



BENCHMARKING THE FUTURE OF NAUTICAL SCIENCES

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Abstract. The maritime sector is evolving rapidly, driven by digitalization, automation, and stricter environmental regulation. These changes are reshaping what is expected from the Officer of the Watch (OOW), but it remains unclear how well existing education programs align with current and future industry needs. To address this gap, a stakeholder-based benchmarking study was conducted at the Antwerp Maritime Academy. The aim was to identify the competences that maritime professionals consider essential for future OOWs, and to assess whether the current Nautical Sciences curriculum reflects those expectations. A mixed-method survey was distributed through alumni and industry networks, resulting in 200 valid responses from professionals across shipping, offshore, logistics, regulation, and port operations. Respondents rated the relevance of predefined competences and soft skills using a Likert scale and were invited to provide additional insights through open-ended questions. Closed questions were analyzed using descriptive statistics. Open-ended responses were analyzed thematically using a condensed inductive coding approach. The results show strong support for including more practical training, particularly in ship maintenance and systems operations. Digital skills such as ECDIS, cybersecurity, and automation were seen as critical by the majority of respondents. Communication, leadership, and teamwork were the highest-rated soft skills. Sector-specific skills and broader maritime awareness were also highlighted. Respondents frequently rated nearly all items as important, which may point to the need for clearer prioritization in future surveys. It is concluded that the current curriculum requires better integration of practical, digital, and interpersonal competences. Stakeholders support a more modular structure that allows both broad academic grounding and targeted specialization, in order to better prepare OOWs for a complex and fast-changing maritime world.

Keywords: Maritime Education; Curriculum Benchmarking; Soft Skills; Nautical Science.

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1. INTRODUCTION

What should a future Officer of the Watch (OOW) be able to do? It's a simple question, but with the pace at which the maritime world is changing, the answer is far from straightforward. Automation, digital workflows and sustainability demands are reshaping life on the bridge. To really understand what this means for education, we need to ask those who know the industry best: professionals who operate, regulate and support ships every day. Recent studies confirm that stakeholder input is essential when adapting maritime training to meet real-world needs. Without involving shipowners, officers, pilots, equipment suppliers, regulators and trainers, there's a risk that educational programs will drift away from operational reality (Fonseca et al., 2019; Kidd & McCarthy, 2019).

Three trends explain the urgency. First, technology is evolving quickly. Software updates and digital decision tools are now part of everyday bridge work, often raising the bar for what OOWs are expected to manage. Second, new IMO regulations like the MASS Code and revised MARPOL annexes shift more responsibility onto the shoulders of deck officers (IMO, 2024). Third, bridge teams have become increasingly diverse, making leadership and teamwork just as important as technical skills (Oksavik et al., 2020; Flin et al., 2008). All of this exposes a growing gap between the static language of the STCW and the fast-changing reality of ship operations (Bartusevičienė, 2020; Sharma et al., 2019). Filling that gap means aligning learning outcomes with real world expectations from the field.

This paper reports on the Antwerp Maritime Academy's first structured benchmarking of its Nautical Sciences program. While full curriculum reform will be covered in a later article, this contribution focuses on the diagnostic phase: identifying which competences stakeholders find critical for future OOWs, and how well the current program addresses them. By combining this input with international frameworks like the Global Maritime Professional Body of Knowledge (IAMU, 2019), and feeding insights back into academic discussions (Achim et al., 2009), we aim to create a shared foundation for future-ready, evidence-based curriculum development.

2. METHODOLOGY

To better understand what the maritime sector expects from future officers, a benchmarking survey was designed that combined both structured questions and open-ended input. The initial draft was developed by a cross-faculty team from the Antwerp Maritime Academy, with a focus on technical

competences, digital literacy, soft skills, assessment practices, and overall curriculum design. This draft was piloted and refined through expert feedback to improve clarity, relevance, and alignment with the research aims, following principles of good survey design as outlined by Punch (2003) and Kitchenham & Pfleeger (2002). Closed items used a five-point Likert scale to measure stakeholder perceptions. Open-ended prompts were added to allow respondents to nuance their views and raise issues not covered by predefined options.

