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Italy – Croatia

MareSkill

INTERREG ITALY-CROATIA
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Smart and innovative blue skills for competitive blue economy MareSkill

D.1.2.2. Analysis report on blue skill gap and education methods

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1. Introduction

This report presents the results of Activity 1.2 under Work Package 1 (WP1) – Entrepreneurial Discovery Process of the MareSkill project, co-financed by the Interreg Italy-Croatia 2021-2027 Programme. The activity aimed to systematically identify existing skills gaps within the blue economy sectors and assess current educational practices and training needs as perceived by relevant stakeholders.

The blue economy encompasses a diverse range of marine-related sectors and activities, including aquaculture, marine and coastal tourism, shipbuilding, environmental protection, and maritime technologies. These sectors are rapidly evolving due to digitalization, the green transition, and emerging technologies. Consequently, there is an urgent need to better align education and training systems with the evolving demands of the labor market.

To tackle this challenge, project partners collaborated with both private and public stakeholders- including businesses, educational institutions, research organizations, and NGOs across Italy and Croatia- to develop a multilingual, cross-sector questionnaire. The responses collected provide valuable data on current skill levels, gaps, and priorities for future training initiatives.

The primary objective of this activity was to gain a comprehensive understanding of critical skill deficiencies within key sectors of the blue economy. Additionally, it aimed to assess how stakeholders perceive the relevance and importance of various types of competencies, including digital, green, business, and soft skills, which are essential for adapting to contemporary labor market demands. The activity also sought to collect informed feedback from stakeholders on preferred educational methods and training formats to identify approaches that are both effective and scalable. Ultimately, the insights derived from this analysis aim to inform the development of targeted pilot training programs under Work Package 2 (WP2), ensuring that educational interventions are evidence-based, demand-driven, and aligned with the strategic priorities of sustainable blue growth.

2. Research Methodology

To establish a robust and context-sensitive understanding of skill shortages and educational needs within the blue economy, the project team developed and implemented a multilingual stakeholder survey as part of Activity 1.2. The questionnaire was meticulously designed to reflect the objectives of Work Package 1, which focuses on the Entrepreneurial Discovery Process. It was made

available in English, Italian, and Croatian to accommodate linguistic diversity and ensure accessibility across the Italy–Croatia programme area.

The survey targeted a diverse group of stakeholders actively engaged in or supporting the blue economy, including small and medium-sized enterprises, government institutions, educational and research organizations, and non-governmental organizations. These participants operate in key sectors such as aquaculture, coastal and nautical tourism, maritime technologies, environmental protection, and innovation-driven entrepreneurship. Their perspectives were deemed essential for capturing a representative and detailed overview of the regional skills landscape.

Importantly, and in contrast to many conventional survey approaches, all data collection was conducted exclusively through on-site engagement with stakeholders. Project partners visited stakeholders at their premises to administer the questionnaire in person. This methodology was deliberately chosen to enhance the reliability and depth of responses, as it enabled direct interaction with respondents in their operational environments. Conducting interviews face-to-face allowed project representatives to clarify any uncertainties in real time, ensure consistent interpretation of terminology, and establish a relationship of trust that encouraged openness and reflection.

The on-site approach also provided valuable contextual understanding. By observing the organizational settings in which stakeholders operate, researchers could interpret the challenges identified in the survey more effectively, particularly those related to skills gaps and training limitations. This environment enriched the qualitative component of the research and added depth to the thematic analysis of stakeholder narratives.

The questionnaire examined various thematic areas, including the presence and perceived importance of digital, green, soft, business, and sector-specific professional skills. Respondents were also asked to comment on the impact of skill deficits on productivity, workforce morale, and organizational performance. Additional questions explored the effectiveness of existing training formats, such as in-person or blended learning. They encouraged stakeholders to suggest technologies and practices they believed should be included in future training content.

More than forty complete and valid responses were collected during January 2025. Quantitative data were analyzed using descriptive statistical methods to identify patterns and trends, while open-ended responses were examined through qualitative thematic coding to highlight emerging priorities and contextual challenges. The exclusive use of face-to-face, on-site interviews proved critical in

ensuring the collected data remained of high quality. They were firmly anchored in the real conditions of the blue economy sector.

This approach enabled the project consortium to deliver a well-informed and context-aware analysis that transcends abstract conclusions, offering concrete insights to inform the design of demand-driven training programs in the subsequent phases of the project.

3. Survey results

3.1. Demographic and Organizational Overview

A total of 46 respondents participated in the MareSkill interviews about blue economy skill gaps and educational needs. The respondents came from two countries: Croatia (25 respondents, approximately 54%) and Italy (21 respondents, approximately 46%), highlighting the project's cross-border focus.

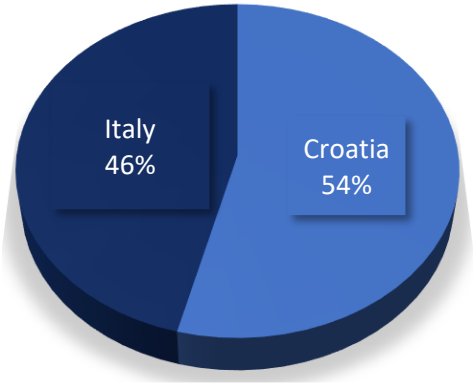

Figure 1: Respondents by country

The participants represent a diverse range of blue economy sectors, with some respondents involved in multiple areas. Specifically, approximately 26% of respondents come from maritime transport, 20% from marine living resources (such as fisheries and aquaculture), 17% from shipbuilding and repair, and 11% from marine or coastal tourism. Additionally, about 26% indicated involvement in other blue economy sectors, including port management, marine renewables, and research and education in marine fields.

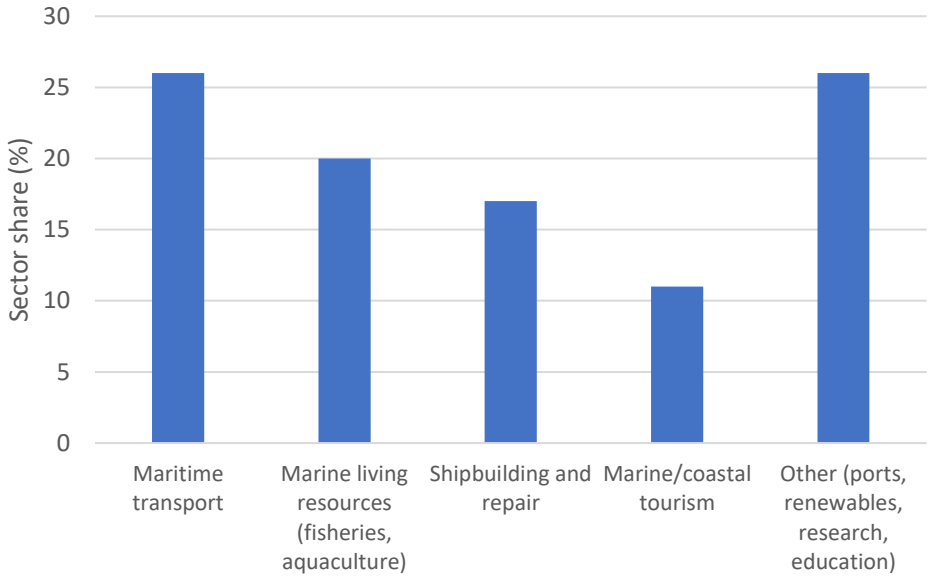

Figure 2: Respondents by blue economy sector

The respondent pool primarily consists of experienced professionals in senior roles. The average age of participants is approximately 48 years, ranging from 27 to 74. Regarding job positions, about 66% of respondents hold senior management roles, around 30% occupy mid-management positions, and approximately 4% are at the entry level.

