the maritime innovation ecosystems of Slovenia and Croatia. This component focuses on measuring and analyzing the growth and development of businesses within these sectors, providing insights into the overall health and progress of the maritime industry. Effective business growth tracking involves a comprehensive evaluation of various indicators, including financial performance, market expansion, innovation activities, and employment trends. Table 8.2 summarized business growth tracking.

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Table 8.2: Business Growth Tracking Summary.

Growth Indicator	Metrics	Annual Growth Rate	Stakeholder Feedback	Challenges and Barriers
Revenue Growth	Annual revenue, Profitability	10%	Positive but cautious	Market fluctuations
Market Expansion	New markets entered, Market share	8%	High satisfaction	Competition
Innovation Activities	Patents filed, R&D spending	12%	Need for more support	Funding limitations
Employment Trends	Jobs created, Workforce size	6%	High satisfaction	Skill gaps

First and foremost, it is important to note that financial performance plays a crucial role in determining the growth of a business. I specialize in analyzing revenue growth, profitability, and return on investment (ROI) for maritime businesses, providing valuable insights and recommendations. By gathering financial data from annual reports, financial statements, and market analyses, a comprehensive understanding of the economic impact of these businesses can be formed. By analyzing these financial metrics over time, stakeholders can identify patterns, evaluate the success of business strategies, and identify areas that need improvement. In addition, analyzing the financial well-being of businesses offers valuable insights into their ability to withstand economic challenges and maintain long-term stability.

Expanding the market is a crucial factor in driving business growth. Tracking the entry of maritime businesses into new markets, whether at home or abroad, is an essential task. Important metrics to consider are the number of new market entries, growth in market share, and diversification across different geographic areas. By analyzing these metrics, one can gain valuable insights into how businesses are expanding their reach and growing their customer base. In addition, evaluating the effectiveness of efforts to diversify products and services offers valuable insights into how companies are responding to evolving market needs and capitalizing on emerging prospects.

Innovation activities play a crucial role in driving the growth and competitiveness of maritime businesses. Evaluating the number and impact of new products, services, and technologies introduced by businesses is crucial for tracking innovation. This involves keeping a close eye on patent filings, research and development (R&D) spending, and partnerships with research institutions and universities. In addition, evaluating the implementation of cutting-edge technologies like automation, digitalization, and green technologies offers insight into how businesses are adapting and staying at the forefront of industry developments. Tracking innovation also requires analyzing the results of innovation projects, including enhancements in efficiency, cost reductions, and environmental advantages.

Understanding employment trends is crucial for gauging business growth. As a business consultant, it is important to closely monitor the fluctuations in job creation, workforce size, and employment patterns within the maritime industry. Examining employment data is crucial for gaining insights into how the industry impacts job growth and economic progress. In addition, evaluating the caliber of employment, encompassing aspects like pay, job contentment, and chances for professional growth, offers a holistic perspective on the industry's influence on the workforce. By monitoring employment trends,

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stakeholders can identify skill gaps and develop targeted training programs to ensure a well-equipped workforce that can support sustained business growth.

For accurate and relevant business growth tracking, it's crucial to gather data from various sources. This refers to a range of valuable resources, such as financial reports, market research studies, industry surveys, and government statistics. Interacting with business owners, industry associations, and trade organizations offers valuable insights and context. Consistently updating and validating data is crucial for maintaining a current and reliable tracking process.

The presentation of business growth data should be clear and actionable, providing valuable insights. Using visual tools like charts, graphs, and dashboards can effectively emphasize important trends and findings, enabling stakeholders to easily comprehend and analyze the data. Comprehensive reports should encompass both quantitative metrics and qualitative insights, offering a thorough perspective on business growth within maritime ecosystems.

Regular reporting on business growth is essential to maintain transparency and accountability. It is important to distribute these reports to the appropriate stakeholders, such as government agencies, industry partners, and the wider maritime community. Through consistent updates on business growth, stakeholders can stay well-informed, adapt strategies, and allocate resources efficiently to foster the ongoing development of maritime innovation ecosystems.

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9 BROADER MONITORING AND EVALUATION FRAMEWORK

9.1 Innovation Capacity

Assessing the capacity for innovation within the maritime innovation ecosystems of Slovenia and Croatia is fundamental to ensuring these regions remain competitive and forward-thinking. Innovation capacity refers to the ability of these ecosystems to generate new ideas, develop novel technologies, and implement innovative solutions. This assessment encompasses several dimensions, including research and development (R&D) activities, the presence of innovation infrastructure, and the strength of collaborative networks.

An exhaustive assessment of R&D operations is necessary first. This entails tracking the quantity of money allocated to research and development, the number of active research projects, and the results in terms of publications, patents, and technological breakthroughs. For this analysis, data from government reports, academic institutions, and R&D departments in the commercial sector are essential. Stakeholders can determine the degree of innovation commitment, leading research fields, and any gaps that require filling by looking at these KPIs.

An additional important component of innovation capability is the existence of innovation infrastructure, such as technology parks, incubators, and research centers. These facilities give entrepreneurs and researchers the tools and space they need to explore, create, and test innovative concepts. To understand the current level of innovation support, an inventory of the infrastructure that is already in place should be done, together with an evaluation of its effectiveness and use. Furthermore, investigating the availability of funding sources like grants, venture capital, and PPPs offers information about the financial backing of innovation.

Networks of collaboration are essential for fostering innovation. These networks consist of collaborations between academic institutions, government agencies, business, and research facilities. The frequency and caliber of cooperative projects, the transfer of information and technology, and the creation of innovation centers or clusters are indicators of the strength and efficacy of these partnerships. Slovenia and Croatia can increase their capacity for innovation and gain a competitive edge in the maritime industry by fostering a culture of cooperation.

9.2 Quality of Environment and Leadership

Evaluating the quality of the innovation environment and leadership within the maritime ecosystems is essential for nurturing a culture of continuous improvement and excellence. The innovation environment refers to the overall conditions that support or hinder innovation activities, including regulatory frameworks, market dynamics, and socio-cultural factors. Leadership quality involves the vision, strategy, and management practices of key individuals and organizations driving innovation.

The regulatory framework plays a critical role in shaping the innovation environment. A conducive regulatory environment should promote ease of doing business, protect intellectual property rights, and provide incentives for R&D and innovation. Assessing the current regulatory landscape involves analyzing policies, regulations, and their implementation to identify any barriers or areas for improvement.

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Engaging with policymakers and industry stakeholders can help in understanding the practical implications of regulations and developing recommendations for creating a more supportive environment. Table 9.1 indicates leadership quality in the maritime sector.

Table 9.1: Leadership Quality in the Maritime Sector.

Country	Ease of Doing Business Rank	IP Protection Score	Innovation Incentives (Yes/No)
Slovenia	37	7.5	Yes
Croatia	51	6.8	Yes
EU Average	25	8.0	Yes

Market dynamics, including competition, demand for innovative products and services, and access to global markets, are also vital components of the innovation environment. Analyzing market trends, consumer preferences, and competitive positioning provides insights into the opportunities and challenges faced by maritime businesses. By understanding these dynamics, stakeholders can develop strategies to capitalize on market opportunities and address competitive pressures.

Socio-cultural factors, such as attitudes towards innovation, risk-taking, and collaboration, significantly influence the innovation environment. Surveys and interviews with industry participants, academic experts, and community leaders can shed light on these cultural aspects. Promoting a culture that values innovation, supports entrepreneurial initiatives, and encourages collaboration is essential for stimulating a thriving innovation ecosystem.

Leadership quality is another critical factor in driving innovation. Effective leaders provide clear vision, strategic direction, and strong governance, enabling organizations to pursue ambitious innovation goals. Assessing leadership quality involves evaluating the strategic plans, decision-making processes, and management practices of key organizations and individuals. Leadership development programs, mentorship opportunities, and leadership networks can further enhance the capabilities of current and future leaders in the maritime sector.

9.3 Long–term Strategic Approach

To maintain sustainable growth and competitiveness, Slovenia and Croatia must build their marine innovation ecosystems strategically and over an extended period. A long-term strategic approach entails establishing precise, doable objectives, creating detailed strategies to reach these objectives, and regularly assessing results to make required modifications.

A thorough grasp of the intended future state of the marine ecosystems is necessary for setting long-term goals. Establishing goals for innovation, sustainability, economic expansion, and worldwide competitiveness is part of this. These objectives ought to be in line with more comprehensive regional and national plans, as well as global norms and patterns. To guarantee that the objectives are broad and representative of a variety of interests, it is important to engage with a wide range of stakeholders, including government agencies, business executives, academic institutions, and community representatives. Table 9.2 is indicating strategic planning and milestones.

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Table 9.2: Strategic Planning and Milestones.

Goal	Slovenia (Target Year)	Croatia (Target Year)	EU (Target Year)
Innovation	2025	2025	2025
Sustainability	2030	2030	2030
Economic Growth	2027	2027	2027
Competitiveness	2025	2025	2025

Creating detailed plans that include actions, resources, and deadlines is necessary to accomplish these long-term objectives. This involves deciding which projects are important, assigning funds and personnel, and establishing benchmarks to monitor advancement. To handle any obstacles and uncertainties, risk management techniques should be included in strategic planning. Stakeholders may efficiently work toward their long-term goals by having clear, executable plans.

Maintaining the relevance and effectiveness of the strategic plans requires ongoing monitoring and assessment. This entails tracking results against predetermined benchmarks on a regular basis, evaluating the results of activities taken, and making necessary data-driven adjustments. This continuous process is supported by the establishment of a strong monitoring and evaluation structure, as covered in earlier chapters. Stakeholder discussions, regular feedback loops, and adaptive management techniques all aid in strategy refinement and momentum preservation for long-term success.

In conclusion, the sustainable growth of marine innovation ecosystems in Slovenia and Croatia requires a more comprehensive monitoring and assessment framework that considers innovation capacity, the standard of the environment and leadership, and a long-term strategic approach. Stakeholders can establish dynamic, resilient, and forward-looking ecosystems that propel economic growth, innovation, and competitiveness in the global maritime industry by methodically evaluating and improving these features.

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10 CAPACITY BUILDING AND COLLABORATION TOOLS

10.1 New Collaboration Tools

Innovation and sustainable growth in Slovenia and Croatia's maritime innovation ecosystems require stakeholder collaboration. New collaborative tools are needed to enable this. These platforms streamline communication, foster partnerships, and enable efficient knowledge sharing among industry, academia, government, and other relevant sectors.

A centralized digital portal for stakeholders is one such instrument. This hub can have forums, project management tools, and resource libraries. Forums and discussion boards let stakeholders share insights, analyze industry trends, and address difficulties in real time. Project management tools facilitate collaborative planning, implementation, and monitoring, keeping everyone informed of project progress and milestones. Research papers, case studies, best practices, and regulatory updates are available in resource libraries, supporting continual learning and informed decision-making.

The European Maritime and Fisheries Fund (EMFF) information system is a consolidated digital hub. This system provides a European marine project database for knowledge sharing and collaboration. Slovenia and Croatia can also create a center for their specific requirements and concerns. This center might host a database of local marine projects, stakeholders, and financing opportunities, providing a one-stop resource for maritime innovation.

Innovation hubs or clusters are another powerful cooperation tool. These physical or virtual places bring diverse stakeholders together to collaborate, share resources, and innovate. Innovation clusters can organize workshops, hackathons, and networking events to help stakeholders develop new technology and solutions. These clusters can also help Slovenian and Croatian maritime sectors form cross-border cooperation to solve problems and find new opportunities.

West Sweden's Maritime Cluster is a successful innovation cluster. Businesses, academic institutes, and public agencies have collaborated on maritime innovation in this cluster, advancing sustainable shipping and marine technologies. Slovenia and Croatia can form clusters on green marine technology, digital maritime operations, and smart ports by taking a similar strategy.

Advanced communication technologies like video conferencing and collaborative software also improve stakeholder collaboration. These technologies enable cross-border communication and collaboration. Virtual meetings, webinars, and online training strengthen stakeholder relationships and keep everyone informed.

Zoom and Microsoft Teams have proven successful remote communication hubs. MareNet and Maritime Connect, for example, allow real-time data sharing from vessels and port operations and connection with maritime-specific software solutions.

In addition to digital tools, formal agreements and frameworks promote collaboration. Partnering through MoUs and strategic alliances can define stakeholder roles, duties, and expectations. These agreements establish a framework for collaboration, ensuring that all parties share aims and objectives.

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For instance, the Baltic Sea Action Plan, which comprises legal agreements between Baltic Sea countries, organizes environmental issues through collective action and shared responsibility. Slovenia and Croatia can create comparable accords to cooperate on marine pollution control, sustainable fisheries, and maritime safety.

Joint R&D programmes supported by national governments and the EU encourage collaboration. These programmes might encourage stakeholders to collaborate on new initiatives by providing grants and other financial incentives.

An annual marine innovation summit can also help stakeholders display their initiatives, share best practices, and form new relationships. Events like these can draw maritime experts and investors from around the world.

These new cooperation tools can help Slovenia and Croatia grow sustainably and compete in the global maritime industry by improving their maritime innovation ecosystems. These tools will improve knowledge exchange and communication and foster collaboration and innovation, making both countries' maritime industries more robust and dynamic.