The survey was distributed digitally via alumni channels, industry contacts and maritime professional networks. In total, 200 complete and valid responses were collected from across different sectors, providing a broad cross-section of maritime expertise. Responses to the closed items were analysed using descriptive statistics to identify general trends. The open-text answers were analysed thematically, using a condensed but structured coding approach grounded in the literature on pragmatic qualitative survey analysis. The strategy was inspired by Ryan's (2023) model, which promotes balance between analytical depth and practical feasibility when working with open-ended data. The coding followed an inductive workflow, informed by established methods from Miles and Huberman (1994) and further developed by Saldaña (2016). It started with multiple close readings of the data, followed by the identification of recurring surface-level themes. These were grouped into thematic categories using open coding, and then refined to ensure coherence and analytic clarity.

Because the open-ended questions were quite focused and the number of responses was manageable, we chose to concentrate on spotting clear and recurring themes. The goal wasn't to analyze every single sentence in extreme detail, but to draw out patterns that could help understand what really matters to our stakeholders. In short, this mixed approach aimed to give both breadth and depth: capture a wide variety of views while making sure that important feedback about competence gaps and curriculum priorities were also reflected.

3. RESULTS

The survey was completed by 200 respondents, each of whom could indicate one or more sectors they work in. The most common answer by far was shipping: offshore and dredging, mentioned by 93 participants. This shows a strong interest from this specialized and growing part of the maritime world. The second most frequently mentioned sector was shipping: long passage, with 43 respondents, reflecting the continued importance of traditional

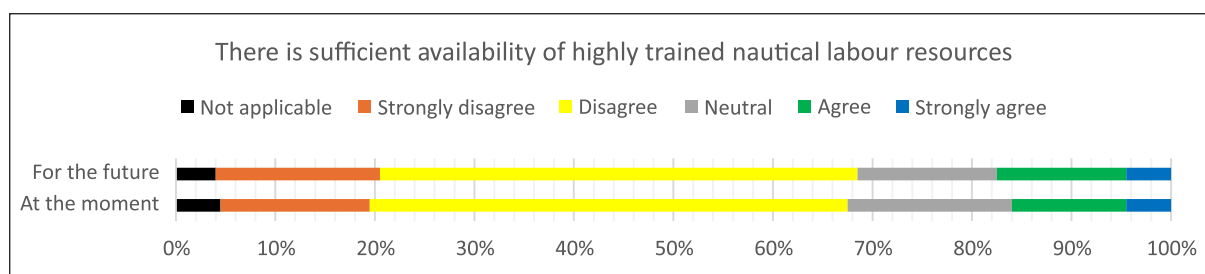


Figure 1. There is sufficient availability of highly trained nautical labour resources

seafaring careers. Other sectors that stood out included energy (26 respondents), port operations (25), shipping: short sea (23), and ship maintenance (22). These numbers show that many participants are closely involved in operational and technical roles. Additionally, sectors like government and legislation (18) and logistics (17) were also represented, suggesting that the survey reached a broad group of professionals from across the maritime supply chain.

The next part of the survey looked at how people view the current and future availability of well-trained nautical professionals. Using a standard Likert scale from “strongly disagree” to “strongly agree”, respondents were asked if there are enough skilled people available today, and whether that will also be the case in the coming years. The responses show a clear trend: around 70% of people said they disagreed or strongly disagreed. This suggests there’s a widespread sense that the maritime sector is already facing a shortage of qualified labour—and that this shortage could become even more critical in the future.

In the next part of the survey, respondents were asked to think about specific competences that might be useful in their line of work. While most competences were seen as important, some clearly stood out. Technology and innovation, risk and accident analysis, and environmental protection were each rated as useful or very useful by more than 80% of respondents. On the other hand, competences like advanced medicine, insurance, and maritime economics received less support, with only around 40% saying they found them relevant. This doesn’t mean those topics aren’t valuable, but perhaps they’re more specialized or context-dependent.