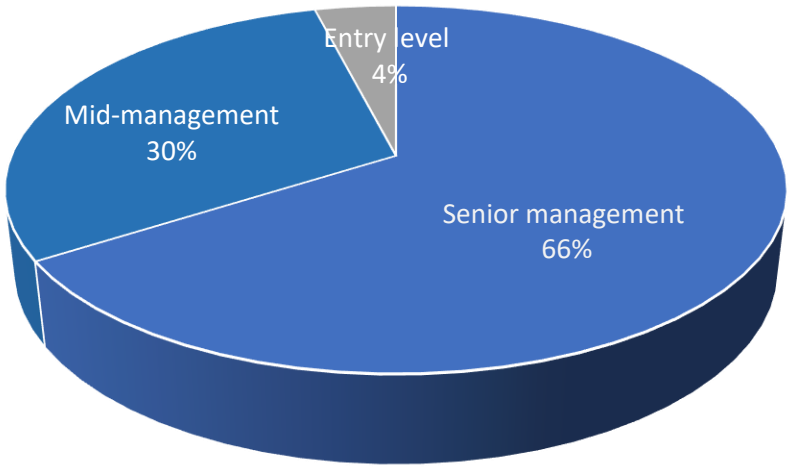

Figure 3: Respondents by job positions

Respondents demonstrate substantial professional experience, with an average of 23 years of total work experience (a median of around 20 years) and an average of 14 years spent with their current employer.

Organizations represented by respondents vary in size. Approximately 30% are large organizations (more than 250 employees), 30% are small organizations (fewer than 50 employees), about 22% are micro-enterprises (fewer than 10 employees), and roughly 15% are medium-sized organizations (fewer than 250 employees). Regarding organizational type, around 65% of respondents come from the private sector, approximately 22% from the public sector, about 11% from educational institutions, and about 2% from non-governmental organizations (NGOs).

Finally, almost 90% of organizations operate internationally, reflecting a strong level of global or regional engagement among the respondents.

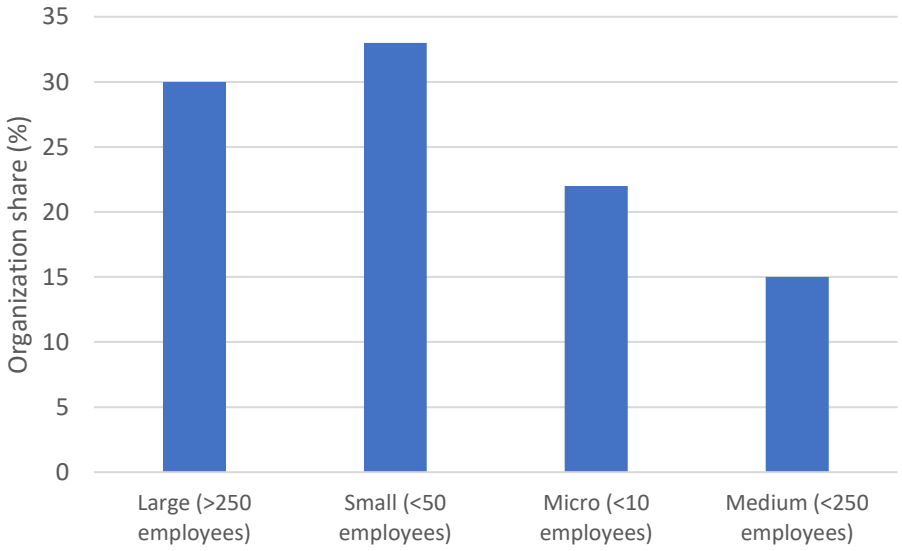

Figure 4: Respondents by organization size

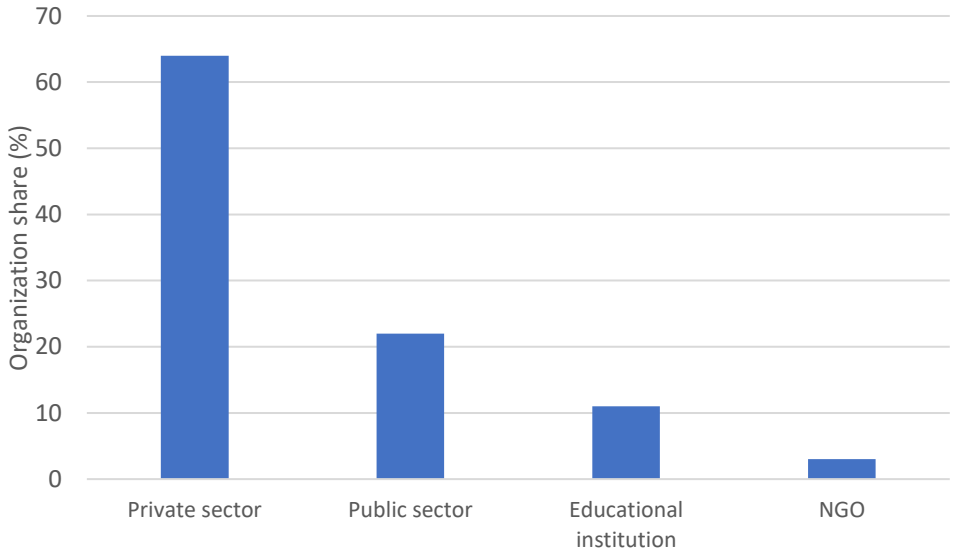

Figure 5: Respondents by organization type

3.2. Common Qualification Levels

Respondents were asked about the most common European Qualifications Framework (EQF) level for jobs within their organizations. The results indicate a high overall level of education among the workforce.

The most frequently cited qualification was EQF Level 7 (Master's level), mentioned by approximately 44% of participants. The second most common qualification was EQF Level 6 (Bachelor's level), noted by about 32% of participants.

Reports of lower qualification levels were less frequent. EQF Levels 3 and 4, which include secondary education, post-secondary non-tertiary education, and short-cycle tertiary education, were identified by around 20% of respondents each.

Only a small percentage, 4%, of respondents indicated that EQF Level 8 (doctoral level) is the most common, particularly among research-oriented or highly specialized organizations.

This distribution suggests that most roles within the surveyed blue economy sectors require highly skilled workers with tertiary education. Accordingly, training programs and curricula should primarily focus on advanced skill sets aligned with higher education standards. However, the

presence of lower qualification levels also highlights the importance of maintaining vocational education pathways. In particular, micro-credentials and short-cycle tertiary programs at EQF Level 5 can provide flexible, targeted upskilling opportunities to bridge the gap between technician-level and full tertiary qualifications, addressing emerging sectoral needs efficiently.

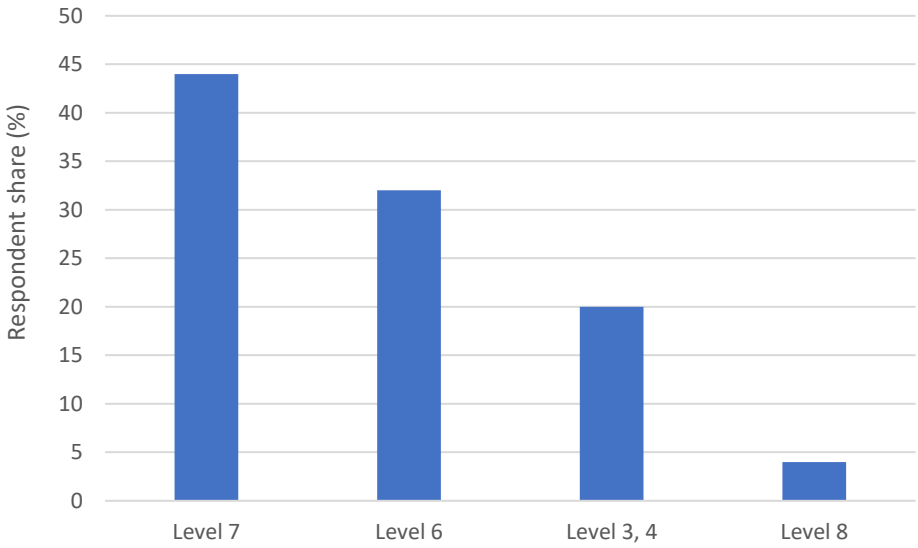

Figure 6: Distribution of reported qualification levels by EQF

3.3. Current Workforce Skills – Proficiency vs Importance

Respondents evaluated the proficiency of their current employees across various skill categories: digital, green, soft, business, and professional skills. They rated the importance of each category for their organization separately. This comparison reveals potential "skill gaps" as the difference between current skill levels and the perceived importance of each competency.