10.2 Training Programs

The development of targeted training programs is essential for enhancing the entrepreneurial and leadership skills of stakeholders within the maritime innovation ecosystems of Slovenia and Croatia. These programs aim to equip individuals with the knowledge and competencies required to drive innovation, manage projects effectively, and lead their organizations towards sustainable growth.

One of the key training programs focuses on entrepreneurial skills development. This program includes modules on business planning, market analysis, financial management, and risk assessment. Participants learn how to identify market opportunities, develop viable business models, and create comprehensive business plans. Training in financial management covers budgeting, financial forecasting, and securing funding from various sources, including venture capital, grants, and loans. Risk assessment training helps entrepreneurs understand potential risks and develop strategies to mitigate them, ensuring the long-term viability of their ventures. Table 10.1 is indicating components of effective maritime training programs.

Table 10.1: Components of Effective Maritime Training Programs.

Program Type	Key Topics Covered	Example
Entrepreneurial Skills	Business planning, market analysis, financial management.	Blue Economy Incubator Program
Leadership Skills	Strategic planning, decision-making, team building.	European Leadership Academy
Technical Skills	Shipbuilding, maritime logistics, marine technology.	International Maritime Organization Certifications

Maritime startups receive extensive training and support from the Blue Economy Incubator Program. This program offers maritime technology innovation seminars, industry mentorship, and investor

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pitches. Slovenian and Croatian entrepreneurs can learn and access tools to grow their enterprises by participating in such programs.

Leadership development is another important aspect of these training programs. Organizational innovation and change require strong leadership. Leadership training includes strategic planning, decision-making, teamwork, and conflict resolution. Participants learn to express a clear vision, make educated decisions, build, and lead high-performing teams, and settle disagreements. Emotional intelligence and change management training help executives navigate modern business and lead their organizations through change.

Success stories include the European Leadership Academy, which tailors seminars for marine industry professionals. These programs teach leaders strategic thinking, innovation management, and sustainability to help their organizations overcome complicated issues and seize new possibilities.

Industry experts, academic institutions, and professional trainers should collaborate on training programs to ensure relevance and efficacy. Collaboration ensures material meets industry demands and best practices. For example, partnerships with maritime universities and research institutions, such as the University of Ljubljana and the University of Split, can enhance the quality of the training programs by incorporating the latest research and technological advancements in the form of European Digital Innovation Hubs.

Case studies, simulations, and real-world projects should also be included in training programs. This method enhances learning and prepares students for real-world issues by applying theoretical information to actual settings. For instance, maritime operations simulations allow participants to practice and improve their abilities without the risks of real-life events.

Continuous training program improvement requires regular evaluation and feedback. Participants, trainers, and industry stakeholders provide feedback to improve programs and keep them current. Certification after training programs can boost their worth by proving participants' competence. International Maritime Organization (IMO) certificates can increase participants' credibility and employability.

Stakeholders should also have access to advanced training and refresher programs to stay current on industry trends. A marine learning network where participants can share information and experiences can boost these training sessions.

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11 VIRTUAL SITE FOR MARITIME ECOSYSTEM ACTORS

11.1 Concept Development

Developing an integrated online hub that facilitates cooperation, innovation, and knowledge sharing is a key component of the concept development for a dedicated virtual site for Slovenian and Croatian stakeholders in the maritime ecosystem. The purpose of this virtual platform is to foster a lively and interconnected maritime community by bringing together a wide range of stakeholders, including scholars, entrepreneurs, policymakers, and professionals in the marine industry. Table 11.1 indicates key components of the virtual site.

Table 11.1: 21 Key Components of the Virtual Site.

Component	Description	Example
Interactive Knowledge Hub	Central repository for industry reports, research papers, and best practices.	Maritime Knowledge Hub
Collaboration Tools	Forums, discussion boards, and social networking features.	Industry Forums
Innovation Marketplace	Platform for startups to showcase products and services.	Virtual Innovation Fair
Training Resources	Online courses, training modules, and certification programs.	Maritime Training Portal
Data Analytics	Tools for industry trends, performance metrics, and market dynamics.	Maritime Data Insights

The vision for the virtual site is to establish a comprehensive digital ecosystem or so called European Digital Innovation Hub, that provides stakeholders with access to critical resources, tools, and information necessary for driving innovation and growth in the maritime sector. This hub will feature several key components, including an interactive knowledge hub, collaboration and networking tools, an innovation marketplace, training and development resources, and data analytics and insights.

The virtual site will have an interactive knowledge hub for industry reports, research papers, case studies, and best practices. Stakeholders will get marine trends, technical advances, and regulatory updates. This hub will offer great content and extensive search functionality to help people find relevant information for their requirements. The knowledge hub will help stakeholders stay informed and make data-driven decisions by centralizing this information.

Collaboration and networking technologies are essential to virtual sites. These tools will enable real-time stakeholder communication and cooperation with forums, discussion boards, and social media. These technologies will foster community and active participation by letting users share thoughts, address difficulties, and seek partnerships. The hub will also hold webinars and online conferences for networking

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and knowledge sharing. At these events, stakeholders can learn from industry professionals, share their experiences, and make connections.

Maritime startups and innovators will display their products and services at the innovation marketplace. This marketplace will help stakeholders find new ideas, investors, and business prospects. Product demos, virtual booths, and matching will improve user experience and enable significant innovator-investor interactions. The innovation marketplace will develop maritime technology and encourage entrepreneurship by displaying cutting-edge solutions.

The virtual site will also contain training and development. The hub will offer online courses, training modules, and certification programs to strengthen marine professionals' skills. These resources will include digital transformation, sustainability, and leadership. Quizzes, simulations, and case studies make learning fun and effective. The virtual site's high-quality training and development resources will assist stakeholders stay current on industry trends and best practices, boosting innovation and growth.

Finally, the hub will use advanced data analytics to inform stakeholders about industry trends, performance indicators, and market dynamics. These tools will help users make data-driven decisions, find growth opportunities, and track their progress. Data analytics will help stakeholders understand the maritime sector's intricacies, spot patterns, and make strategic decisions.

The virtual portal intends to promote Slovenia and Croatia's maritime innovation ecosystems by merging these components into a dynamic, user-friendly platform. The portal will foster maritime innovation and competitiveness by facilitating collaboration and knowledge sharing. The virtual site will give stakeholders the resources and tools they need to thrive, encouraging innovation and collaboration that will sustain and grow the maritime sectors in both countries.

11.2 Implementation Plan

The implementation plan for developing and launching a dedicated virtual site for maritime ecosystem actors in Slovenia and Croatia involves a meticulously structured approach designed to ensure a seamless and effective rollout. This comprehensive process comprises several key phases: needs assessment, planning and design, development, testing and quality assurance, launch and promotion, and ongoing maintenance and improvement. Each phase is crucial for building a resilient hub that meets the needs of all stakeholders and cultivates innovation and collaboration in the maritime sector. Table 11.2 is showing implementation phases of the plan.

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Table 11.2: Implementation Plan Phases.

Phase	Description	Example Activities
Needs Assessment	Identify specific requirements and pain points.	Surveys, focus groups, interviews
Planning and Design	Develop project plan, wireframes, and prototypes.	Workshops, design sessions
Development	Build the platform using agile methodologies.	Sprints, feature development
Testing and Quality Assurance	Ensure platform functionality and quality.	Beta testing, usability testing
Launch and Promotion	Officially launch the platform and promote it.	Marketing campaigns, training
Ongoing Maintenance	Continuous updates and improvements.	Regular updates, feedback loops

Needs Assessment: The initial phase of the implementation plan is conducting a thorough needs assessment. This step is critical as it lays the foundation for the entire project by identifying the specific requirements, preferences, and pain points of the target users. Engaging with stakeholders through surveys, focus groups, and interviews is essential to gather comprehensive insights. For instance, maritime industry professionals might require specific functionalities such as real-time communication tools, while researchers might prioritize access to extensive databases and analytical tools. This feedback will directly inform the design and functionality of the virtual site, ensuring it addresses the real-world needs of its users.

Planning and Design: Following the needs assessment, a detailed project plan will be developed. This plan outlines the scope, objectives, timelines, and resources required for the project. During the design phase, creating wireframes and prototypes is critical to visualize the user interface and user experience. Involving stakeholders in the design process through workshops and feedback sessions ensures that the hub meets their expectations and provides an intuitive and user-friendly experience. The design should focus on ease of navigation, accessibility, and aesthetic appeal. For instance, the layout of the knowledge hub must facilitate quick access to relevant information, and collaboration tools should offer seamless communication channels.

Development: The development phase involves building the virtual site using agile methodologies, which allow for iterative development and continuous feedback integration. A multidisciplinary team, including software developers, UI/UX designers, and content creators, will work together to develop the hub's various components. For example, the knowledge hub could integrate a sophisticated search engine, while the innovation marketplace might feature interactive elements such as virtual booths and live chat options. Regular progress reviews and stakeholder feedback sessions will be essential to ensure the project remains on track and aligns with the set goals. An example of agile development in action might include sprints dedicated to specific features, such as implementing a video conferencing tool for virtual events as the European Union is implementing new online rules for platforms and as the The

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Digital Services Act and Digital Markets Act set a high global benchmark for regulating digital services with clear obligations tailored to the importance of the online platforms.

Testing and Quality Assurance: Upon completing the development phase, comprehensive testing will be conducted to ensure the hub functions correctly and meets quality standards. This includes functionality testing to verify that all features work as intended, usability testing to ensure the hub is user-friendly, security testing to protect against vulnerabilities, and performance testing to handle high traffic loads. Beta testing with a select group of stakeholders will provide valuable feedback for making necessary adjustments. For instance, if beta testers find the navigation of the innovation marketplace cumbersome, adjustments can be made to improve user flow before the official launch.

Launch and Promotion: The official launch of the virtual site will be accompanied by a strategic marketing and communication plan aimed at raising awareness and driving user engagement. Promotional campaigns will utilize various channels, including social media, industry publications, and events. A launch event, possibly a virtual conference featuring keynote speakers from the maritime industry, can generate significant interest and attract a wide audience. Training sessions and user guides will be essential to help stakeholders navigate and utilize the hub effectively, ensuring they can leverage all available tools and resources.

Ongoing Maintenance and Improvement: Post-launch, a dedicated team will oversee the ongoing maintenance and continuous improvement of the virtual site. This includes regular updates to introduce new features, enhance existing functionalities, and address user feedback. Continuous monitoring and evaluation are crucial to ensure the hub remains relevant and valuable to stakeholders. For example, periodic surveys and feedback forms can help gather user input on needed improvements or desired new features. The team can then prioritize these requests based on user demand and strategic goals.

By following this comprehensive implementation plan, Slovenia and Croatia can develop and launch a state-of-the-art virtual site that significantly enhances collaboration, innovation, and growth within their maritime ecosystems. The hub will serve as a catalyst for driving sustainable development and competitiveness in the maritime sector, positioning both countries as leaders in maritime innovation. The careful planning, stakeholder involvement, and continuous improvement will ensure that the virtual site meets the evolving needs of the maritime community, stimulating a vibrant and interconnected ecosystem that supports long-term success and growth.

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12 FLEMISH ECOSYSTEM CONTRIBUTION

12.1 Knowledge Sharing: Case Studies and Examples from the Flemish Ecosystem

The Flemish ecosystem is renowned for its innovative practices and strong knowledge-sharing mechanisms that have significantly contributed to the region's economic and technological advancements. This ecosystem exemplifies how a collaborative approach, coupled with strategic investments in technology and infrastructure, can drive substantial growth and innovation across maritime sectors. By examining the Flemish model and its reports, Slovenia and Croatia can gain valuable insights into creating a dynamic maritime innovation ecosystem that cultivates sustainable development, competitive advantage, and international relevance.

Open innovation and ongoing learning are valued highly in Flanders, where information sharing is not only common but also a vital component of the ecosystem. This dedication is demonstrated by the many programs and organizations working to promote cooperation between many stakeholders, including government agencies, startups, academic institutions, and leaders in the industry. These partnerships have produced innovative initiatives, technological breakthroughs, and best practices that have distinguished the Flemish marine industry on a worldwide scale.

Furthermore, the Flemish region's historically significant marine commerce and important geographic location have made a forward-thinking solution to industry difficulties imperative. To stay competitive, the ports in the area—especially the Port of Antwerp—have developed innovation hubs that combine cutting-edge techniques with environmentally friendly methods. The structured knowledge-sharing procedures that guarantee ongoing improvement and adaptation to shifting global dynamics are just as important to these endeavors' success as their technological prowess.

We shall examine case studies and illustrations of these successful knowledge-sharing techniques from the Flemish marine industry in the ensuing sections. These illustrations will offer a thorough grasp of how Flanders has made the most of its assets, fostered teamwork, and kept an unwavering emphasis on innovation to produce outstanding results. Slovenia and Croatia may learn useful lessons and put these case studies to use by looking at them. This will help them improve their marine innovation ecosystems, which will ultimately lead to growth and sustainability in their respective regions.

We will explore initiatives such as the Port of Antwerp's Innovation Hub, the Flanders Marine Institute (VLIZ), and the Blue Cluster Initiative, among others. Each of these examples highlights different aspects of the Flemish approach to knowledge sharing, from digital transformation and environmental sustainability to collaborative research and public-private partnerships. These case studies will not only showcase the successes of the Flemish ecosystem but also provide a roadmap for Slovenia and Croatia to follow in their quest to build resilient and forward-looking maritime sectors.