The third list of items aimed to get a better idea of how people view soft skills. These are becoming more and more important on board, especially with increasingly diverse and multidisciplinary teams. Respondents were again asked to rate these skills using the same scale. Communication and collaboration came out on top, while creativity and emotional intelligence scored slightly lower—but still had a minimum positivity rate of 70%. In other words, even

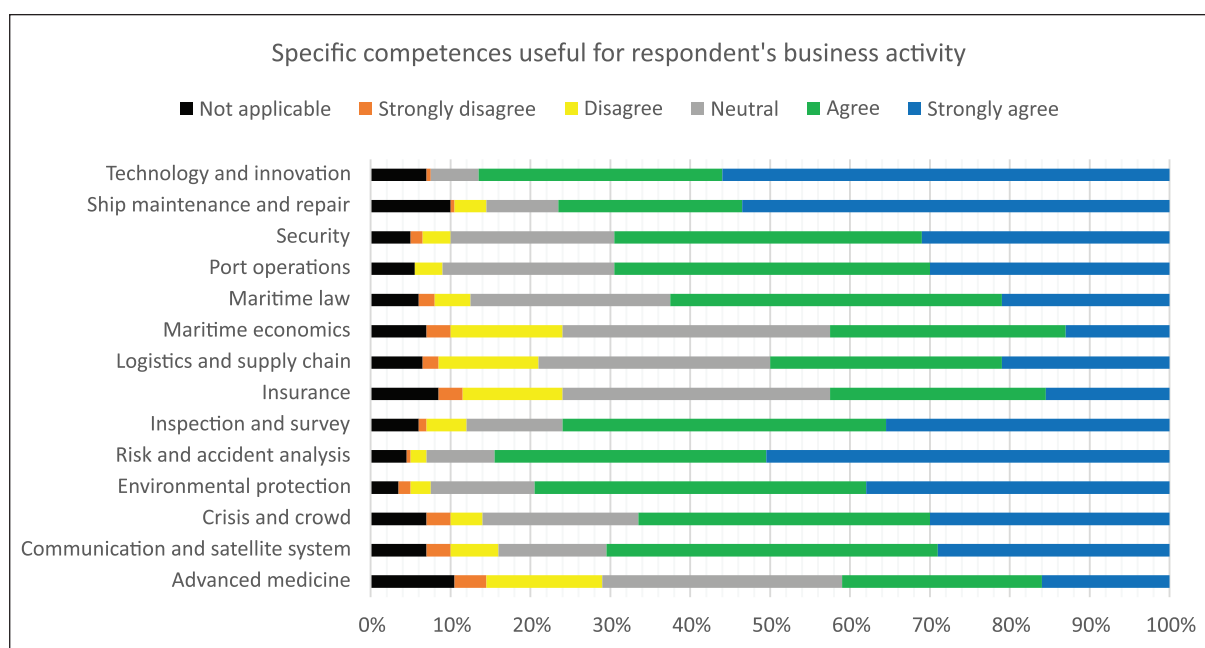


Figure 2. Specific competences useful for respondent’s business activity

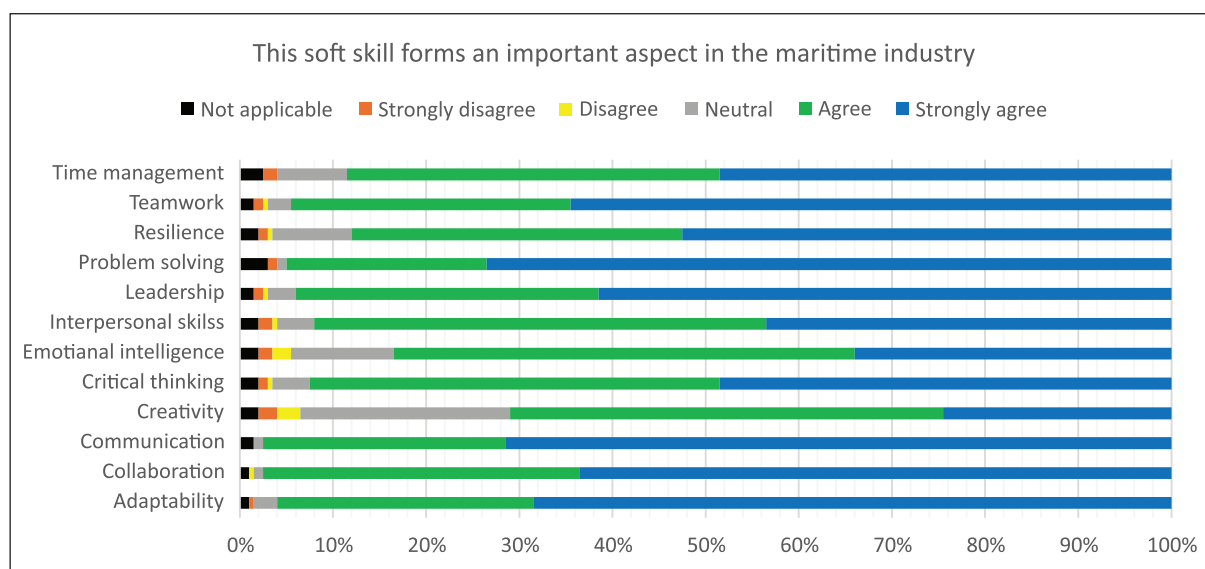


Figure 3. This soft skill forms an important aspect in the maritime industry

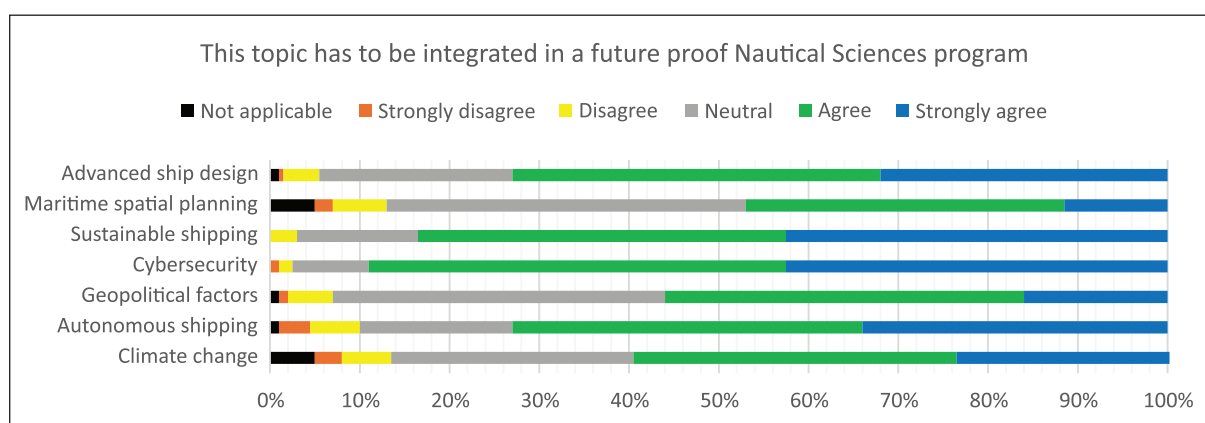


Figure 4. This topic has to be integrated in a future proof Nautical Sciences program

the least popular soft skills were still seen as relevant by the vast majority.

The last closed question set investigated which future topics should be added to a revised nautical sciences curriculum. These were areas that might not yet be fully covered in existing programs. Cybersecurity was seen as the most urgent addition, with strong support across the board. In contrast, topics like maritime spatial planning and geopolitics received fewer votes, though they were still recognized as important by many. One interesting finding was that even though environmental protection scored very high as a useful competence (Figure 2), only 60% of respondents thought climate change needed to be explicitly included in the program. That gap might point to a difference between general awareness and the perceived need for formal training on specific environmental themes.

The open-ended answers on specific competences gave a good picture of what today's maritime stake-

holders expect from the next generation of officers. After reviewing and thematically analyzing all responses, five main themes stood out.