In terms of digital skills, most respondents reported that their employees possess intermediate to advanced capabilities. About one-third indicated an advanced level of digital proficiency, while a smaller proportion (approximately 10%) assessed their staff at an expert level. However, 20% of respondents noted that only basic digital skills are present among their employees. Importantly, no respondents selected “None” for digital skills, indicating that all employees possess at least a fundamental level of digital competence. Regarding importance, digital skills were deemed critical by virtually all organizations, with approximately 80% rating them as "Important" or "Extremely

important." The high importance placed on digital skills, combined with a range of proficiency levels, suggests a moderate digital skills gap in some organizations. While many employees are reasonably skilled, rising expectations regarding digital competencies, particularly in areas such as advanced software usage, data platforms, and programming, highlight the need for continuous upskilling.

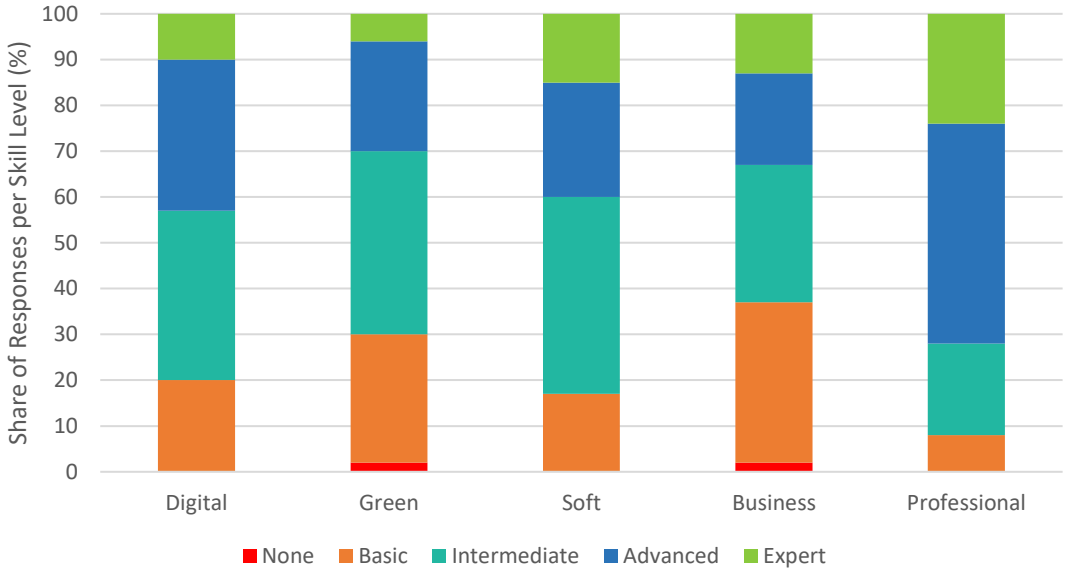

Figure 7: Self-reported skill proficiency across key competency areas

Regarding green skills, which encompass sustainable practices and resource-efficient operations, the gap appears even more pronounced. Approximately 40% of respondents assessed their employees' green skills at an intermediate level, while around 28% indicated only basic green competencies. Only about 24% of respondents reported advanced proficiency in green skills, with very few (around 6%) noting expert-level environmental knowledge within their organizations. One respondent even stated that their staff had no green skills at all. Meanwhile, the importance of green skills is almost universally recognized: about 89% of respondents considered them "Important" or "Extremely important," with several emphasizing their utmost significance. This significant mismatch between the high value placed on green skills and the more modest proficiency levels underscores a substantial skills gap, highlighting the urgent need for upskilling in areas such as environmental regulations, sustainable technologies, and eco-friendly operational practices.

In the domain of soft skills, such as communication, teamwork, and problem-solving, the situation appears somewhat more favorable. Approximately 43% of respondents rated their employees' soft skills at an intermediate level, while 25% reported advanced or expert levels. Specifically, 15% of respondents assessed their staff as having expert soft skills, reflecting strong interpersonal or leadership abilities within some organizations. Nevertheless, about 17% of respondents indicated only basic soft skills. As with other skill areas, no respondents selected “None.” The importance of soft skills was consistently emphasized, with around 55% of respondents considering them important, and approximately 35% highlighting them as extremely important. Overall, soft skills are seen as both highly valued and relatively well-developed among current employees; however, continuous improvement, particularly among those with only basic skills, would further enhance collaboration, leadership, and innovation capacities.

For business skills encompassing financial literacy, marketing, customer service, and policy understanding, the gap is moderate. Approximately 65% of respondents indicated that their employees possess basic or intermediate business skills. Specifically, a notable share of organizations reported that their staff have a fundamental understanding of business, and only about 20% assessed their employees as having advanced business skills, with even fewer recognizing expert-level capabilities. A small number of respondents noted a complete absence of business skills within their organizations. Although about 75% of organizations consider business skills important or extremely important, their perceived importance is slightly lower compared to digital, green, and soft skills. Nonetheless, for organizations that prioritize business acumen, the limited proficiency among employees represents a significant gap, particularly in areas such as entrepreneurship, budgeting, marketing, and client relations. Addressing this gap through targeted training in business fundamentals could significantly enhance innovation and organizational growth in the blue economy.

In contrast, professional (job-specific) skills that refer to the technical competencies required in specific blue economy roles, such as marine engineering or aquaculture, appear to be strengths. Approximately 48% of respondents reported advanced professional skills among their employees, while an additional 24% assessed these skills at an expert level. Together, over 70% of respondents indicated strong job-specific competencies within their organizations. Only a few respondents rated professional skills as basic, and none selected “None.” The importance of professional skills was nearly unanimous, with about 95% considering them important or extremely important, and more than half of all respondents emphasizing them as extremely important. This alignment between high

skill levels and great importance suggests that fundamental technical expertise is generally not a significant concern among the surveyed organizations. However, the evolving nature of the blue economy means that even strong professional skills will require continuous development to remain relevant, particularly as new technologies and practices emerge.

In summary, across all skill categories, the most pronounced gaps appear in transversal areas such as green skills and business skills, where current employee proficiency often lags behind the high importance placed on these competencies. Digital skills are also in high demand, and while many employees demonstrate moderate to advanced proficiency, continuous upskilling is necessary to meet the growing expectations driven by technological advancement. Soft skills are critical and generally well-developed; however, there are opportunities to strengthen them further, especially among employees currently assessed at only basic levels. Professional technical skills are a strong point for most organizations, but ongoing professional development will be essential to ensure that employees remain at the forefront of industry evolution.

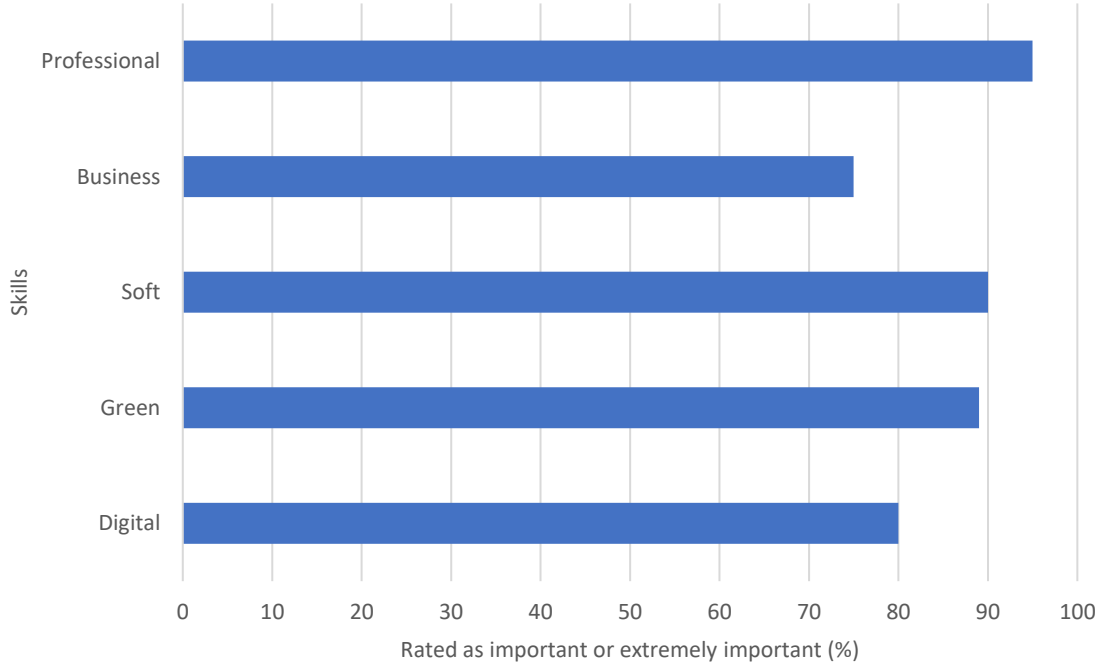

Figure 8: Importance of skill categories according to respondents

3.4. Key Skills Sought by Organizations

When asked openly, "*What are the key skills your organization currently seeks in employees?*", respondents provided a variety of answers, emphasizing a combination of technical and soft skills across blue economy sectors.