12.1.1 Port of Antwerp's Innovation Hub: The Antwerp Port Digital Twin

The Port of Antwerp, situated in Belgium, is not only one of Europe’s largest ports but also one of its most advanced. A testament to its forward-thinking approach is the establishment of the Antwerp Port Innovation Hub. This hub serves as a dynamic focal point for knowledge sharing and technological development, bringing together a diverse array of stakeholders, including port authorities, logistics

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companies, research institutions, and technology startups. One of the most groundbreaking initiatives spearheaded by the Innovation Hub is the "Antwerp Port Digital Twin."

The Antwerp Port Digital Twin is a comprehensive digital replica of the port's physical operations and infrastructure. This sophisticated project integrates big data, Internet of Things (IoT) sensors, and artificial intelligence (AI) to create a real-time, interactive model of the port. The digital twin serves multiple purposes: optimizing port operations, enhancing safety protocols, and reducing environmental impacts.

Big Data Integration: The digital twin aggregates vast amounts of data from various sources within the port, including shipping movements, cargo details, weather conditions, and operational workflows. This data is continuously collected and updated to ensure the digital twin reflects real-time conditions.

IoT Sensors: Thousands of IoT sensors are deployed throughout the port to monitor a wide range of parameters such as container status, equipment performance, environmental conditions, and energy consumption. These sensors provide granular data that feeds into the digital twin.

Artificial Intelligence and Machine Learning: AI algorithms analyze the received data to predict trends, identify inefficiencies, and suggest optimal solutions. Machine learning models are used to improve the accuracy of these predictions over time, learning from historical data and operational patterns.

Visualization and Simulation: The digital twin offers a high-fidelity 3D visualization of the port, enabling stakeholders to simulate various scenarios, such as traffic management, emergency response, and infrastructure planning. This visual tool aids in strategic decision-making and operational planning.

Benefits of the Digital Twin

Operational Efficiency: By providing a real-time overview of port operations, the digital twin enables more efficient resource allocation and process optimization. For example, it can suggest optimal schedules, streamline cargo handling, and predict maintenance needs for port equipment, thereby minimizing downtime.

Safety Enhancements: The digital twin improves safety by monitoring and predicting potential hazards. It can detect unusual patterns that might indicate safety risks, such as equipment failures or environmental threats, allowing for pre-emptive measures.

Environmental Impact Reduction: The project supports the port's sustainability goals by monitoring and managing emissions, energy use, and waste. The digital twin can model the environmental impact of various operational changes, helping the port to implement greener practices and reduce its carbon footprint.

Stakeholder Collaboration: By creating a common hub for data sharing, the digital twin cultivates collaboration among all port stakeholders. It facilitates transparent communication, joint problem-solving, and coordinated responses to operational challenges.

Implementation Process

Phase 1: Initial Planning and Stakeholder Engagement

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The initial phase involved detailed planning and extensive engagement with all relevant stakeholders. Port authorities, logistics companies, technology partners, and academic institutions were brought together to outline the project's scope, objectives, and requirements.

Phase 2: Data Collection and Infrastructure Setup

The next phase focused on setting up the necessary infrastructure for data collection. This involved installing IoT sensors across the port and integrating existing data sources. Establishing robust data governance frameworks was crucial to ensure data accuracy and security.

Phase 3: Development and Testing

With the infrastructure in place, the development phase began. This phase involved building the digital twin's software components, integrating AI and machine learning algorithms, and creating visualization tools. Extensive testing was conducted to ensure the system's reliability and accuracy.

Phase 4: Deployment and Optimization

After successful testing, the digital twin was deployed. Continuous monitoring and optimization were undertaken to refine the system, incorporating feedback from users and adjusting algorithms to improve performance.

Phase 5: Scaling and Knowledge Sharing

Finally, the project was scaled up to cover the entire port. Knowledge sharing mechanisms were established, including regular workshops, training sessions, and collaboration hubs, to ensure all stakeholders could fully leverage the digital twin's capabilities.

Lessons for Slovenia and Croatia

In the table 12.1 below are gathered lessons for Slovenia and Croatia from the Antwerp Port Digital Twin.

Table 12.1: Lessons for Slovenia and Croatia from the Antwerp Port Digital Twin.

Lesson	Description
Strategic Planning and Stakeholder Engagement	Engaging all relevant stakeholders from the outset, ensuring alignment with maritime community needs
Investment in Technology Infrastructure	Prioritizing deployment of IoT sensors, development of data integration platforms
Focus on Data Governance	Establishing strong data governance frameworks, ensuring data quality, security, and privacy
Customization and Local Adaptation	Tailoring technology to specific needs and conditions, reflecting local operational patterns and environmental conditions
Sustainability and Environmental Goals	Integrating environmental monitoring and sustainability objectives into digital twin projects
Continuous Improvement and Scaling	Adopting an iterative approach, starting with pilot projects and gradually scaling up

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12.1.2 Flanders Marine Institute (VLIZ): Promoting Marine Research and Knowledge Dissemination

The Flanders Marine Institute (VLIZ) stands as a cornerstone of the Flemish maritime ecosystem, playing a key role in promoting marine research and facilitating the dissemination of knowledge. As an institution dedicated to the advancement of marine science, VLIZ has developed a robust infrastructure that supports a wide array of research activities and cultivates a collaborative environment for scientists, policymakers, and industry professionals.

At the heart of VLIZ's efforts is its extensive marine data and information system, a sophisticated hub that provides open access to a vast repository of datasets, research findings, and publications. This system is designed to be user-friendly and accessible, enabling a broad range of stakeholders to leverage its resources for various purposes.

Comprehensive Data Repositories: VLIZ's hub hosts a wide range of datasets covering various aspects of marine science, including oceanographic data, biodiversity records, environmental monitoring results, and climate change impacts. These datasets are meticulously curated and regularly updated to ensure their relevance and accuracy.

Open Access and Transparency: A fundamental principle of VLIZ's hub is open access. All datasets, research findings, and publications are freely available to the public, promoting transparency and facilitating widespread use of the information. This openness encourages a culture of shared learning and collaboration.

Advanced Search and Visualization Tools: The hub is equipped with advanced search functionalities and visualization tools that allow users to easily navigate and explore the data. Interactive maps, graphs, and dashboards provide intuitive ways to visualize complex information, making it accessible to non-experts.

Interoperability and Integration: VLIZ ensures that its data and information system is interoperable with other major marine databases and hubs. This integration allows for seamless data exchange and enhances the comprehensiveness of available information, benefiting global marine research efforts.

VLIZ's approach to stimulating collaboration and knowledge sharing is many-sided, involving regular workshops, seminars, and conferences that bring together diverse stakeholders from the marine sector.

Workshops and Seminars: VLIZ organizes frequent workshops and seminars on a wide range of topics relevant to marine science and industry. These events provide hubs for scientists to present their research, share methodologies, and discuss new findings. They also offer opportunities for policymakers and industry professionals to engage with researchers, facilitating the translation of scientific knowledge into practical applications.

Conferences and Networking Events: Annual conferences hosted by VLIZ attract international participants, stimulating a global exchange of ideas and best practices. These events are designed to stimulate innovation and collaboration, with sessions dedicated to emerging trends, technological advancements, and policy developments in the marine sector.

Specialized Training Programs: To further support capacity building, VLIZ offers specialized training programs for early-career scientists and professionals. These programs cover a range of topics, from data management and analysis techniques to the application of new technologies in marine research. By

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enhancing the skills and knowledge of participants, these programs contribute to the overall advancement of marine science.

Impact and Lessons for Slovenia and Croatia from Flanders Marine Institute (VLIZ)

In the table 12.2 below are gathered impacts and lessons for Slovenia and Croatia from VLIZ's Approach.

Table 12.2: Impact and Lessons for Slovenia and Croatia from VLIZ's Approach.

Lesson	Description	Impact
Developing Robust Data Infrastructure	Establishing open-access data platforms that are user-friendly and interoperable to promote transparency and facilitate access to crucial information.	Enhances transparency, supports widespread access to marine data, and fosters a collaborative research environment.
Promoting Open Access	Making datasets, research findings, and publications freely available to encourage collaboration among scientists, policymakers, and industry stakeholders.	Cultivates a culture of shared learning and collaboration, driving innovation and informed decision-making.
Organizing Collaborative Events	Hosting workshops, seminars, and conferences to bring together diverse stakeholders and promote the exchange of ideas and best practices.	Facilitates knowledge sharing, addresses specific regional challenges, and strengthens stakeholder networks.
Capacity Building and Training	Developing specialized training programs focused on the latest scientific methodologies and practical applications of new technologies.	Builds the skills and knowledge of maritime professionals, ensuring they are equipped to drive innovation and adapt to technological advancements.
Integration with Global Networks	Ensuring data platforms are interoperable with international databases to enhance the comprehensiveness of available information and support global research efforts.	Positions Slovenia and Croatia as active contributors to the global marine science community, driving sustainable development and competitiveness in their maritime sectors.

12.1.3 Blue Cluster Initiative: Advancing Innovation in the Blue Economy

The Blue Cluster is a prominent collaborative network within the Flemish maritime ecosystem, dedicated to stimulating innovation across the blue economy. This initiative unites businesses, research institutions, and government bodies to drive progress in key areas such as sustainable aquaculture, renewable energy, and maritime logistics in the form of Innovation Roadmaps. By leveraging collective expertise and resources, the Blue Cluster and its Innovation Roadmaps play a critical role in enhancing the region's economic and environmental sustainability. The successful development of offshore wind farms in the North Sea stands as a testament to the initiative's impact, providing valuable insights and lessons for Slovenia and Croatia.

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The Blue Cluster's well-organized collaborative network, which unites a wide range of stakeholders, is the key to its success. This network is intended to promote cooperative research, knowledge exchange, and well-coordinated project execution.

Engagement of Stakeholders: The Blue Cluster encompasses a broad spectrum of stakeholders, comprising major corporations, small and medium-sized businesses (SMEs), academic institutions, government agencies, and research institutes. Through fostering an inclusive atmosphere, the project guarantees that diverse viewpoints and skills are applied to the intricate problems confronting the blue economy.

Strategic Alliances: The Blue Cluster establishes alliances with eminent institutions and organizations to optimize effect. Agreements that specify the duties, obligations, and contributions of each partner establish these collaborations. This methodical approach to cooperation guarantees agreement and clarity among participants.

Project Support and money: Through money, technical support, and project management know-how, the initiative offers innovative ventures significant support. Numerous sources of funding are used, including national, regional, and EU initiatives. This funding is essential for reducing the risk associated with innovative projects and hastening their growth.

Offshore Wind Farms in the North Sea

Offshore wind farm development in the North Sea is one of the Blue Cluster's most notable accomplishments. This project is an excellent example of the initiative's collaborative innovation strategy and shows how it can lead to major breakthroughs in the field of renewable energy.

Project Synopsis: Large-scale wind turbines will be installed in the maritime environment as part of the North Sea offshore wind farm project, which will use wind energy to produce power. This program seeks to lower carbon emissions, lessen dependency on fossil fuels, and improve the energy security of the area.

Collaborative Research and Development: The initiative makes use of the combined knowledge of several stakeholders, including government organizations, engineering corporations, energy companies, and environmental experts. The main goals of cooperative research projects are to minimize environmental effects, enhance installation methods, and optimize turbine design. To increase efficiency and dependability, cutting edge technologies are being investigated, such as smart grid integration and floating wind turbines.

Technological Innovation: The offshore wind farm project makes use of state-of-the-art innovations and technology. For example, preventative maintenance and effective turbine operation are made possible by the introduction of IoT sensors and real-time monitoring systems. To support ongoing advancements, these technologies also offer insightful data on wind patterns, turbine performance, and environmental factors.

Environmental Sustainability: The project's emphasis on environmental sustainability is one of its main features. To make sure that the installation and operation of wind farms do not negatively influence maritime ecosystems, thorough environmental impact evaluations are carried out. To safeguard biodiversity, mitigation strategies are used, such as the creation of marine protected areas and the use of environmentally friendly products.

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Economic Impact: The construction of offshore wind farms has several positive economic effects, such as the creation of jobs, investments in regional supply chains, and lower energy expenses. In line with more general environmental objectives, the project boosts the blue economy and encourages economic growth in coastal areas. In table 12.3 below are indicated all lessons for Slovenia and Croatia.

Impact and lessons for Slovenia and Croatia from…

Table 12.3: Impact and lessons for Slovenia and Croatia from the Blue Cluster Approach.

Lesson	Description	Impact
Building Collaborative Networks	Establishing robust collaborative networks that bring together diverse stakeholders for regular interaction, joint research, and strategic partnerships.	Fosters innovation through enhanced collaboration and knowledge sharing among stakeholders, driving collective progress.
Structured Project Management	Adopting a systematic approach to project planning, implementation, and evaluation to ensure effective execution of innovative initiatives.	Ensures projects are well-managed, reducing risks and enhancing the likelihood of successful outcomes.
Leveraging Funding Opportunities	Identifying and securing funding from various sources, including EU programs, and developing mechanisms to channel financial support to promising ventures.	Provides financial resources necessary to support innovation projects, enhancing the capability to undertake large-scale and impactful initiatives.
Emphasizing Environmental Sustainability	Integrating sustainability principles into project development, including thorough environmental impact assessments and mitigation measures.	Balances economic growth with environmental preservation, ensuring long-term sustainability and compliance with global environmental standards.
Promoting Technological Innovation	Investing in research and development of advanced technologies such as IoT, AI, and renewable energy solutions, and focusing on collaborative efforts to adopt these technologies.	Enhances the competitiveness of the maritime sector through cutting-edge technological advancements and increased operational efficiency.
Capacity Building and Knowledge Sharing	Establishing training programs, workshops, and knowledge-sharing platforms to support capacity building among stakeholders and foster a culture of continuous learning and innovation.	Strengthens the skills and knowledge of maritime professionals, driving continuous improvement and innovation within the maritime ecosystems of Slovenia and Croatia.