First, many respondents pointed to the need for practical and technical skills. A large group felt that students should have a stronger grip on basic tasks like using hand tools, understanding shipboard systems, and carrying out general maintenance. This was especially emphasized by people working in offshore and dredging, where officers are often expected to get hands-on with technical equipment. Several contributors expressed concern that recent graduates aren't getting enough exposure to this kind of work. Many suggested including more maintenance-focused training, simulator time, and hands-on internships throughout the curriculum.

A second theme focused on digital literacy and readiness for modern technology. As vessels become more complex and data-driven, stakeholders stressed the importance of strong IT skills and familiarity with

onboard digital systems. Specific systems that were frequently mentioned include ECDIS (with an emphasis on type-specific use), radar, dynamic positioning systems, and the ability to work with data for ship operations. Cybersecurity and knowledge of autonomous or remote navigation were also seen as important. Overall, the message was clear: maritime officers need to be more than users—they need to understand the systems they work with.

The third theme was all about soft skills and leadership. A lot of respondents, especially employers and senior crew, said that officers need to be able to lead, communicate, and collaborate effectively on board. They highlighted skills like stress management, conflict resolution, intercultural awareness, and safety leadership. These comments reflect a shared understanding that technical knowledge is essential, but not enough on its own. To run a safe and efficient ship, officers need the human skills to manage a team, handle difficult situations, and create a strong safety culture.

The fourth cluster dealt with industry-specific and niche competences. While the broad foundation offered by the Academy was appreciated, many felt that students entering areas like offshore, port logistics, or hydrography were not fully prepared for the specific challenges of those fields. There were calls for deeper coverage of topics like offshore operations, working with LNG and alternative fuels, environmental compliance, hydrography, and ship handling techniques such as azipod maneuverings or DP control. These are the kinds of skills that help graduates hit the ground running in specialist roles.

Finally, a number of respondents called for a broader understanding of the maritime sector as a whole. Beyond what happens on board, they wanted students to develop insight into areas like international regulations, port operations, insurance, crewing, and budget planning. This kind of systemic knowledge was seen as essential for graduates who may later move into managerial or shore-based positions.

It's worth noting that these themes weren't raised in isolation. Many respondents linked technical knowledge with soft skills, or combined calls for sector-specific expertise with regulatory awareness. All in all, the message is clear: maritime education needs to strike a balance between theory and practice, and between traditional seamanship and the new realities of digitalization, sustainability, and team leadership. What's needed is a more integrated, competence-based approach—one that prepares students for the wide variety of challenges they'll face both at sea and ashore.

4. DISCUSSION

The results of this survey make one thing clear: the world around maritime education is changing fast, and expectations from the field are evolving just as quickly. While respondents still value a solid theoretical base, many pointed out that this alone isn't enough. Graduates need to be ready to apply their knowledge on board, in high-pressure situations, and in a sector where the demands are increasingly complex. Many respondents feel that students are leaving the academy with solid knowledge but not enough hands-on experience. Knowing how to use tools, understand ship systems, or carry out basic maintenance isn't just a "nice extra"—it's often expected from day one, especially in areas like offshore work or dredging. Alongside this, digital skills are becoming just as important. It's no longer just about knowing how to use ECDIS or radar. Today's officers need to understand automated systems, data flows, cybersecurity risks, and even remote diagnostics.

Another recurring point in the answers was the need for more specialisation. While the broad base of the current curriculum is appreciated, many respondents said they'd like to see options for students to dive deeper into specific areas—like port logistics, offshore energy, or environmental regulation. A more modular or elective-based structure could help prepare students better for different career paths, whether they want to stay at sea or move into a shore-based role later on. Soft skills were also a big topic: teamwork, leadership, communication and conflict resolution were mentioned over and over again. It's clear officers also need to be good managers and strong team players. Still, it's worth noting that not all soft skills were rated equally. While communication and leadership got strong support, skills like emotional intelligence or creativity were seen as slightly less essential.