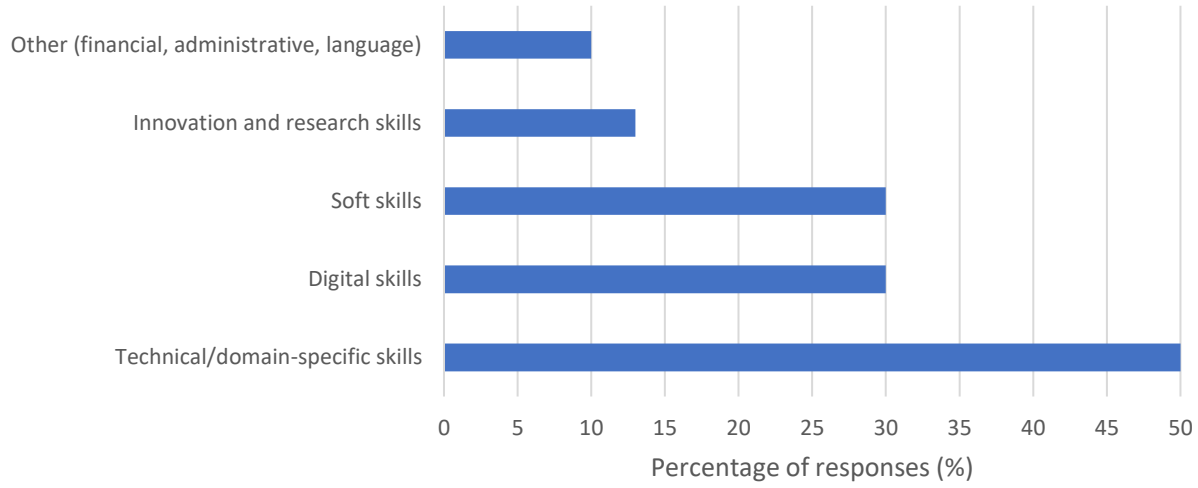

Figure 9: Essential skills sought by organizations

Approximately 50% of respondents emphasized the importance of technical and domain-specific skills. These included sector-specific competencies such as aquaculture techniques, marine engineering knowledge, nautical operations, and mechanical skills. For example, one aquaculture company stressed the importance of a "passion for aquaculture activities" alongside practical farming expertise, while another noted the need for mollusk farming experience. Additional examples included skills in maritime navigation and marina operations, as well as a general requirement for a "high academic profile" in engineering or architecture, particularly for research-focused roles. This underscores that strong professional expertise in the relevant blue economy field remains a baseline expectation among employers.

Approximately 30% of respondents explicitly identified digital skills as a critical need. Cited abilities included digital literacy, IT skills, and proficiency with specialized software. Respondents emphasized the importance of competencies in "advanced software and tools," familiarity with digital platforms, and high-level programming knowledge. This finding aligns with the broader recognition

of digital skills as essential for workforce development. Organizations seek employees with expertise in areas such as data analysis, software operation (e.g., GIS, BIM), and emerging technologies like AI and automation. One respondent specifically described a need for "digital, administrative, transversal" skills, indicating that a combination of digital proficiency and broader cross-sectoral competencies is increasingly desirable.

Soft skills also featured prominently, with approximately 30% of respondents identifying attributes such as problem-solving ability, teamwork, leadership, communication, flexibility, and initiative as highly sought-after qualities. Examples included a "strong inclination for teamwork," leadership capabilities, and problem-solving skills. Other mentions highlighted learning capacity and adaptability as essential traits. This suggests that employers in the blue economy are seeking not only technically capable staff but also individuals who can collaborate, adapt to changing circumstances, and demonstrate leadership potential. Particularly in innovative or project-driven environments, the ability to work effectively in teams and approach challenges creatively is considered just as important as technical expertise.

In addition, around 13% of respondents emphasized the importance of innovation and research skills. References to "innovation, research skills" and "academic research skills" illustrate the demand for employees capable of engaging in research activities, handling specialized data (such as biostatistics and bioinformatics), and contributing innovative thinking to their organizations. High academic qualifications, particularly master's and PhD degrees, are regarded as valuable assets, especially in organizations involved in R&D or high-tech marine fields.

A few respondents also mentioned other skills, although they did so less frequently. These included financial and administrative skills, which were often noted alongside digital and leadership competencies. Language proficiency, particularly in English, as well as communication skills for professional and social media contexts, were also highlighted.

In summary, organizations seek a well-rounded skill set in their talent pipeline—combining strong technical expertise, digital literacy, and essential soft skills such as problem-solving, teamwork, and leadership. Notably, digital and soft skills are emphasized as frequently as technical qualifications, reflecting how job requirements in the blue economy evolve towards multidisciplinary competencies. For example, a port operations role may now require not only maritime navigation expertise but also the ability to utilize digital platforms and collaborate effectively. Similarly, an aquaculture business values practical farming knowledge alongside innovation and teamwork abilities. This evolving skill

profile should guide curriculum development by integrating technical training with digital tools and enhancing soft skills, ensuring that future workers are fully prepared for the demands of the modern blue economy.

3.5. Critical Technologies and Innovation Needs

Respondents identified several crucial and emerging technologies relevant to their sectors, emphasizing areas where new skills are becoming increasingly critical.

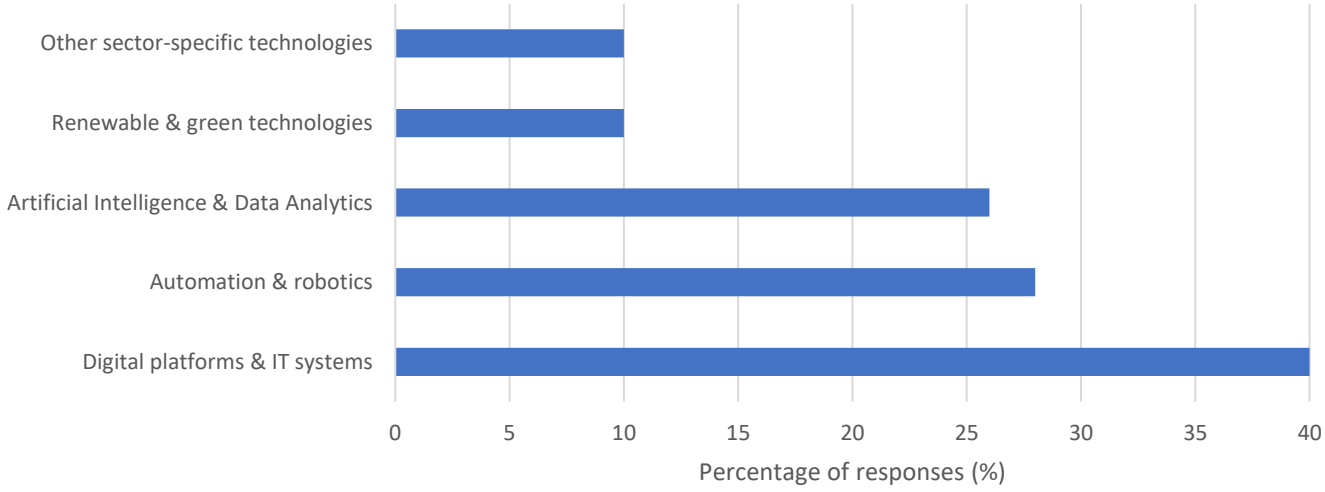

Figure 10: Key Technology Areas Identified by Respondents

The most frequently mentioned technologies were digital platforms and IT systems. Approximately 40% of respondents referenced the importance of digital platforms, advanced software, or IT tools. Many indicated "*digital platforms*," suggesting that the use of online systems for data management, communication, and operational processes is now essential across various blue economy sectors. Others specifically mentioned cloud computing, digital archives, interoperable management software, and data analytics systems. These findings confirm that digitalization is a cross-cutting priority, whether in innovative port management, digital marketing in marine tourism, or fisheries data tracking. Consequently, there is a growing need for skills in software usage, database management, and digital workflow optimization.