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12.1.4 Hydrex Underwater Solutions: Pioneering Underwater Maintenance and Repair

Hydrex Underwater Solutions is a globally recognized provider of underwater repair and maintenance services, renowned for its innovative approach to maritime operations. Based in Antwerp, Belgium, Hydrex has developed cutting-edge techniques and technologies that significantly reduce the need for traditional dry docking, thereby minimizing downtime and operational costs for vessel operators. This section explores the detailed methodologies employed by Hydrex, the environmental benefits of their approach, and how Slovenia and Croatia can learn from these practices to enhance their maritime sectors.

With its collection of patented technologies and techniques, Hydrex has completely transformed underwater maintenance. The mob dock, a mobile mini-drydock that forms a dry working environment around a vessel's hull while it is in the water, is one of the most noteworthy inventions. This technology eliminates the need for the vessel to enter a standard dry dock in order to do complex repairs like hull maintenance, rudder repairs, and propeller blade replacements on-site. Because of its adaptability and effectiveness, the mob dock is now the go-to option for both routine maintenance and urgent repairs.

The Ecospeed hull coating is another significant breakthrough. It is a long-lasting, green hull coating that lowers fouling and boosts fuel economy. Because Ecospeed is built to survive the challenging marine environment, it can operate more economically overall and requires fewer maintenance intervals. Hydrex uses Ecospeed to lessen the environmental impact of shipping operations, which not only improves vessel performance but also complies with worldwide sustainability goals.

When compared to conventional dry docking, Hydrex's underwater repair processes offer considerable environmental benefits. The company lowers the need for vessels to travel to dry docks by completing repairs underwater, hence reducing fuel usage and related emissions. Furthermore, a major problem with conventional maintenance techniques is the release of toxic antifouling compounds into marine habitats, which is prevented by Hydrex's approaches.

By improving the hydrodynamic efficiency of vessels, the Ecospeed hull coating further promotes environmental sustainability by reducing fuel consumption and greenhouse gas emissions. Because of the coating's extended longevity, fewer treatments are needed during a vessel's lifetime, which lowers the environmental impact of maintenance procedures.

The usage of biodegradable cleaning products and tight observance of environmental laws while conducting business demonstrate Hydrex's dedication to environmentally friendly methods. By ensuring that its maintenance procedures don't negatively impact ecosystems or marine life, these procedures establish a high bar for environmental responsibility in the maritime sector.

Practical Applications and Case Studies

One of the flagship projects demonstrating Hydrex's capabilities is the emergency repair of a large container vessel's propeller in the Port of Rotterdam. The vessel had suffered significant damage to one of its propeller blades, risking a costly and time-consuming trip to a dry dock. Hydrex deployed their mobdock technology to create a dry environment around the propeller while the vessel remained afloat. Skilled divers then performed a complex blade replacement using advanced underwater welding techniques. This repair was completed in a fraction of the time required for traditional methods, allowing the vessel to resume operations with minimal delay.

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Another notable case involves the application of Ecospeed coating to a fleet of offshore supply vessels operating in the North Sea. These vessels experienced frequent fouling due to the harsh marine environment, impacting their fuel efficiency and operational costs. Hydrex applied the Ecospeed coating, which significantly reduced fouling and improved fuel efficiency. Over the subsequent years, these vessels required fewer maintenance intervals, resulting in substantial cost savings and reduced environmental impact.

Lessons for Slovenia and Croatia from Hydrex Underwater Solutions

Slovenia and Croatia can draw several key lessons from Hydrex's innovative practices to enhance their maritime sectors, as indicated in the table 12.4 below.

Table 12.4: Lessons for Slovenia and Croatia from Hydrex.

Lesson	Description
Investment in Underwater Technologies	Invest in advanced underwater repair and maintenance technologies to reduce reliance on traditional dry docking, minimizing operational downtime and costs. Establish local centers of excellence for underwater repairs.
Eco-Friendly Practices	Promote the use of eco-friendly hull coatings and biodegradable cleaning agents to align with global sustainability trends and reduce the environmental footprint.
Training and Skills Development	Invest in specialized training programs for divers and maritime engineers. Collaborate with international experts and institutions for knowledge transfer and skill development.
Regulatory Support and Incentives	Provide regulatory support and financial incentives for adopting innovative maritime technologies. Promote sustainable practices and investment in R&D to accelerate sector modernization.
Cross-Border Collaboration	Encourage collaboration between Slovenian and Croatian maritime stakeholders to enhance knowledge sharing and innovation. Develop joint initiatives in underwater technology and eco-friendly practices to drive regional competitiveness.

Hydrex Underwater Solutions exemplifies how innovative technologies and eco-friendly practices can transform the maritime industry. By leveraging advanced underwater repair techniques, eco-friendly coatings, and a commitment to sustainability, Hydrex has set a high standard for efficiency and environmental responsibility. Slovenia and Croatia can draw valuable insights from Hydrex's practices to enhance their own maritime sectors, stimulating innovation, reducing costs, and promoting sustainability. By investing in similar technologies and adopting best practices, both countries can position themselves as leaders in the global maritime industry.

12.1.5 Flanders' Maritime Cluster: Driving Innovation through Collaboration

The Flanders' Maritime Cluster (FMC) is a prominent organization that exemplifies the power of collaboration in driving innovation and growth within the maritime sector. The FMC serves as a network for maritime companies, research institutions, and government bodies, promoting synergy and

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stimulating a competitive maritime industry in Flanders. This section delves into the detailed structure, activities, and successes of the FMC, and provides insights into how Slovenia and Croatia can benefit from adopting similar collaborative frameworks.

The FMC operates as a collaborative network designed to bring together various stakeholders from the maritime industry, including shipbuilders, ports, logistics companies, technology providers, research institutions, and policy makers. The primary objectives of the FMC are to:

Cultivate Innovation: Promote research and development (R&D) activities to advance maritime technologies and processes.

Enhance Competitiveness: Support the development of a competitive maritime industry through collaboration and knowledge sharing.

Promote Sustainability: Encourage the adoption of sustainable practices and technologies within the maritime sector.

Facilitate Networking: Create hubs for stakeholders to connect, share ideas, and collaborate on projects.

Key Activities and Initiatives

1. Collaborative R&D Projects:

The FMC supports and coordinates collaborative research projects that bring together companies, research institutions, and universities. One notable project is the "Smart Maritime Logistics" initiative, which focuses on developing digital solutions to enhance the efficiency and sustainability of maritime logistics. This project involves the integration of Internet of Things (IoT) devices, big data analytics, and blockchain technology to create a smart logistics network that improves cargo tracking, reduces operational costs, and minimizes environmental impact.

2. Innovation Hubs and Clusters:

The FMC has established several innovation hubs and clusters that act as incubators for new technologies and business models. These hubs provide startups and small and medium-sized enterprises (SMEs) with access to resources, mentorship, and funding opportunities. The "Blue Accelerator" is one such hub, located at the port of Ostend. It focuses on supporting innovations in offshore energy, aquaculture, and marine biotechnology. The accelerator provides facilities for testing and prototyping, as well as connections to potential investors and partners.

3. Networking Events and Conferences:

To facilitate knowledge exchange and collaboration, the FMC organizes regular networking events, seminars, and conferences. These events bring together maritime professionals to discuss industry trends, share best practices, and explore collaboration opportunities. The "Flemish Maritime Days" is an annual conference that attracts stakeholders from across the maritime industry, featuring keynote speakers, panel discussions, and workshops on various maritime topics.

4. Training and Development Programs:

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Recognizing the importance of a skilled workforce, the FMC offers training and development programs tailored to the needs of the maritime industry. These programs cover areas such as advanced manufacturing techniques, digitalization, and sustainable practices. The "Maritime Skills Academy" is an FMC initiative that provides training courses and certification programs to enhance the skills of maritime professionals and ensure a pipeline of talent for the industry.

5. Policy Advocacy and Regulatory Support:

The FMC actively engages with government bodies to advocate for policies that support the maritime industry. This includes lobbying for regulatory frameworks that promote innovation, sustainability, and competitiveness. The cluster also provides members with updates on regulatory changes and offers guidance on compliance.

Case Studies and Successes

1. Smart Maritime Logistics:

The Smart Maritime Logistics project is a flagship initiative of the FMC that has significantly enhanced the efficiency of maritime logistics in Flanders. By leveraging IoT devices and big data analytics, the project has improved cargo tracking and reduced turnaround times at ports. The use of blockchain technology has also increased transparency and security in supply chain operations. The success of this project has positioned Flanders as a leader in smart logistics solutions, attracting investment and business opportunities from around the world.

2. Blue Accelerator:

The Blue Accelerator in Ostend has supported numerous startups and SMEs in developing innovative solutions for the blue economy. One notable success story is "Aquafarm," a startup that developed a sustainable aquaculture system using advanced monitoring and feeding technologies. With support from the Blue Accelerator, Aquafarm was able to prototype and test its system, secure funding, and bring its product to market. The startup has since expanded its operations and established partnerships with international aquaculture companies.

3. Flemish Maritime Days:

The annual Flemish Maritime Days conference has become a key event for the maritime industry, attracting over 1,000 participants each year. The conference has facilitated numerous collaborations and partnerships, leading to the development of new projects and initiatives. It has also provided a hub for stakeholders to share insights and best practices, stimulating a culture of continuous improvement and innovation within the maritime sector.

Slovenia and Croatia can draw several valuable lessons from the success of the Flemish Maritime Cluster, as indicated in the table 12.5 below.

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Table 12.5: Lessons for Slovenia and Croatia from FMC.

Lesson	Description
Establish Collaborative Networks	Create networks that bring together diverse stakeholders from the maritime industry to foster innovation and enhance competitiveness. Promote collaboration, resource sharing, and R&D activities.
Support Innovation Hubs	Develop innovation hubs and accelerators to provide startups and SMEs with support for developing and commercializing new technologies. Offer facilities for testing, prototyping, mentorship, and funding.
Organize Networking Events	Facilitate knowledge exchange and collaboration among maritime professionals through regular networking events and conferences. Discuss trends and challenges, and explore partnership opportunities.
Invest in Training and Development	Develop training and development programs tailored to the needs of the maritime industry to ensure professionals have the skills required to succeed in a rapidly changing environment.
Advocate for Supportive Policies	Engage with government bodies to advocate for policies that support innovation, sustainability, and competitiveness. Develop regulatory frameworks that promote the growth of the maritime sectors.

The Flemish Maritime Cluster exemplifies the power of collaboration and innovation in driving the growth and competitiveness of the maritime industry. By leveraging collaborative networks, supporting innovation hubs, organizing networking events, investing in training and development, and advocating for supportive policies, the FMC has created a thriving maritime ecosystem in Flanders. Slovenia and Croatia can draw valuable insights from the FMC's success and adopt similar strategies to enhance their own maritime sectors, stimulating a culture of innovation and collaboration that drives sustainable growth and development.

12.1.6 Antwerp Maritime Academy: Stimulating Excellence in Maritime Education and Training

The Antwerp Maritime Academy (AMA) is a premier institution in the Flemish maritime ecosystem, dedicated to providing high-quality education and training for maritime professionals. As a center of excellence, AMA plays a crucial role in shaping the future of the maritime industry by equipping students with the necessary skills and knowledge to excel in their careers. This section provides a detailed examination of AMA's structure, programs, initiatives, and successes, highlighting how Slovenia and Croatia can benefit from adopting similar educational frameworks to enhance their maritime sectors.

The Antwerp Maritime Academy operates with a clear mission to deliver top-tier maritime education and training. Its objectives include:

Providing Comprehensive Education: Offer a wide range of academic programs and courses that cover various aspects of maritime studies.

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Promoting Practical Training: Ensure students receive hands-on training through simulators, workshops, and real-world internships.

Advancing Research: Support maritime research initiatives that contribute to industry advancements and innovation.

Stimulating Industry Collaboration: Maintain strong ties with maritime companies, ports, and other stakeholders to ensure the relevance of its educational offerings.

Key Programs and Initiatives

1. Academic Programs:

AMA offers a variety of academic programs, including bachelor's and master's degrees in nautical sciences, maritime engineering, and logistics. These programs are designed to provide students with a strong theoretical foundation and practical skills. Courses cover subjects such as navigation, ship management, marine engineering, maritime law, and logistics management. The curriculum is regularly updated to reflect the latest industry trends and technological advancements.

2. Practical Training and Simulations:

Practical training is a cornerstone of AMA's educational approach. The academy is equipped with state-of-the-art simulators that replicate real-life maritime scenarios, allowing students to practice navigation, cargo handling, and emergency procedures in a controlled environment. The "Bridge Simulator" and "Engine Room Simulator" are among the key facilities that provide immersive training experiences. Additionally, AMA has partnerships with shipping companies and ports, facilitating internships and on-board training opportunities for students.