Many participants seemed to rate everything as important. In questions about competences or soft skills, lots of respondents checked nearly all the boxes. That in itself is a message: expectations are high, and there's a sense that officers need to be good at everything. But in practice, you can't teach everything in the same way or to the same depth in one program. In hindsight, asking respondents to rank or prioritise skills might have given us more nuanced insight. In the end, the challenge is clear: maritime education needs to offer a broader skillset, but without overloading students or losing focus on the core of the profession. It's about finding the right balance between strong foundations and flexible pathways, between theory and practice, and between traditional knowledge and new demands. What we take away from this survey is not just a list of expectations but a

call to think differently about how maritime officers are prepared for the future.

5. CONCLUSION

This benchmarking exercise highlighted a clear need for maritime education to keep pace with a sector that is changing fast. Stakeholders from across the maritime world shared a wide range of expectations for the next generation of officers. Their input revealed a consistent call for balance: between academic theory and practical readiness, between technical expertise and human skills, and between broad training and specialised pathways. A growing mismatch was identified between traditional training frameworks and the current demands placed on deck officers. With technology evolving, regulations becoming stricter, and crews becoming more diverse, it is no longer enough to rely solely on existing models. Preparing students for today's operational challenges requires a curriculum that reflects real-world complexity and anticipates future shifts. The responses collected in this survey represent a collective signal from the field. They point to the need for flexible learning structures, more hands-on experience, and a stronger integration of emerging topics like digitalisation and environmental regulation. While no single curriculum can cover everything in equal depth, a clear direction has been set. If maritime education is to remain relevant and future-proof, stakeholder input must continue to guide its development, not as a one-time consultation, but as an ongoing part of academic planning and review.

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REFERENCES

- Achim, M., Căbulea, L., Popa, M., Mihalache, S., 2009. On the role of benchmarking in the higher education quality assessment, *Annales Universitatis Apulensis Series Oeconomica*, 2(11). Available at: <http://dx.doi.org/10.29302/oeconomica.2009.11.2.27>.
- Bartusevičienė, I., 2020. Maritime education and training as a tool to ensure safety at sea in the process of introduction of MASS in shipping. *Transport Means - Proceedings of 24th International Scientific Conference part 1*, 368–374.
- Flin, R., O'Connor, P., Crichton, M., 2008. *Safety at the Sharp End: A Guide to Non-Technical Skills*. Ashgate.
- Fonseca, T., Lagdami, K., Schröder-Hinrichs, J.-U., 2019. Emergent technologies and maritime transport: Challenges and opportunities. *IAMU Conference – Proceedings of the 20th Commemorative Annual General Assembly*.
- International Association of Maritime Universities (IAMU), 2019. *Global Maritime Professional Body of knowledge*. Tokyo: International Association of Maritime Universities.
- International Maritime Organization (IMO), 2024. Outcome of the regulatory scoping exercise for the use of Maritime Autonomous Surface Ships (MASS). *Maritime Safety Committee (MSC 109)*. [Accessed: April 2025]. Available at: <https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/MSC-109th-session.aspx>.
- Kidd, R., McCarthy E., 2019. Maritime education in the age of autonomy. *Urban and Maritime Transport 2022*, 221–230. Available at: <http://dx.doi.org/10.2495/MT190201>.
- Kitchenham, B., Pfleeger, S., 2002. Principles of survey research: Part 3: Constructing a survey instrument. *ACM SIGSOFT Software Engineering Notes*, 27, 20–24. Available at: <https://doi.org/10.1145/511152.511155>.
- Miles, M.B., Huberman, A.M., 1994. *Qualitative Data Analysis: An Expanded Sourcebook*, 2nd ed. SAGE Publications.
- Oksavik, A., Hildre, H.P., Pan, Y., Jenkinson, I., Kelly, B., Paraskevadis, D., Pyne, R., 2020. Skillsea Future Skill and Competence Needs. Available at: <https://hdl.handle.net/11250/2648963>.
- Punch, K. F., 2003. *Survey Research: The Basics*. Sage.
- Ryan, C., 2023. What to Do with All Those Open-Ended Responses? *Survey Practice*, 16(1). <https://doi.org/10.29115/SP-2023-0006>.
- Saldaña, J., 2016. *The Coding Manual for Qualitative Researchers*, 3rd ed. SAGE Publications.