Approximately 28% of respondents identified automation and robotics as critical. This included references to process mechanization, sensor use, remotely operated vehicles (ROVs), and workflow automation. Examples highlighted the automation of mollusk processing in aquaculture and broader mentions of marine robotics, automated docking systems, underwater imaging technologies, and intelligent autonomous systems. These developments underscore the growing importance of knowledge in mechatronics, robotics operation and maintenance, and process automation for the blue economy workforce.

Around 26% of respondents specifically cited artificial intelligence (AI) and data analytics as key technological trends. Some mentioned generally "AI" or "machine learning," while others pointed to specific applications, such as AI for administrative processes, positioning large marine structures, or understanding the limits of AI systems. High-level programming skills (e.g., Python) and expertise in advanced data analytics were also emphasized. These insights reflect a growing recognition that AI and big data are becoming integral to predictive maintenance, resource management, and environmental monitoring, necessitating workforce skills that enable the effective use and integration of AI-driven tools into traditional operations.

Although fewer in number, several respondents highlighted renewable energy and green technologies as emerging priorities. Examples included references to electrical motors, solar panels, offshore wind energy, and alternative fuels such as nuclear fuel cells and advanced batteries. These responses align with the blue economy's shift towards sustainability, particularly in sectors like maritime transport, which explore cleaner propulsion methods and marine renewable energy sources. Accordingly, there is a need for expertise in renewable energy systems, energy efficiency technologies, and environmental engineering.

Some respondents also pointed out industry-specific emerging technologies. In marine construction and engineering, Building Information Modeling (BIM) and innovative materials for shipbuilding were mentioned. In maritime operations, technologies such as innovative port management systems, automated docking systems, and advanced navigation tools indicate a clear trend toward smart shipping and Internet of Things (IoT) applications. In marine environmental science, skills related to underwater imaging, remote sensing, and spatial analytics are highlighted, suggesting a demand for geospatial technologies and drone-based monitoring. In marine biotechnology and aquaculture, references to marine biotechnology innovations and the large-scale production of macro and microalgae point to a growing need for biotechnological expertise.

Overall, the findings illustrate that digitalization, automation, and AI are at the forefront of technological change in the blue economy. Respondents emphasized a clear need to keep pace with Industry 4.0 in a marine context, whether through the implementation of IoT and robotics in ports, AI-driven logistics and vessel operations, or the utilization of digital platforms in marine tourism and education. Additionally, a significant environmental technology component is emerging from the adoption of renewable and green technologies.

These technological trends are closely related to urgent training needs. Nearly all respondents (approximately 95%) indicated that there are significant unmet requirements for technology-related training within their sectors. Only two respondents reported not perceiving any specific needs. The identified areas for upskilling include AI application training and advanced programming, particularly in languages such as Python, robotics training that involves operating simulation-based equipment, and the use of digital tools like CAD software, maritime digital platforms, and IoT solutions for port management.

Further areas of need included training in data analytics and statistics, particularly bioinformatics and biostatistics for marine science applications. Sector-specific technical certifications were also highlighted, with examples such as Cisco networking courses and Global Wind Organisation (GWO) certifications for offshore wind energy safety. Additionally, maritime-specific technology training needs were frequently mentioned, including digital navigation and safety procedures, predictive maintenance practices in shipping, automation in marina operations, and alternative marine propulsion technologies.

Several respondents also emphasized the importance of green and regulatory training, which includes familiarity with ISO standards such as ISO 9001 and ISO 14001 and broader environmental sustainability practices. Interestingly, a few responses highlighted the need for improved business communication and language skills in technical contexts, stressing that effective collaboration and the implementation of technologies increasingly require strong communication abilities along with technical expertise.

In summary, organizations in the blue economy recognize a broad and urgent need for technology-related upskilling. Emphasis is particularly placed on digitalization, AI, and automation skills. However, there is also significant demand for sector-specific technical training and interdisciplinary competencies such as communication, standards compliance, and sustainable practices. The near-universal recognition of current training inadequacies highlights the urgent need

to update curricula and expand professional development opportunities, ensuring that the workforce is well-equipped to support technological innovation and sustainable growth in the blue economy.

3.6. Sustainable Practices Knowledge Gaps

Sustainability is a central theme in the blue economy. When asked openly, "*What sustainable practices or knowledge do you consider crucial within your sector?",* respondents provided various answers, emphasizing a mix of technical and soft skills across blue economy sectors.

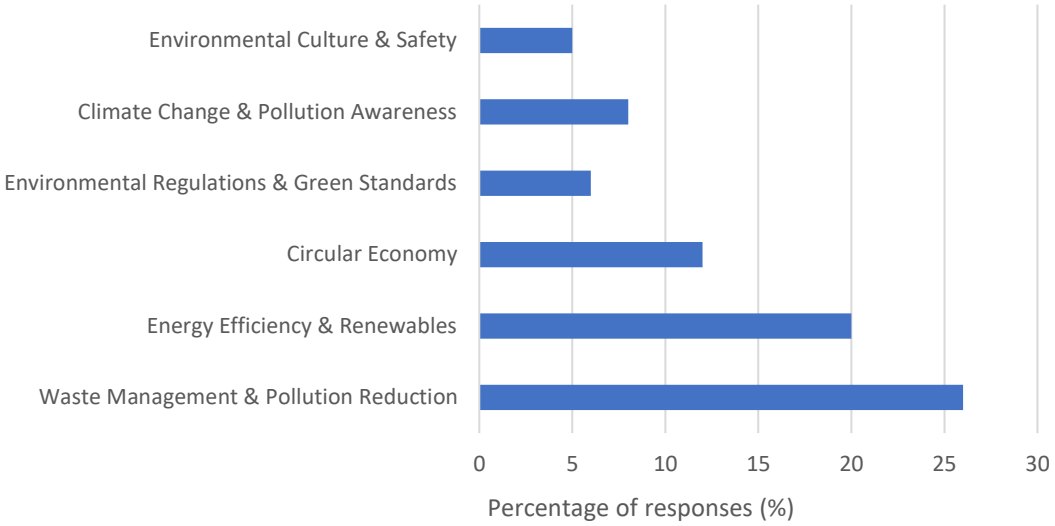

Figure 11: Key sustainability areas in the blue economy according to respondents

The most cited sustainability areas were waste management and pollution reduction. Approximately 26% of respondents emphasized the importance of efficient waste management, waste reduction, and recycling, referencing practices such as "*efficient waste management in ports*" "*differentiated waste collection (recycling)*" and "reducing waste discharge into the sea." The reduction of plastic pollution was also mentioned, particularly the need for awareness of plastic's environmental impacts. Many organizations noted internal initiatives focused on waste sorting and handling special waste types, such as shipyard waste. These findings highlight the necessity for employees to develop practical skills in waste handling, minimize pollutants, and implement recycling programs as essential components of sustainable operations.

Energy efficiency and renewable energy adoption emerged as the next central theme, mentioned by approximately 20% of respondents. They emphasized the importance of energy-saving practices and knowledge of renewable energy technologies, with examples such as "*energy efficiency in public institutions*" and "*renewable energies skilling, energy management*". Internally, organizations reported measures such as reducing electricity consumption and adopting renewable energy solutions like hydropower. Consequently, skills related to energy auditing, the integration of solar and wind energy systems, and fuel optimization are increasingly required in the sector.