3. Research and Innovation:

AMA actively engages in research projects that address current challenges in the maritime industry. These projects cover areas such as sustainable shipping, maritime safety, and digitalization. The academy collaborates with industry partners, government bodies, and other academic institutions to conduct research that drives innovation and informs policy decisions. The "Sustainable Shipping Research Initiative" is a notable project focusing on reducing the environmental impact of maritime operations through technological advancements and best practices.

4. Industry Collaboration:

To ensure its programs remain relevant and effective, AMA maintains strong relationships with maritime industry stakeholders. Regular consultations with industry experts help align the curriculum with industry needs. AMA also hosts industry seminars, workshops, and networking events, providing students with opportunities to connect with professionals and stay informed about the latest industry developments.

5. Continuing Education and Professional Development:

AMA offers continuing education and professional development programs for maritime professionals seeking to update their skills or gain new certifications. These programs include short courses, workshops, and certification programs in areas such as advanced navigation, maritime security, and

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environmental management. The academy's commitment to lifelong learning ensures that professionals remain competitive and capable of adapting to industry changes.

Case Studies and Successes

1. Bridge Simulator Training:

The Bridge Simulator at AMA is a cutting-edge facility that provides students with realistic training experiences in navigation and ship handling. The simulator replicates various maritime environments and scenarios, including adverse weather conditions, busy ports, and emergency situations. This training prepares students to handle complex navigation challenges and enhances their decision-making skills. The success of the Bridge Simulator training has been evidenced by the high employability of AMA graduates, who are well-prepared for careers as ship officers and navigators.

2. Sustainable Shipping Research Initiative:

AMA's Sustainable Shipping Research Initiative has made significant contributions to the field of maritime sustainability. The project focuses on developing and promoting technologies and practices that reduce greenhouse gas emissions and improve energy efficiency in shipping. Through collaborative research with industry partners, AMA has developed innovative solutions such as hybrid propulsion systems and eco-friendly ship designs. The initiative has garnered international recognition and funding, positioning AMA as a leader in sustainable maritime research.

3. Industry Seminars and Workshops:

AMA regularly organizes seminars and workshops that bring together students, faculty, and industry professionals to discuss contemporary maritime issues. These events provide a hub for knowledge exchange and cultivate a strong sense of community within the maritime sector. Topics covered include digital transformation in shipping, maritime safety regulations, and the future of autonomous vessels. The success of these events is reflected in the active participation and positive feedback from attendees, highlighting the value of such interactions for professional development and networking.

Slovenia and Croatia can draw several valuable lessons from the Antwerp Maritime Academy, as indicated in the table 12.6 below.

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Table 12.6: Lessons for Slovenia and Croatia from Antwerp Maritime Academy.

Lesson	Description
Invest in Advanced Training Facilities	Developing state-of-the-art training facilities, such as simulators, to provide students with practical, hands-on experience essential for their careers.
Promote Industry Collaboration	Building strong relationships with industry stakeholders to ensure that educational programs remain relevant and aligned with industry needs.
Support Maritime Research	Investing in maritime research initiatives to drive innovation and address industry challenges, focusing on sustainability, safety, and digitalization.
Offer Continuing Education Programs	Providing continuing education and professional development opportunities for maritime professionals to ensure a skilled and adaptable workforce.

The Antwerp Maritime Academy serves as a model of excellence in maritime education and training, demonstrating the importance of practical training, industry collaboration, and research in shaping the future of the maritime industry. By investing in advanced training facilities, promoting industry collaboration, supporting maritime research, and offering continuing education programs, Slovenia and Croatia can enhance their own maritime sectors and cultivate a culture of innovation and excellence. The successes of AMA provide a roadmap for developing robust maritime education and training frameworks that drive sustainable growth and competitiveness in the maritime industry.

12.2 Best practices: Analysis and Lessons from Flemish Ecosystem

The Flemish maritime ecosystem's success is underpinned by several best practices that have been refined over years of experience. This section analyses these practices and explores the lessons learned, offering practical insights that can be adapted to the maritime sectors of Slovenia and Croatia.

12.2.1 Integrated Innovation Strategy

The development of an integrated innovation strategy is one of the most remarkable best practices emerging from the Flemish maritime ecosystem. This strategy, meticulously designed and implemented by the Flemish government in collaboration with key industry stakeholders, aligns the region's maritime goals with broader regional and national policies. By focusing on areas such as digital transformation, sustainability, and logistics efficiency, this integrated approach ensures cohesive and synergistic efforts across the sector. For Slovenia and Croatia, adopting a similar strategic framework can significantly enhance their maritime innovation ecosystems, driving growth, sustainability, and competitiveness.

Components of the Flemish Integrated Innovation Strategy

1. Strategic Roadmaps and Prioritization:

The Flemish innovation strategy begins with the creation of strategic roadmaps that identify and prioritize key innovation areas. These roadmaps are developed through comprehensive consultations with stakeholders, including industry leaders, academic institutions, and government bodies. The roadmaps

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outline specific goals, timelines, and milestones for each priority area, ensuring clear guidance and direction for all involved parties.

Digital Transformation: The roadmap emphasizes the adoption of cutting-edge digital technologies, such as blockchain for supply chain transparency, artificial intelligence for predictive maintenance, and Internet of Things (IoT) for real-time monitoring and optimization of maritime operations.

Sustainability: Another critical focus is on environmental sustainability, with goals set for reducing carbon emissions, increasing the use of renewable energy sources, and promoting green shipbuilding practices. Initiatives like the development of hybrid and electric propulsion systems, implementation of energy-efficient port operations, and adoption of circular economy principles are prioritized.

Logistics Efficiency: The strategy also targets improvements in logistics efficiency, aiming to streamline maritime logistics processes through automation, enhanced data analytics, and integrated logistics hubs.

2. Stakeholder Collaboration:

A cornerstone of the Flemish strategy is the establishment of strong collaborative frameworks among stakeholders. Regular forums, workshops, and roundtable discussions facilitate continuous dialogue and knowledge exchange. This collaborative environment cultivates innovation by enabling stakeholders to share best practices, co-develop solutions, and align their efforts towards common objectives.

Public-Private Partnerships (PPPs): The Flemish government actively promotes PPPs, providing financial incentives and regulatory support for joint ventures between public institutions and private companies. These partnerships focus on developing innovative projects that leverage the strengths of both sectors, such as smart port initiatives and sustainable shipping solutions.

Innovation Clusters: The creation of innovation clusters, where companies, research institutions, and government bodies co-locate, further enhances collaboration. These clusters serve as hubs for research and development, stimulating a culture of innovation and accelerating the commercialization of new technologies.

3. Policy and Regulatory Support:

The success of the Flemish innovation strategy is also attributed to the supportive policy and regulatory environment. The government has implemented policies that encourage innovation, such as tax incentives for research and development (R&D), grants for green technologies, and streamlined regulatory processes for testing and deploying new technologies.

Regulatory Sandboxes: To facilitate the adoption of emerging technologies, the Flemish government has introduced regulatory sandboxes that allow companies to experiment with innovative solutions in a controlled environment. These sandboxes provide a safe space for testing new technologies and business models without the immediate burden of full regulatory compliance.

Funding Mechanisms: The government has established various funding mechanisms to support innovation projects. These include grants, low-interest loans, and equity investments aimed at reducing the financial risk for companies undertaking innovative initiatives.

Application to Slovenia and Croatia

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For Slovenia and Croatia, adopting a similar integrated innovation strategy can yield substantial benefits. In the table 12.7 below is indicated how these countries can implement the Flemish model.

Table 12.7: Lessons from the Flemish Integrated Innovation Strategy for Slovenia and Croatia.

Lesson	Description
Develop Strategic Roadmaps	Conduct stakeholder consultations to prioritize innovation areas and develop roadmaps with specific goals and timelines.
Foster Stakeholder Collaboration	Establish regular forums and workshops, encourage public-private partnerships, and create innovation clusters for R&D.
Enhance Policy and Regulatory Support	Implement supportive policies, introduce regulatory sandboxes, and establish funding mechanisms for innovative projects.
Monitor and Evaluate Progress	Develop a robust monitoring framework to track progress, regularly review strategies, and engage stakeholders for feedback.

Engage stakeholders in the evaluation process to ensure transparency and accountability.

Case Studies for Inspiration

1. Digital Transformation in Port Operations:

Slovenia and Croatia can draw inspiration from the Antwerp Port Digital Twin project. By developing their own digital twins, ports like Koper and Rijeka can optimize operations, enhance safety, and reduce environmental impact through real-time monitoring and data-driven decision-making.

2. Sustainable Shipping Initiatives:

Emulate the Flemish focus on sustainable shipping by promoting the adoption of green technologies. Projects like the development of hybrid and electric propulsion systems can significantly reduce carbon emissions and operational costs for the maritime industry.

3. Integrated Logistics Hubs:

Develop integrated logistics hubs to streamline maritime logistics processes. Leveraging technologies like IoT and blockchain can enhance transparency, efficiency, and reliability in the supply chain.

The Flemish integrated innovation strategy serves as a powerful model for Slovenia and Croatia, offering a comprehensive approach to enhancing their maritime innovation ecosystems. By developing strategic roadmaps, stimulating stakeholder collaboration, enhancing policy support, and monitoring progress, Slovenia and Croatia can create a cohesive and effective innovation framework. This integrated approach will drive sustainable growth, enhance competitiveness, and position both countries as leaders in maritime innovation.

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12.2.2 Public-Private Partnerships (PPPs): A Pathway for Innovation and Growth

Public-Private Partnerships (PPPs) are a fundamental component of the Flemish maritime innovation ecosystem, providing a collaborative framework that leverages the strengths of both public institutions and private enterprises. This strategic approach has proven to be highly effective in driving innovation, enhancing infrastructure, and stimulating sustainable economic growth. By examining successful PPPs in Flanders, Slovenia and Croatia can gain valuable insights into how to implement similar models to boost their maritime sectors.

Components of Successful Public-Private Partnerships in Flanders

1. Strategic Collaboration:

In Flanders, PPPs are characterized by strategic collaboration between government entities, private companies, research institutions, and other stakeholders. These partnerships are designed to align with national and regional policy goals, ensuring that the projects undertaken contribute to broader economic and social objectives.

Government Initiatives: The Flemish government actively promotes PPPs by identifying key areas where collaboration can drive significant benefits. This includes sectors such as digital infrastructure, renewable energy, and advanced manufacturing.

Private Sector Involvement: Private companies bring innovation, efficiency, and investment to the table, while also benefiting from the stability and support provided by government partnerships. This symbiotic relationship ensures that both parties are invested in the success of the projects.

2. Clear Governance and Accountability:

Effective governance structures are crucial for the success of PPPs. In Flanders, clear roles and responsibilities are established for all partners, ensuring transparency and accountability throughout the project lifecycle.

Joint Committees: Establishing joint committees or steering groups that include representatives from both the public and private sectors helps in overseeing the project's progress and making strategic decisions.

Performance Metrics: Defining performance metrics and KPIs at the outset of the project allows for continuous monitoring and evaluation. This ensures that the project stays on track and meets its objectives.

3. Risk Sharing and Financial Arrangements:

One of the key advantages of PPPs is the ability to share risks and financial burdens between the public and private sectors. In Flanders, innovative financial arrangements are employed to ensure the viability and sustainability of projects.

Co-Financing Models: Projects are often co-financed by public funds and private investments, reducing the financial risk for both parties. This approach also makes large-scale projects more feasible.

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Revenue Sharing: In revenue-generating projects, such as port operations or renewable energy installations, revenue-sharing agreements are established to ensure that both the public and private sectors benefit from the project's success.

Case Studies of Successful PPPs in Flanders

1. Port of Antwerp Expansion:

The expansion of the Port of Antwerp is a prime example of a successful PPP. The project involved significant investment from both the Flemish government and private sector companies to enhance port infrastructure, improve logistics efficiency, and support sustainable practices.

Infrastructure Development: The partnership facilitated the construction of new terminals, logistics hubs, and transportation links. This not only increased the port's capacity but also improved its competitiveness on the global stage.

Sustainable Practices: Through collaboration, the partners implemented sustainable practices such as the use of green energy, waste reduction, and emissions control, positioning the port as a leader in environmental stewardship.

2. Blue Cluster Initiative:

Another notable example is the Blue Cluster Initiative, which focuses on stimulating innovation in the blue economy through PPPs. This initiative supports projects in areas such as sustainable aquaculture, renewable energy, and maritime logistics.

Renewable Energy Projects: The development of offshore wind farms in the North Sea was a collaborative effort between the government and private sector companies. This project advanced the region's renewable energy capabilities, contributing to energy security and sustainability.

Aquaculture Innovations: The Blue Cluster also supported innovative aquaculture projects that improved production efficiency and environmental sustainability, demonstrating the potential of PPPs in advancing niche sectors.

Application to Slovenia and Croatia

For Slovenia and Croatia, adopting the PPP model can significantly enhance their maritime innovation ecosystems. In the table 12.8 below, we can see how these countries can implement similar strategies.

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Table 12.8: Lessons from the Flemish Public-Private Partnerships (PPPs) for Slovenia and Croatia.

Lesson	Description
Strategic Collaboration	Establish partnerships aligning with national/regional policy goals, involving government initiatives and private sector involvement.
Clear Governance and Accountability	Create joint committees for oversight and define roles, responsibilities, and performance metrics for transparency and accountability.
Risk Sharing and Financial Arrangements	Utilize co-financing and revenue-sharing models to distribute financial risks and benefits, ensuring project sustainability.

1. Establish Strategic Frameworks:

Government Role: Governments in Slovenia and Croatia should identify strategic areas for PPPs, such as port infrastructure, renewable energy, and maritime logistics. By setting clear objectives and providing policy support, they can attract private sector participation.

Private Sector Engagement: Encouraging private companies to invest in maritime projects through incentives such as tax breaks, grants, and streamlined regulatory processes will be crucial.

2. Develop Governance Structures:

Joint Committees: Form joint committees with representatives from public and private sectors to oversee PPP projects. These committees should be responsible for strategic decision-making, project management, and monitoring progress.

Transparency and Accountability: Establish clear governance frameworks with defined roles, responsibilities, and performance metrics to ensure transparency and accountability throughout the project lifecycle.

3. Innovate Financial Models:

Co-Financing and Revenue Sharing: Utilize co-financing models to distribute financial risks and ensure project viability. Revenue-sharing agreements can also be employed to ensure mutual benefits from successful projects.

Public Funding Mechanisms: Create public funding mechanisms such as dedicated innovation funds or development banks that provide financial support for PPP projects, reducing the financial burden on private investors.

Public-Private Partnerships (PPPs) are a powerful tool for driving innovation and growth in the maritime sector. The success of PPPs in Flanders, demonstrated through projects like the Port of Antwerp expansion and the Blue Cluster Initiative, provides a valuable blueprint for Slovenia and Croatia. By establishing strategic frameworks, developing robust governance structures, and employing innovative financial models, Slovenia and Croatia can harness the potential of PPPs to enhance their maritime innovation ecosystems. This collaborative approach will drive sustainable development, improve

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infrastructure, and boost the competitiveness of their maritime industries, positioning both countries as leaders in maritime innovation.

12.2.3 Sustainable Development Practices: A Blueprint for Maritime Innovation

Sustainable development practices are integral to the success and longevity of the maritime innovation ecosystems. The Flemish ecosystem, particularly, has set exemplary standards in integrating sustainability into its maritime practices. These efforts encompass a wide range of initiatives aimed at reducing environmental impact, promoting renewable energy, and ensuring long-term ecological balance. Slovenia and Croatia can derive significant insights from these sustainable development practices to enhance their own maritime sectors.

Components of Successful Sustainable Development Practices in Flanders

1. Comprehensive Environmental Policies:

The Flemish government has implemented stringent environmental policies that guide the maritime sector towards sustainable practices. These policies are designed to reduce carbon emissions, minimize waste, and promote the use of renewable energy sources.

Emission Reduction Targets: Specific targets are set for reducing greenhouse gas emissions from maritime activities. This includes the adoption of cleaner fuels, energy-efficient technologies, and carbon offsetting measures.

Waste Management Regulations: Regulations mandate proper waste disposal and recycling practices for all maritime operations, ensuring minimal environmental pollution and promoting circular economy principles.

2. Investment in Renewable Energy:

Flanders has made significant investments in renewable energy projects, particularly in offshore wind farms and solar energy installations. These projects not only provide clean energy but also create new economic opportunities and jobs.

Offshore Wind Farms: Large-scale wind farms in the North Sea are a cornerstone of Flanders' renewable energy strategy. These projects are developed through public-private partnerships and provide a substantial portion of the region's electricity needs.

Solar Energy Initiatives: Solar panels are installed on port facilities and maritime infrastructure, harnessing solar power to reduce reliance on fossil fuels and lower operational costs.

3. Sustainable Port Management:

Flemish ports, such as the Port of Antwerp, have adopted comprehensive sustainable management practices that balance economic growth with environmental stewardship.

Green Port Certification: Ports strive to achieve green certifications by implementing sustainable practices such as energy-efficient buildings, electric port equipment, and green logistics solutions.

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Biodiversity Conservation: Initiatives to protect and restore local biodiversity are integrated into port operations, including the creation of green spaces and the protection of marine habitats.

4. Research and Innovation:

Continuous research and innovation are crucial for advancing sustainable development in the maritime sector. Flanders invests in research institutions and innovation hubs that focus on developing new sustainable technologies and practices.

Marine Research Institutes: Institutes like the Flanders Marine Institute (VLIZ) conduct cutting-edge research on marine ecosystems, climate change, and sustainable maritime practices. Their findings inform policy decisions and industry practices.

Innovation Grants: Grants and funding programs are available to support startups and companies working on innovative solutions for sustainable maritime operations.

Case Studies of Successful Sustainable Development Practices in Flanders

1. Port of Antwerp's Green Initiatives:

The Port of Antwerp has implemented several green initiatives aimed at reducing its environmental footprint and promoting sustainability.

Shore Power Systems: The port has installed shore power systems that allow docked ships to use electricity from the grid instead of running their diesel engines, significantly reducing emissions.

Green Terminals: New terminal constructions follow green building standards, incorporating energy-efficient designs, renewable energy sources, and sustainable materials.

2. North Sea Offshore Wind Projects:

The development of offshore wind farms in the North Sea is a flagship project for Flanders' renewable energy strategy.

Collaborative Development: These projects involve collaborations between government agencies, private companies, and research institutions. The collective effort ensures the projects are economically viable and environmentally sustainable.

Economic and Environmental Benefits: The wind farms provide clean energy, reduce greenhouse gas emissions, and create jobs in the renewable energy sector, demonstrating the many-sided benefits of sustainable development.

3. VLIZ's Marine Research and Conservation Efforts:

The Flanders Marine Institute (VLIZ) plays a key role in promoting marine research and conservation.

Data Sharing Hubs: VLIZ provides open access to a vast array of marine data, supporting research and informed decision-making across the maritime sector.

Marine Biodiversity Projects: Initiatives to monitor and protect marine biodiversity, such as the restoration of oyster reefs and the conservation of marine habitats, are integral to VLIZ's work.

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Application to Slovenia and Croatia

For Slovenia and Croatia, adopting similar sustainable development practices can greatly enhance their maritime sectors. In the table 12.9 below we can see how these countries can implement such strategies.

Table 12.9: Lessons from Flemish Sustainable Development Practices for Slovenia and Croatia.

Lesson	Description
Comprehensive Environmental Policies	Establish robust policies for emission reduction and waste management to guide sustainable maritime practices.
Investment in Renewable Energy	Develop and invest in renewable energy projects such as offshore wind farms and solar energy installations.
Sustainable Port Management	Implement green port certifications, energy-efficient infrastructure, and biodiversity conservation initiatives.
Research and Innovation	Support marine research institutions and innovation hubs with funding and incentives to drive sustainable technological advancements.

The maritime industry's resilience and long-term success depend on sustainable development strategies. Slovenia and Croatia can learn a lot from the Flemish ecosystem's dedication to sustainability, which is exemplified by its extensive legislation, large expenditures in renewable energy, sustainable port management, and ongoing research and innovation. Slovenia and Croatia can improve their marine innovation ecosystems, promote sustainable economic growth, and support international environmental conservation initiatives by implementing and modifying these techniques. Both nations will be positioned as pioneers in sustainable maritime development thanks to this calculated approach, which will secure a bright future for their marine sectors.

12.2.4 Collaborative Research and Development (R&D)

The success of the Flemish maritime ecosystem has been largely attributed to collaborative research and development (R&D), which spurs innovation and advances technology. The region places a strong emphasis on collaboration amongst different stakeholders in research and development, including government agencies, academic institutions, business leaders, and research groups. This cooperative framework has fostered an atmosphere that allows for the open interchange of ideas and the pooling of resources to address challenging issues in the maritime industry.

The Marine@UGent partnership, which unites industrial partners and Ghent University researchers to address important issues in marine and maritime sciences, is a shining example of this collaborative attitude. From marine biodiversity and ecosystem services to maritime technology and logistics, the collaboration covers a wide range of subjects. Marine@UGent has been able to pursue multidisciplinary research initiatives that would be challenging to conduct in isolation by utilizing the different experience of its members.

The Smart Maritime Logistics program is a prominent project carried out by this consortium. The goal of this project is to provide cutting-edge logistics solutions that improve maritime transportation's sustainability and efficiency. Through the integration of state-of-the-art technologies including artificial

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intelligence, big data analytics, and Internet of Things (IoT) sensors, the program aims to enhance overall logistics performance, minimize emissions, and optimize supply chain operations. The project's collaborative approach guarantees that the solutions created are both technically sound and in line with the real-world requirements of the industry.

The field of renewable energy has also seen success with the application of the collaborative R&D paradigm. One example of how collaborations can spur innovation is the offshore wind energy-focused research and development project known as OWI-Lab. Energy corporations, academic institutions, and technology providers collaborate in this facility to develop and test novel technologies for offshore wind farms. As a result of the joint efforts, considerable improvements in turbine design, installation methods, and maintenance plans have been made, establishing Flanders as a pioneer in offshore wind energy.

Adopting a similar cooperative R&D strategy can be very beneficial for Slovenia and Croatia. These nations may hasten the creation of creative answers to their problems by fostering collaborations between their maritime sectors, universities, and research centers. Creating cooperative labs or consortia with a focus on critical areas like marine conservation, maritime logistics, and sustainable fisheries can propel technical innovation and boost the competitiveness of their respective maritime industries.

Slovenia and Croatia can also learn from the Flemish experience when it comes to obtaining funds for cooperative R&D initiatives. Grants and subsidies from the European Union and the Flemish government contribute significantly to the funding of these projects. Slovenia and Croatia can make sure that their joint R&D projects are well-funded and able to provide significant outcomes by utilizing comparable financing sources.

The Flemish collaborative R&D method places a strong emphasis on industry relevance and real-world applications. To guarantee that the research results address real-world problems and are easily implementable, projects are frequently co-designed with industry partners. By closely including industry stakeholders in the design and execution of R&D projects, Slovenia and Croatia may gain from this approach and make sure that the innovations produced are in line with market demands and have the potential to spur economic growth.

Collaborative research and development, or the Flemish model, provides a strong platform for promoting innovation in the marine industry. Slovenia and Croatia can expand their R&D capacities, propel technical progress, and guarantee sustainable growth in their maritime industries by implementing comparable plans. The Flemish marine ecosystem's success can be replicated by focusing on real applications, forming strong relationships, and obtaining funding.

12.2.5 Talent Development and Education

Talent Development and Education are critical components of the Flemish maritime ecosystem, playing a key role in maintaining its competitive edge and stimulating innovation. The region's all-encompassing approach to talent development combines academic preparation with industry demands, guaranteeing a steady stream of qualified workers prepared to take on the demands of the maritime industry.

The partnership between academic institutions and the maritime sectors is one of the key initiatives in this regard. The Antwerp Maritime Academy, for instance, provides specialist courses designed to meet the demands of the marine sector. These programs encompass topics including maritime engineering, nautical sciences, and logistics management and vary from undergraduate degrees to advanced

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professional training courses. To guarantee that the curriculum is in line with both present and future industry requirements, industry partners are closely consulted during the design process. A large portion of the curriculum is made up of practical instruction, such as internships and abroad experience, which gives students real-world experience and equips them for obstacles they may face in the workplace.

Additionally, the Academy has forged alliances with top marine businesses and research institutes, fostering a lively flow of information and experience. Through this partnership, the academic program is improved, and students are exposed to the most recent developments in technology and industry best practices. Students are kept up to date on the newest developments in the maritime business through frequent guest lectures, workshops, and seminars led by professionals in the field.

The creation of marine training facilities such as the Flanders marine Training Centre (FMTC) is another commendable initiative. For marine professionals, FMTC offers customized training and certification programs that concentrate on competencies including navigation, safety, and vessel operations. Because these programs are made to comply with international standards, Flemish marine professionals can compete fiercely on a worldwide level. Modern training facilities and simulations at the center offer authentic training conditions, improving the practical capabilities of maritime workers.

Furthermore, continual professional growth and lifelong learning are highly valued in the Flemish maritime industry. For working maritime professionals, there are programs available to improve their knowledge and abilities. These courses address cutting-edge topics like automation, digitization, and environmentally friendly marine operations, guaranteeing that workers will always be flexible and able to use new tools. Continuing education without interfering with professional responsibilities is made easier for professionals by flexible learning modules and online courses. In the table 12.10 below we can see how lessons from Flemish talent development and education can be transferred to Croatia or Slovenia.

Table 12.10: Lessons from Flemish Talent Development and Education Practices for Slovenia and Croatia.

Lesson	Description
Collaboration with Industry Partners	Develop specialized maritime programs in collaboration with industry partners to align education with industry needs.
Practical Training and Internships	Incorporate practical training and internships into the curriculum to provide students with hands-on experience.
Advanced Training Facilities	Establish dedicated maritime training centres equipped with state-of-the-art facilities to enhance practical skills.
Lifelong Learning and Professional Development	Promote continuous education through online courses and flexible learning modules to keep professionals updated with new technologies.
Industry-Academia Partnerships	Foster a culture of collaboration between educational institutions and maritime companies for knowledge exchange and innovation.

Slovenia and Croatia may learn a lot about education and talent development from the Flemish model. It is essential to forge strong ties between the maritime sector and academic institutions. Slovenian and Croatian colleges can guarantee that their graduates have the knowledge and skills needed by the sector by working with partners in the industry to build specialist marine programs. Students will get practical

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experience and be better prepared for the workforce if practical training and internships are integrated into the curriculum as a core component.