Approximately 12% of respondents explicitly mentioned knowledge and application of circular economy practices. Mentions of the "*circular economy*" and related concepts, such as "*high-value enhancement of bio-based by-products*" reflect a growing recognition of the need for the reuse and valorization of waste or by-products. Some organizations have prioritized circular economy principles internally, emphasizing the increasing importance of recycling technologies, life cycle thinking, and sustainable business model development in blue economy sectors.

A smaller group of respondents, around 6%, emphasized the importance of understanding environmental regulations and green standards. References to frameworks such as Minimum Environmental Criteria (MEC), Green Public Procurement (GPP), and the European Green Deal indicate a growing need for knowledge of environmental policies. Furthermore, compliance with standards like ISO 14001 for environmental management is frequently mentioned. These responses suggest that staff should be educated on environmental legislation, certification standards, and sustainable procurement practices and trained to integrate these into daily operations.

In addition to these areas, approximately 8% of respondents emphasized the importance of pollution and climate change awareness. Key topics included understanding ocean pollution, such as acidification, plastic waste, and temperature changes, along with the impacts of climate change on sector-specific activities, including species shifts in aquaculture. Some organizations also identified carbon footprint reduction as an internal goal, stressing the need for employee awareness of climate-related issues and low-carbon operational strategies.

Finally, a small percentage of respondents (approximately 5%) associated sustainability with fostering a culture of safety and environmental protection in their workplaces. Cultivating a culture of ecological respect and workplace safety is considered essential, particularly in industries such as aquaculture and offshore activities. Although it may not be a technical skill, promoting environmental

responsibility among employees is regarded as crucial for integrating sustainability into routine operations.

Overall, the survey findings suggest that the most significant sustainability skill gaps lie in practical environmental management, particularly in effective waste management, energy efficiency, and the implementation of circular economy principles. While many organizations are already engaged in initiatives such as recycling programs and green operations strategies, the consistent emphasis on these topics indicates a need for further education, capacity building, and consistent application. Although companies may have sustainability policies in place, they still require better-trained staff to achieve full implementation. Bridging these gaps necessitates integrating robust environmental sustainability modules into training programs, ensuring that the blue economy workforce is fully equipped to meet evolving green policy goals and adopt innovative eco-friendly technologies.

3.7. Identified Skill Gap Areas

Respondents were asked to select the areas where the most pronounced skill gaps exist within their organizations, offering a focused view of where employee competencies are currently lacking.

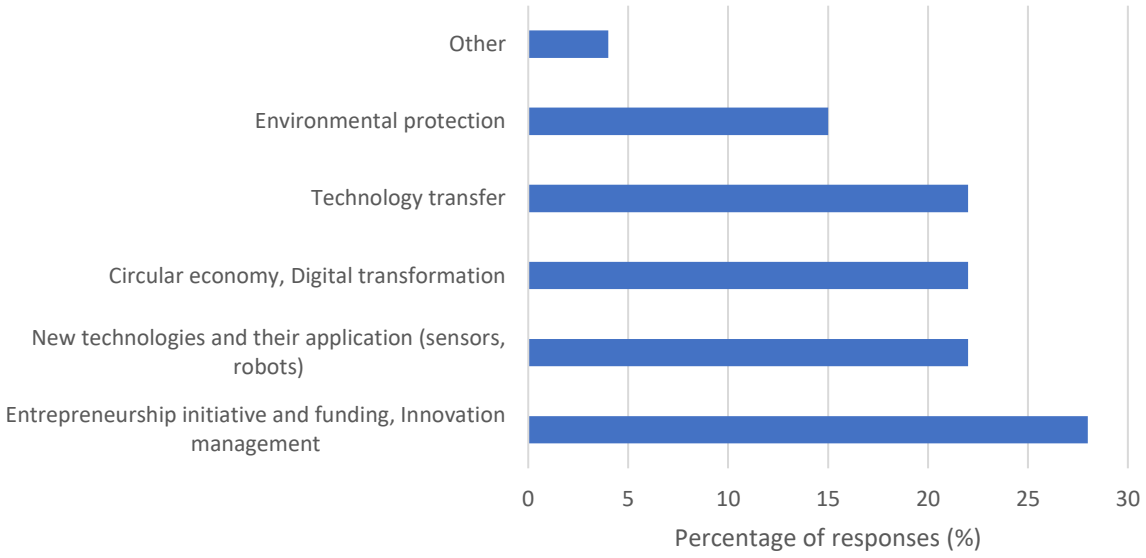

Figure 12: Identified areas of significant skill gaps according to respondents

The most frequently cited skill gaps were in entrepreneurial initiative, funding, and innovation management, as identified by approximately 28% of respondents. This combined category underscores the need for enhanced business development and innovation leadership skills, including generating entrepreneurial ideas, securing funding, and managing innovation processes. These findings align with previous observations that business skills represent a weaker area and indicate that training in project management, fundraising, and creative problem-solving would be beneficial.

About 22% of respondents chose new technologies and their applications, which involve working with sensors, robotics, and automation systems. This underscores a gap in advanced technological competencies, particularly in effectively utilizing emerging Industry 4.0 technologies. To bridge this gap, focused technical training and a strategic approach to hiring technology professionals are essential.

Similarly, about 22% of respondents identified the circular economy and digital transformation as key areas where skills are lacking. Organizations face challenges in integrating digital solutions into traditional workflows while also adopting the principles of the circular economy. This dual transformation requires multidisciplinary expertise, merging digital innovation strategies with sustainable design thinking.

Approximately 22% of respondents identified technology transfer as an important area, which is defined as the ability to move innovations from research to practice. This indicates a significant need to improve collaboration between industry and academia and enhance organizations' capacity to adopt new research outputs and technological innovations. Developing skills in networking, knowledge transfer, and innovation adoption would help bridge this gap.

Approximately 15% of respondents identified environmental protection. Although this figure is slightly lower than in other categories, it emphasizes the ongoing need for expertise in environmental management, monitoring, compliance, and mitigation practices. Strengthening environmental competencies remains essential, especially in sectors closely linked to sustainability objectives.

Finally, approximately 4% of respondents identified specific skill gaps, such as marketing and after-sales services, highlighting the need for flexibility in training programs to address unique organizational requirements.

In summary, the key skill gaps in innovation and entrepreneurship, new technologies, digital and circular transformation, and technology transfer indicate that the future blue economy workforce must be more agile, innovative, and technologically proficient. Traditional technical skills should be complemented by entrepreneurial thinking, digital literacy, and strong collaboration abilities. These findings closely align with the project's focus on smart specialization and industrial transition, highlighting the importance of designing training interventions that enhance business, technology, innovation, and sustainability skills across the sector.

3.8. Impact of Skill Gaps on Performance

Respondents reported how skill gaps affect their organizations in three key areas: productivity and growth, employee satisfaction, and revenue generation. The results clearly indicate that skill gaps have tangible negative impacts across the sector.

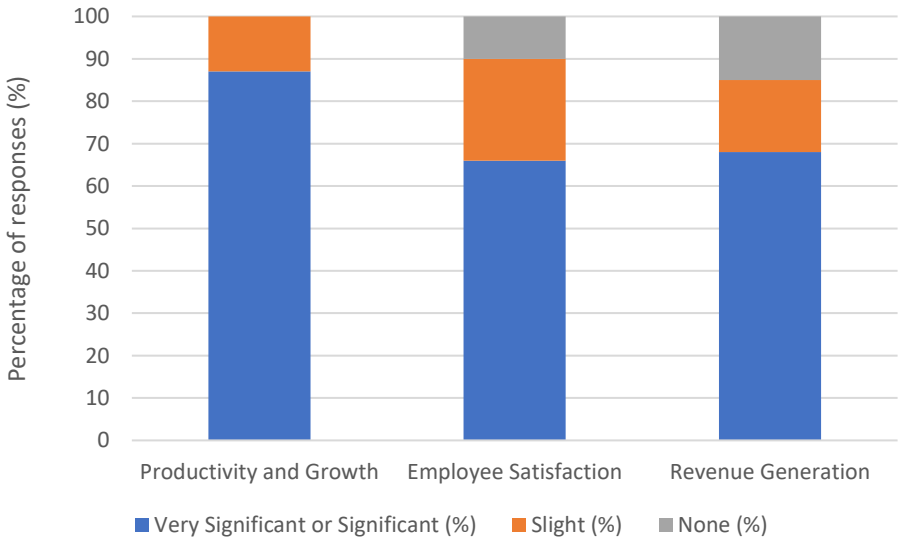

Figure 13: Identified impact of skill gaps on performance

A large majority, approximately 87%, described the impact as significant or very significant regarding productivity and growth. Only about 13% assessed the effect as slight. These results suggest that skill gaps are slowing down operations, reducing efficiency, and limiting organizational expansion. For instance, insufficient digital expertise might delay processes, or a lack of managerial

skills could bottleneck growth initiatives. The fact that more than four-fifths of respondents report moderate or greater productivity losses highlights an urgent need for remedial action through training and skills development initiatives.

Regarding the impact on employee satisfaction, skill gaps also appear to play a substantial role, though with slightly more variation than for productivity. Approximately 66% of respondents indicated that skill gaps have a significant to very significant negative impact on employee satisfaction. Conversely, around 24% perceived only a slight negative impact, and approximately 10% reported no effect on satisfaction. These results suggest that, for most organizations, skill shortages contribute to lower morale, possibly due to increased stress, frustration, or limited personal development opportunities among employees. However, some organizations, particularly those actively managing skill development, may have mitigated these effects. Strengthening employees' skills through continuous learning could therefore not only improve organizational performance but also enhance job satisfaction and retention.

When considering the impact on revenue, approximately 68% of respondents indicated that skill gaps have a significant to very significant effect on their organization's financial performance. Meanwhile, about 17% assessed the impact as slight, and approximately 15% indicated no measurable impact on revenue. These findings suggest that for many organizations, skill gaps can lead to lost income opportunities, inefficiencies, or missed project chances. However, the direct impact on revenue may be less visible in sectors operating with fixed budgets, such as public institutions or research organizations. Nevertheless, in competitive market environments, lacking critical skills can translate to lost contracts, reduced service quality, and limited innovation, ultimately affecting financial sustainability.

Skill gaps exert significant negative effects across all three dimensions: productivity, employee satisfaction, and revenue. Productivity and growth are the most universally impacted; however, employee well-being and financial outcomes are also frequently undermined by skill shortages. This triple impact reinforces the importance of strategic investment in education, training, and talent development. Addressing skill gaps could lead to widespread organizational benefits, including higher efficiency, improved employee morale, and increased revenue growth.

3.10. Cross-Sector Collaboration and External Engagement

The survey explored how often organizations collaborate with external partners or different sectors, especially in fields like technology transfer, innovation, and environmental initiatives. Cross-sector collaboration is vital for knowledge exchange and serves as a strategy to tackle internal skill gaps.

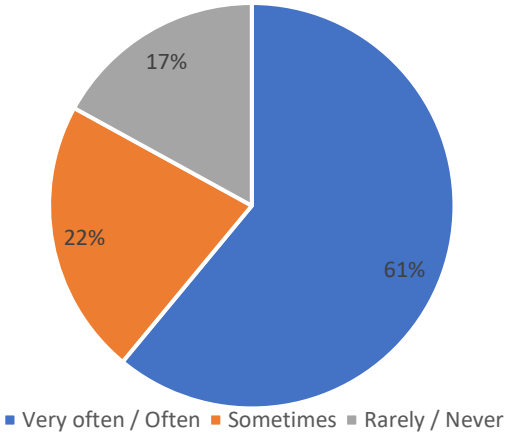

Figure 14: Frequency of cross-sector collaboration among organizations

Most respondents reported a high level of engagement in collaboration frequency. Approximately 61% stated that they collaborate often or very often with external partners. About 22% indicated that they collaborate sometimes, reflecting a more occasional or situational involvement. Around 17% reported collaborating rarely or never, highlighting that a minority of organizations have limited external interaction.

These results demonstrate that collaboration is a widespread practice among many organizations, indicating an openness to exchanging external knowledge and adopting cooperative approaches to workforce and innovation challenges. Collaborative activities likely include participation in multi-stakeholder projects, membership in industry associations, involvement in joint research initiatives, and daily cooperation within supply chains. Organizations with lower levels of collaboration may benefit from structured efforts to integrate into broader innovation ecosystems and cross-sector networks.

When asked whether they had utilized training or educational programs to address skill gaps, approximately 85% of respondents confirmed their active participation in these efforts. Only about 15% indicated they had not engaged in any formal training initiatives.

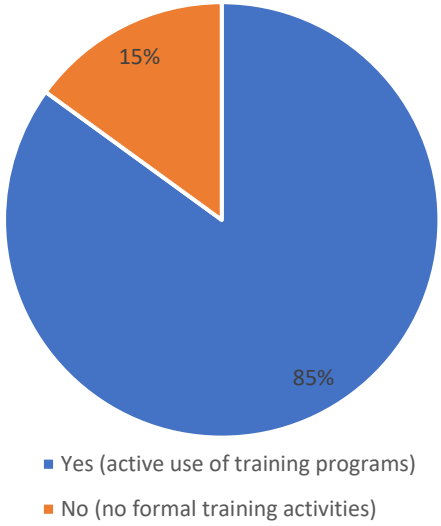

Figure 15: Utilization of training programs to address skill gaps

Among the organizations that implemented training, standard methods included workshops, mentoring programs, online courses, blended learning approaches, and technical certification programs. Workshops and mentoring were especially prominent.

The high prevalence of training usage indicates that most organizations are actively investing in employee development. However, the persistence of identified skill gaps suggests that the content, methods, or targeting of training may need improvement to better meet the evolving demands of the blue economy.

3.11. Effectiveness of Different Training Methods

Respondents evaluated the effectiveness of various training methods, including online courses, in-person training, blended learning, workshops, mentoring schemes, and self-paced online learning, on a scale from 1 (least effective) to 7 (most effective). The results provide valuable insights into which training formats are perceived as most effective for skill development in the blue economy.

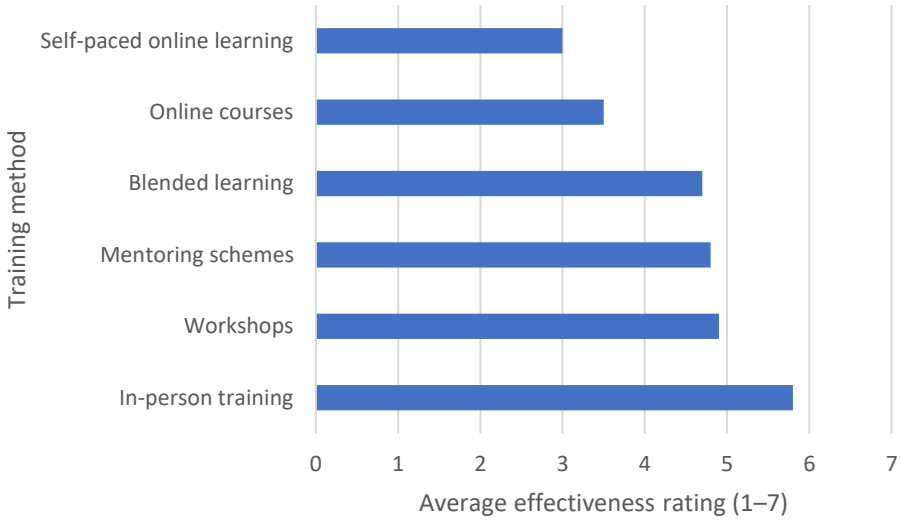

Figure 16: Perceived effectiveness of training methods for skill development

In-person training emerged as the highest-rated method, achieving an average score of approximately 5.8 out of 7. Many respondents awarded it the maximum rating, reflecting a strong belief in the value of traditional face-to-face learning, such as classroom courses, seminars, and on-site sessions. In-person formats are viewed as highly effective due to the opportunities for direct interaction, immediate feedback, and practical, hands-on experiences.

Workshops also received high ratings, averaging around 4.9 out of 7. Often structured as interactive skill-development sessions, they were perceived as nearly as effective as general in-person training. Their practical nature and emphasis on group problem-solving make them a powerful method for quickly building competencies in specific areas.