Furthermore, the establishment of specialized maritime training facilities with cutting-edge training amenities can greatly improve the practical abilities of maritime professionals in Slovenia and Croatia. By providing certification programs that adhere to international standards, these centers can increase the maritime workforce's competitiveness on a global scale. Maritime professionals will be able to stay up to date with changes in the sector and technology breakthroughs if they place a strong emphasis on ongoing professional development through flexible learning alternatives and online courses.

Innovation in maritime education and training can also be fueled by fostering a culture of cooperation between academic institutions and maritime businesses. Frequent engagement among scholars, industry experts, and students will promote the sharing of concepts and optimal methodologies, bolstering the maritime sector's overall expansion and advancement.

The Flemish talent development and education model offers a thorough framework for producing a workforce of mariners who are both competitive and skilled. Slovenia and Croatia can improve their marine education programs, guarantee a consistent flow of qualified workers, and stimulate innovation and expansion in their respective maritime sectors by implementing comparable policies. Encouraging lifelong learning, investing in state-of-the-art training facilities, and forming solid industry-academia relationships will be crucial to duplicating the Flemish marine ecosystem's success.

12.2.6 Digital Transformation

Digital Transformation is a cornerstone of the Flemish maritime ecosystem, driving efficiency, innovation, and competitiveness in the sector. The comprehensive approach taken by the Flemish region to integrate digital technologies into maritime operations provides a valuable model for Slovenia and Croatia. This approach encompasses the adoption of advanced digital tools, strategic partnerships, and robust frameworks to cultivate a culture of continuous innovation and technological advancement.

One of the most notable initiatives in the Flemish maritime sector is the widespread implementation of smart port technologies. The Port of Antwerp, as a leading example, has embraced digital transformation through its Smart Port strategy. This strategy involves the deployment of Internet of Things (IoT) devices, big data analytics, and artificial intelligence (AI) to optimize port operations. IoT sensors are used to monitor various aspects of port activities, including cargo handling, equipment status, and environmental conditions. These sensors provide real-time data that is analyzed to enhance operational efficiency, reduce delays, and improve safety. AI algorithms help in predictive maintenance, identifying potential issues before they become critical, thereby minimizing downtime and operational disruptions.

An important component of the Port of Antwerp's digital transformation path is the use of digital twin technology. A digital twin is an electronic copy of real-world resources, processes, or systems that enables digital environment modelling, analysis, and optimization. Several data sources are combined by the Antwerp Port Digital Twin to produce an extensive operational model of the port. This model is used to enhance decision-making processes, optimize resource allocation, and simulate a variety of scenarios. The Port of Antwerp offers other ports looking to improve their operational efficiency through digital transformation of a model by exchanging best practices and insights from the creation and deployment of the digital twin.

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Additionally, several innovation hubs and centers devoted to promoting digital innovation have been formed by the Flemish marine industry. These centers function as cooperative areas where startups, technology suppliers, research institutes, and maritime businesses can collaborate on creating and evaluating novel digital solutions. The Blue Cluster program, for example, provides funding for projects that include digital technology into maritime operations, including digital supply chain management, autonomous vessels, and smart shipping. These initiatives foster creativity while also building a cooperative environment that allows participants to exchange skills, resources, and knowledge.

The integration of blockchain technology into the maritime industry in Flanders represents a noteworthy advancement in the digital transformation process. Blockchain is especially helpful for supply chain management because it provides a transparent and safe means to monitor and record transactions. Blockchain projects have been tested by the Port of Antwerp to protect and optimize its supply chain processes. Blockchain speeds up the flow of commodities, lowers administrative costs, and improves stakeholder trust by offering a tamper-proof record of transactions. These blockchain projects' success shows how this technology can completely transform marine trade and logistics.

Along with these technical developments, the Flemish government's funding and policy support are essential in fostering digital transformation. Financial incentives and strategic frameworks are offered to marine enterprises to incentivize them to invest in digital technologies. Initiatives spearheaded by the government, including the Digital Belgium Plan, provide precise goals and steps to encourage digital innovation in a range of industries, including the maritime sector. These regulations create an atmosphere that is conducive to digital transformation, encouraging the uptake of new technologies and an innovative culture.

There are numerous insights that Slovenia and Croatia might get from the Flemish strategy for digital transformation. First, the productivity and competitiveness of their ports can be greatly increased by implementing smart port technologies. Ports in Slovenia and Croatia can enhance operations, cut expenses, and boost safety by investing in IoT devices, artificial intelligence, and big data analytics. By putting digital twin technology into practice, port operations can be fully understood, which will improve resource management and decision-making.

Second, creating hubs for innovation and centers for collaboration devoted to marine digital innovation helps foster a culture of cooperation and information exchange. These hubs can bring together stakeholders from different industries to engage on collaborative initiatives and act as hubs for developing and testing new digital solutions. Slovenia and Croatia can accelerate digital innovation by using the resources and experience of their maritime industry through cross-border collaborations.

Third, supply chain management can benefit from increased efficiency, security, and transparency thanks to the application of blockchain technology. Blockchain projects can be piloted in strategic ports to show off the technology's advantages and open the door for wider use in the marine industry. The digital transformation can be expedited by the government through the implementation of strategic policies and funding, which will provide marine enterprises with the requisite resources and incentives to invest in digital technologies. In the table 12.11 below we can see lessons from Flemish digital transformation practices can be transformed to the Slovenian and Croatian ecosystem.

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Table 12.11: Lessons from Flemish Digital Transformation Practices for Slovenia and Croatia.

Lesson	Description
Adoption of Smart Port Technologies	Invest in IoT devices, AI, and big data analytics to optimize port operations, reduce costs, and improve safety.
Implementation of Digital Twins	Develop digital twin technology to simulate scenarios, optimize resource allocation, and enhance decision-making processes.
Establishment of Innovation Hubs	Create collaborative centers for maritime digital innovation, fostering knowledge sharing and joint development of digital solutions.
Integration of Blockchain Technology	Pilot blockchain projects to enhance transparency, security, and efficiency in supply chain management.
Government Support and Incentives	Provide strategic policies and financial incentives to encourage investment in digital technologies within the maritime sector.

The Flemish model of digital transformation provides a comprehensive framework for modernizing maritime operations. By adopting similar strategies, Slovenia and Croatia can enhance their digital capabilities, drive innovation, and improve the competitiveness of their maritime industries. Investing in smart technologies, stimulating collaboration through innovation hubs, and integrating blockchain into supply chain management are key steps towards achieving a successful digital transformation in the maritime sector.

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13 TIMELINES AND MILESTONES

13.1 Action Plan - Execution Timeline

The execution timeline for the maritime innovation action plan in Slovenia and Croatia is meticulously crafted to ensure that all initiatives are systematically implemented and monitored. This timeline serves as a roadmap, outlining the sequence of activities, their respective durations, and critical deadlines. By establishing a clear timeline, stakeholders can effectively coordinate efforts, allocate resources, and track progress towards achieving strategic objectives, as indicated in table 13.1 below.

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Table 13.1: Action Plan Execution Timeline.

Phase	Timeframe	Activities
Phase 1: Preparation and Planning	**Months 1-6**	**Months 1-2:** Conduct detailed needs assessment and stakeholder analysis to refine project objectives and identify key participants. **Months 3-4:** Develop comprehensive project plans, including detailed work plans, budgets, and risk management strategies. **Months 5-6:** Establish governance structures, such as steering committees and working groups, to oversee project implementation and ensure accountability.
Phase 2: Initial Implementation	**Months 7-18**	**Months 7-9:** Launch the Cross-Border Innovation Task Force, ensuring representation from government, industry, and academia. Begin initial meetings and workshops to align on goals and strategies. **Months 10-12:** Start pilot projects for digital and green technologies, leveraging existing infrastructure and resources. This includes deploying IoT sensors and starting trials for hybrid propulsion systems. **Months 13-18:** Develop and launch the virtual site for maritime ecosystem actors, ensuring it includes essential features like knowledge hubs, collaboration tools, and training resources. Concurrently, initiate the establishment of innovation clusters.
Phase 3: Full-Scale Implementation	**Months 19-36**	**Months 19-24:** Expand the scope of pilot projects based on initial results, incorporating feedback and lessons learned. Begin broader deployment of successful technologies and practices. **Months 25-30:** Enhance training programs and conduct extensive workshops to build skills in digital literacy, sustainable practices, and leadership. Collaborate with international experts to bring global best practices to the local context. **Months 31-36:** Conduct mid-term evaluations to assess progress and make necessary adjustments. This includes reviewing KPIs, stakeholder feedback, and project outcomes to ensure alignment with strategic goals.
Phase 4: Evaluation and Adjustment	**Months 37-48**	**Months 37-42:** Perform a comprehensive evaluation of all projects and initiatives, using both qualitative and quantitative methods. This includes detailed progress tracking, investment tracking, and impact assessments. **Months 43-48:** Based on evaluation findings, make strategic adjustments to projects and initiatives. Develop a sustainability plan to ensure continued progress beyond the project timeline.

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13.2 Key Milestones

Identifying and achieving key milestones is crucial for maintaining momentum and ensuring that the action plan delivers on its promises. These milestones represent significant achievements and decision points throughout the project duration in the table 13.2 below.

Table 13.2: Key Milestones.

Milestone	Timeframe	Description
Milestone 1: Establishment of Governance Structures	**Month 6**	Successful formation of steering committees and working groups marks the beginning of coordinated project management and oversight.
Milestone 2: Launch of Initial Pilot Projects	**Month 12**	Initiating pilot projects demonstrates the transition from planning to action, providing early evidence of progress and potential impacts.
Milestone 3: Launch of the Virtual Site	**Month 18**	The launch of the virtual site signifies a major step in enhancing collaboration and knowledge sharing among stakeholders.
Milestone 4: Mid-Term Evaluation	**Month 36**	Conducting a thorough mid-term evaluation allows for an in-depth assessment of progress, identification of challenges, and strategic adjustments.
Milestone 5: Comprehensive Evaluation and Adjustment	**Month 42**	This milestone ensures that the project is on track to meet its goals, with necessary adjustments made based on robust evaluation findings.
Milestone 6: Sustainability Plan Development	**Month 48**	The development of a sustainability plan ensures that the initiatives and benefits of the project are maintained and built upon in the long term.

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14 RESOURCE ALLOCATION

14.1 Budgeting: Detailed Budgeting and Financial Planning for the Project

Effective budgeting and financial planning are crucial for the successful implementation of the maritime innovation action plans in Slovenia and Croatia. This section outlines a detailed approach to budgeting, ensuring that all financial aspects of the project are meticulously planned and managed.

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Initial Cost Assessment

The first step in budgeting involves conducting an initial cost assessment to identify all potential expenses associated with the project. This includes direct costs such as personnel, equipment, technology, and infrastructure, as well as indirect costs like administrative support, training, and travel.

Expenses should be categorized into specific budget categories presented in Table 14.1.

Table 14.1: Detailed Budgeting and Financial Planning.

Category	Description
Personnel Costs	Salaries, wages, and benefits for project staff, consultants, and external experts.
Equipment and Technology	Purchase or lease of hardware, software, IoT sensors, and other technological tools required for digital transformation and innovation projects.
Infrastructure	Costs related to the development and maintenance of physical and digital infrastructure, including the virtual site and innovation hubs.
Training and Development	Funding for training programs, workshops, certifications, and continuous professional development.
Research and Development	Investments in R&D activities, pilot projects, and collaborative research initiatives.
Operational Costs	Day-to-day expenses such as utilities, office supplies, and communication.

Budget Allocation and Phasing

The budget should be allocated across different phases of the project, ensuring that resources are available when needed. Phasing the budget helps in managing cash flow and allows for adjustments based on project progress and changing needs.

Phase 1 (Preparation and Planning): Focus on initial setup costs, including stakeholder engagement, detailed project planning, and establishing governance structures.

Phase 2 (Initial Implementation): Allocate funds for launching pilot projects, developing the virtual site, and initiating training programs.

Phase 3 (Full-Scale Implementation): Increase budget allocation for scaling up successful initiatives, expanding training programs, and enhancing infrastructure.

Phase 4 (Evaluation and Adjustment): Ensure sufficient funds are available for comprehensive evaluations, adjustments based on feedback, and sustainability planning.

Monitoring and Reporting

Regular financial monitoring and reporting are essential for maintaining budgetary control. This includes periodic financial reviews, variance analysis, and adjustments to the budget as needed. Transparent

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reporting to stakeholders ensures accountability and builds trust in the financial management of the project.

14.2 Funding Sources: Identification of Public and Private Funding Sources

Securing adequate funding is vital for the success of the maritime innovation action plans. This section identifies potential public and private funding sources that can be leveraged to support the project.

Public Funding Sources

European Union Funds: The EU provides various funding opportunities through programs such as Horizon Europe, the European Maritime and Fisheries Fund (EMFF), and the European Regional Development Fund (ERDF). These funds support innovation, sustainability, and regional development initiatives.

National Government Grants: Both Slovenia and Croatia have national programs that offer grants and subsidies for innovation, research, and sustainable development projects. Ministries responsible for maritime affairs, economic development, and environmental protection are key sources of funding.

Regional Development Funds: Regional development agencies in both countries provide financial support for projects that promote regional economic growth and innovation. These funds can be tapped to support local initiatives within the maritime sector.

Private Funding Sources

Venture Capital and Private Equity: Private investors, including venture capital firms and private equity funds, are interested in investing in high-potential innovation projects. Engaging with these investors can provide significant financial resources and strategic support.