Mentoring schemes received a similarly positive response, achieving an average rating of approximately 4.8 out of 7. This mentoring, which involves structured knowledge transfer between seasoned mentors and less-experienced employees, was praised for its personalized approach and practical relevance. Although mentoring was rated less frequently than workshops, participants found it to be significantly beneficial for professional development.

Blended learning, which combines online and in-person elements, received a favorable score with an average effectiveness of approximately 4.7 out of 7. This approach effectively balances the

flexibility of online learning with the engagement of face-to-face interaction. Respondents indicated that when appropriately implemented, blended formats can nearly match the effectiveness of traditional in-person training.

Online courses, however, received a more moderate rating of approximately 3.5 out of 7. Although still considered somewhat effective, online-only training formats were generally viewed as less engaging and impactful. Potential limitations mentioned include a lack of interaction, variability in course quality, and reduced learner motivation in a purely virtual environment.

Self-paced online learning, which includes recorded modules and independent study materials, received the lowest effectiveness rating, averaging only about 3.0 out of 7. Many respondents expressed skepticism about this approach, likely due to low completion rates, a lack of guidance, and challenges in applying complex knowledge without real-time support.

Very few respondents suggested "other" methods, and no consistent alternative format emerged. However, references to hands-on training, seminars, and brainstorming sessions indicated a general preference for interactive and participatory learning environments.

Alongside these ratings, qualitative feedback emphasized a preference for interactive human learning. Many organizations reported positive experiences with workshops and in-person events, while purely online formats were often seen as less satisfactory.

When asked about their openness to participating in further engagement activities under the project, approximately 89% of respondents indicated a willingness to be involved. Among the preferred formats, workshops were the top choice, selected by around 39% of respondents, followed by roundtables at 17% and brainstorming sessions at 11%. About one-third of participants expressed their readiness to engage in any of the available formats.

These findings have clear implications for future training initiatives aimed at addressing skill gaps. Programs should prioritize interactive, face-to-face components whenever possible. Even when geographic constraints exist, virtual live workshops or mentoring through videoconferencing would be preferable to solitary self-paced modules. Additionally, incorporating mentorship or coaching elements into training initiatives, such as pairing trainees with experienced industry mentors, could significantly enhance learning outcomes. The strong willingness among stakeholders to engage in further activities indicates that initiatives based on interactive formats are likely to be well-received and highly impactful.

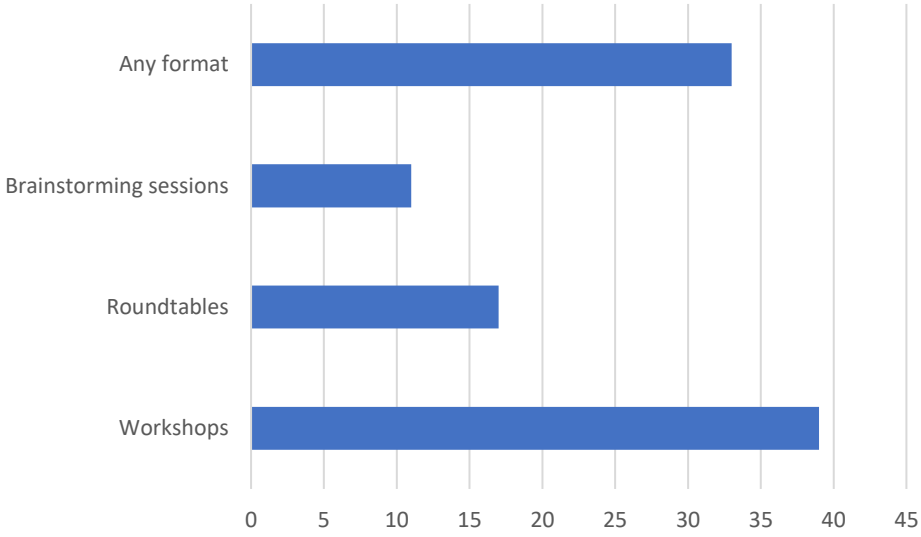

Figure 17: Preferred formats for future engagement activities

4. Conclusion

The MareSkill stakeholders' interview results offer a comprehensive view of the skill gaps in the blue economy and the educational strategies required to address them. Numerous key conclusions and actionable recommendations emerge from the findings.

Organizations report that while core professional skills are relatively strong, significant gaps persist in strategic areas critical for sustainable growth and innovation. Skills in entrepreneurship and innovation management are lacking, with many organizations indicating a need for staff to be better equipped to develop new business ideas, secure funding, and manage innovative projects. Digital and technological competencies represent another significant gap, as employees often require stronger expertise in emerging technologies such as automation, artificial intelligence, and digital platform usage, as well as in the broader processes of digital transformation. Furthermore, knowledge related to sustainability, including waste management, energy efficiency, and green practices, remains underdeveloped among employees. The ability to transfer and apply knowledge, whether from research to practice or across sectors, has also been identified as inadequate, slowing the pace of innovation adoption. Overall, the results point to the necessity of evolving the blue economy workforce beyond traditional technical expertise by nurturing skills in innovation, digital technologies, sustainability, and cross-sector collaboration.

The impact of these skill gaps is not merely theoretical; it is tangible and substantial. Nearly all respondents reported that skill gaps negatively affect productivity and growth, with the majority describing the impact as moderate to very significant. Employee satisfaction also suffers, with approximately two-thirds of respondents indicating a detrimental effect on morale, often linked to stress or frustration caused by inadequate training. Financially, around two-thirds of organizations reported a negative impact on revenue, with skill shortages leading to lost opportunities, operational inefficiencies, or missed project chances. This underlines the critical importance of skill development for maintaining competitive performance and fostering workforce well-being.

In addressing these gaps, the preferred educational methods are clear. Respondents overwhelmingly favor interactive, hands-on learning approaches. Traditional in-person training and collaborative workshops were rated as the most effective formats for building complex skills, closely followed by mentoring schemes. Conversely, purely online or self-directed learning was perceived as less effective, often lacking the engagement and contextual understanding necessary for skills such

as machinery operation, problem-solving, or complex project management. Future training programs should, therefore, emphasize practical engagement: classroom sessions, field-based training, on-the-job mentoring, and blended learning models that combine flexibility with meaningful interaction.

The findings also highlight several priority areas for curriculum development. Digital and AI competencies should be integrated across marine sector education, ensuring even traditional fields such as marine science and engineering incorporate current IT and data analysis skills. Sustainability must become a core component of training, featuring dedicated modules on environmental protection, energy management, and circular economy principles, reinforced through hands-on projects and applied learning exercises. Innovation and entrepreneurship training should be expanded to encourage business planning, innovation management, and navigation of funding mechanisms, incorporating hackathons or innovation labs into programs where possible. To promote better cross-sectoral collaboration and technology transfer, interdisciplinary projects between fields such as engineering, IT, and business should be embedded within curricula. Finally, for the existing workforce, accessible lifelong learning programs, including micro-credentials and flexible certification schemes, are essential, particularly those that integrate mentorship components.

In terms of implementation, several strategic actions are recommended. Encouraging stronger partnerships between industry and academia will enable the co-development of targeted training programs that closely align with industry needs. Organizations should cultivate a culture of continuous learning by establishing regular in-house training sessions, supporting external educational opportunities, and promoting peer learning groups or roundtables to share best practices. Formal mentoring programs should be introduced to ensure knowledge transfer between experienced and younger employees. Additionally, incorporating experiential and problem-based learning formats into both academic and professional training contexts is essential for building practical, cross-cutting competencies. Furthermore, training outcomes must be systematically monitored and evaluated to ensure continuous improvement, and training methods should be adapted based on measurable impacts on productivity, satisfaction, and innovation performance.

Finally, the survey reveals a motivated workforce eager to grow and organizations willing to invest in development. The competitive future of the blue economy relies on addressing the identified skill gaps by promoting advanced digital and green skills, strengthening innovation and entrepreneurial

capacities, and employing training methods that actively engage learners. Implementing these recommendations will lead to a more skilled and agile workforce, capable of driving sustainable growth, technological innovation, and prosperity across blue economy sectors, fully aligned with the MareSkill project's objectives of advancing smart specialization and fostering a stronger entrepreneurial skill base in the Italy-Croatia region.