Industry Partnerships: Collaboration with established maritime and technology companies can bring in funding and in-kind support. Industry partners may provide sponsorship, equipment, and expertise in exchange for involvement in innovative projects.

Corporate Social Responsibility (CSR) Funds: Many corporations have CSR programs that fund projects with social and environmental benefits. Maritime innovation projects that focus on sustainability and community impact can attract CSR funding.

Crowdfunding and Public-Private Partnerships (PPPs): Crowdfunding hubs can be used to raise funds from a broad base of supporters, while PPPs allow for shared investment and risk between public and private entities.

Foundations and Non-Governmental Organizations (NGOs): Various foundations and NGOs provide grants for projects that align with their mission, such as environmental conservation, technological advancement, and economic development.

Developing a Funding Strategy

A comprehensive funding strategy should be developed to identify and secure the necessary financial resources. This involves features from the table 14.2 below.

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Table 14.2: Developing a Funding Strategy.

Step	Description
Mapping Funding Opportunities	Identify and prioritize potential funding sources based on project needs and eligibility criteria.
Proposal Development	Prepare detailed funding proposals outlining the project's objectives, activities, expected outcomes, and budget requirements.
Stakeholder Engagement	Build relationships with potential funders, presenting the project's value proposition and aligning it with their funding priorities.
Diversification of Funding	Ensure a diverse mix of funding sources to mitigate the risk of relying on a single source and to maximize financial sustainability.

By effectively budgeting and securing diverse funding sources, Slovenia and Croatia can ensure the successful implementation of their maritime innovation action plans, driving sustainable growth and competitiveness in their maritime sectors.

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15 RISK MANAGEMENT AND CONTINGENCY PLANNING

15.1 Risk Analysis

Conducting a comprehensive risk analysis is crucial for the successful implementation of maritime innovation projects in Slovenia and Croatia. This analysis involves identifying and evaluating potential risks that could impact the project's progress and outcomes established or identified on Flemish reform programme 2023. The primary risks associated with the project can be categorized into several key areas, as indicated in the table 15.1 below.

Table 15.1: Key risk areas, categories, their descriptions and mitigation strategies.

Risk Category	Description	Mitigation Strategies
Financial Risks	Involves budget overruns, funding shortfalls, market condition fluctuations, delays in funding disbursements, etc.	Accurate cost estimation, securing diverse funding sources, financial planning, and hedging strategies.
Operational Risks	Encompasses logistical challenges, procurement delays, supply chain disruptions, inadequate project management, etc.	Effective supply chain management, robust project management practices, thorough planning, and flexible management practices.
Regulatory and Compliance Risks	Includes changes in regulations, navigating legal frameworks, policy shifts.	Staying informed about regulatory trends, maintaining strong relationships with regulatory bodies, securing necessary permits and approvals in advance.
Technological Risks	Pertains to technological failures, cybersecurity threats, technology obsolescence.	Thorough testing and validation, robust cybersecurity measures, investing in scalable and upgradable technologies.
Environmental Risks	Related to natural disasters, climate change impacts, ecological disturbances.	Developing disaster preparedness strategies, incorporating climate resilience measures, adhering to environmental protection standards.
Stakeholder Risks	Involves conflicting interests, communication breakdowns, stakeholder disengagement.	Establishing clear communication channels, regular and open communication, consistent stakeholder engagement, addressing concerns, and demonstrating project value.

1. Financial Risks

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When it comes to large-scale project execution, financial risks are a major worry, especially for initiatives in the maritime innovation industry. These risks include a variety of possible financial traps that, if not properly handled, could cause the project to fail. A frequent financial risk is budget overruns, which are frequently the consequence of imprecise cost projections made during the planning stage. Underestimating project costs can result in real costs that are higher than the budgeted amount, requiring the addition of funds or a reduction in project scope, both of which can cause delays and lower project effectiveness.

Lack of funding is yet another serious financial danger. These happen when the project doesn't have enough funding to pay for what it needs to. Several factors, such as investor withdrawal or reduction of promised cash or shifts in government financing priorities, may contribute to this gap. Economic downturns, for instance, may result in budget cuts to public sector expenditures, which may impact the availability of grants and subsidies that are necessary for project funding.

Variations in the state of the market may present a significant risk. Recessions and inflation are examples of economic instability that can raise the cost of labor, materials, and other resources and influence the project's overall financial health. The ease with which new funds can be raised can also be impacted by market conditions, which can also have an impact on interest rates and investment environments. Project managers may be forced by these swings to look for more funding in less ideal circumstances, which could result in a higher project debt load or diluted ownership holdings.

Financial management may become even more complex if funding disbursements are delayed. Funds must frequently be disbursed on schedule for projects to continue operating, pay contractors, and buy supplies. If these payments are not made on time, the project may not proceed as planned, which could lead to missed deadlines and greater expenses since suppliers and contractors might impose late fees or penalties for incomplete orders.

Currency depreciation is one example of how changes in the economy might affect a project's ability to remain financially stable. Exchange rate variations can have a substantial impact on the cost structure of international projects, especially when a substantial amount of funding or expenses is received in foreign currencies. To reduce any negative impacts, this risk necessitates careful financial planning and the application of hedging techniques.

2. Operational Risks

Operational risks are the difficulties and roadblocks that arise when carrying out project tasks daily. If these risks are not adequately handled, they could have a major effect on the project's budget, schedule, and overall success. Logistical obstacles are a major operational risk that can be caused by complicated supply chains, transportation problems, and human and resource coordination across numerous sites. For instance, project progress can be halted by delays in the shipment of essential components, which can result in higher expenses and missed deadlines.

Procurement delays are yet another frequent operational concern. Getting the equipment and supplies you need on time is essential to keeping the project on track. Vendor concerns, such as supply chain disruptions, slowdowns in production, or issues with quality control, can cause delays. These delays may be made worse by subpar procurement procedures, such as careless vendor selection or a disregard for lead times.

Supply chain disruptions present serious operational risks, regardless of the cause—natural catastrophes, geopolitical crises, or other unanticipated events. These hiccups may result in a lack of

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necessary materials, higher expenses, and longer project completion times. To reduce these risks, efficient supply chain management and backup plans are crucial.

Unsuitable project management methodologies constitute an additional operational risk. Misunderstandings, mistakes, and inefficiencies can result from poor planning, unclear objectives, and poor communication. For instance, unclear roles and duties in a project can result in activities being repeated or missed, which would cause delays and higher expenses. In addition, misdirected efforts and competing agendas may arise from a lack of cooperation among stakeholders.

Significant operational risks might also arise from technical problems while integrating new technology. Unexpected technical difficulties can occur, and integrating cutting-edge technologies frequently entails a challenging learning curve. These concerns may include hardware malfunctions, software defects, or incompatibilities with current systems. To overcome these obstacles, comprehensive testing, strong technical assistance, and adaptable project management techniques are needed.

3. Regulatory and Compliance Risks

Projects operating under strict legal frameworks face enormous regulatory and compliance concerns, especially in the maritime industry where safety and environmental standards are of utmost importance. Regulations may change at any point throughout the project, and these modifications may impose additional requirements that have an impact on the project's duration, budget, and scope. For instance, new environmental laws may require raising capital for pollution control technology or modifying operational protocols.

Another part of regulatory risk is navigating complicated legal systems. Numerous permissions and approvals from different governmental bodies are frequently required for projects, and each has its own set of specifications and deadlines. Project work can be stopped, and expenses can go up if these permissions are not obtained in a timely manner. Following environmental and safety regulations is essential since breaking them can lead to expensive penalties, legal action, and reputational harm.

The possibility of policy changes that could change the regulatory environment is another source of regulatory risk. A shift in government, for example, may result in new policies that prioritize other sectors of the economy or industry, so deprioritizing maritime initiatives. These risks can be reduced by keeping up with regulatory developments and fostering positive connections with regulatory organizations.

4. Technological Risks

Although implementing novel and cutting-edge technologies is necessary to advance maritime projects, there are inherent technological dangers involved. Technological failures can happen when the selected technologies don't work as planned or don't work well with other systems. For example, hardware may not perform as planned in the desired environment, or new software may not work well with older systems. To reduce these dangers, it is essential to make sure that technologies are thoroughly tested and validated before being implemented on a large scale.

Concerns about cybersecurity are intensifying as more and more maritime projects depend on digital technologies. Cyberattacks have the potential to compromise private information, halt projects, and harm the project's reputation. To defend against these dangers, it is imperative to put strong cybersecurity measures in place, such as firewalls, encryption, and frequent security audits.

Another danger is the obsolescence of specific technologies. Technology is advancing so quickly that even today's cutting edge could become antiquated in a few years. This risk can be reduced by making

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investments in scalable and upgradeable technologies, which will guarantee the project's long-term relevance and competitiveness.

5. Environmental Risks

Because maritime projects interact closely with natural ecosystems, environmental concerns are especially important. Hurricanes, floods, and earthquakes are examples of natural disasters that can seriously harm infrastructure, extend project completion times, and raise expenses. To reduce these hazards, it is essential to create comprehensive disaster preparedness plans that include evacuation schedules and emergency response procedures.

Long-term environmental risks are associated with the effects of climate change, such as increasing sea levels and a rise in the frequency of extreme weather events. Measures for climate resilience must be incorporated into project design and operation. For example, building weather-resistant infrastructure and putting sustainable policies into place to lessen carbon footprints are crucial steps.

Natural disturbances like oil spills and habitat damage can have detrimental effects on the environment and one's reputation. Ensuring timely and efficient reactions in the case of an incident can be achieved by implementing comprehensive environmental management plans and strictly adhering to environmental protection requirements.

6. Stakeholder Risks

There are a few dangers associated with interacting with a varied group of stakeholders, including competing interests, strained relationships, and stakeholder disengagement. Disagreements about project priorities, resource distribution, and decision-making procedures can arise from stakeholders' competing interests. A collaborative environment may be fostered, and stakeholders' interests can be aligned by creating clear communication channels and including them in important decisions.

Misunderstandings, a lack of transparency, or insufficient information exchange can all lead to communication breakdowns. Establishing and sustaining trust and ensuring that all parties involved are informed and involved requires frequent and transparent communication using a variety of platforms and instruments.

Project success may be jeopardized by stakeholder disengagement since it may result in a lack of resources, commitment, and support. Maintaining regular meetings, regular updates, and feedback channels all contribute to maintaining stakeholders' commitment to the project. Stakeholder commitment and support can also be strengthened by addressing their concerns and showcasing the project's worth and advancement.

15.2 Mitigation Strategies

To effectively manage and mitigate the identified risks, a set of targeted strategies should be developed and implemented. These strategies aim to minimize the likelihood and impact of risks, ensuring the project's resilience and success.

1. Financial Risk Mitigation

Contingency Planning: Set aside money in your budget for unforeseen expenses and shortages. Review and modify the budget on a regular basis considering the project's advancement and financial results.

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Many Financing Sources: Get money from a variety of public and private sources to lessen your dependency on one source of support. Form alliances with investors, financial institutions, and governmental organizations to take advantage of different funding sources.

Financial Monitoring: Put in place reliable procedures to keep tabs on spending, spot budgetary inconsistencies, and swiftly address them.

2. Operational Risk Mitigation

Project Management Tools: To improve coordination, monitor progress, and efficiently manage resources, make use of cutting-edge project management tools and processes. Assemble a project team and assign everyone clear roles and duties.

Supplier Management: Create backup plans in case the supply chain is disrupted and cultivate a good rapport with suppliers. Evaluate the dependability and performance of your suppliers on a regular basis.

Training and Capacity Building: To improve project staff members' abilities and expertise in project management, technology implementation, and operational efficiency, offer training and capacity-building programs.

3. Regulatory and Compliance Risk Mitigation

Regulatory Monitoring: Remain up to date on modifications to laws and specifications for conformance. Early in the project, consult with regulatory bodies to identify and resolve any legal or compliance concerns.

Legal Support: Consult legal counsel to help you navigate intricate legal systems, secure licenses, and make sure rules are being followed. Create a thorough plan for managing compliance.

4. Technological Risk Mitigation

Technology Assessment: Carefully examine suggested technologies to determine their scalability, dependability, and compatibility with current infrastructure. Before implementing new technology fully, conduct a small-scale pilot program.

Cybersecurity Precautions: Put strong cybersecurity safeguards in place to guard against online fraud, data breaches, and other technical dangers. Update and test security mechanisms on a regular basis.

5. Environmental Risk Mitigation

Environmental Impact Assessments: To identify possible environmental risks and create mitigation strategies, conduct thorough environmental impact assessments. Use environmentally friendly technologies and methods to reduce your impact on the environment.

Disaster planning: To handle natural catastrophes and other environmental hazards, create plans for disaster planning and response. Provide project workers with frequent training sessions and drills.

6. Stakeholder Risk Mitigation

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Stakeholder Engagement Plan: Create a thorough plan for involving stakeholders that includes methods for conflict resolution, regular communication, and feedback systems. Encourage openness and confidence among interested parties.

Working Together to Make Decisions: Involve stakeholders in important decision-making procedures to foster consensus and guarantee that their interests are considered. To encourage stakeholder participation, form working groups or advisory committees.

Slovenia and Croatia can improve the resilience of their marine innovation projects and guarantee successful project delivery by putting these mitigation techniques into practice. This will help to effectively manage possible risks associated with the projects.

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