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DEVELOPMENT OF POST GRADUATE STUDIES IN SUPPORT OF MARITIME SECTOR

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Abstract. Education, research, and social engagement manage function in harmony in a university. With the increasing pace of technological development, the maritime industry also has an acute need for advanced research and development. University-based R&D is well supported by postgraduate studies. There is an increase in the number of maritime postgraduate students, but there tends to be a gap between the academic research programs and the dynamically evolving demands of the industry. In order to satisfy the requirements of the maritime industry's research needs, postgraduate education needs to be tailored to these demands. This study aims to give a proposal for future research dealing with the development of postgraduate studies in support of the maritime sector. The methodology establishes an initial strategy by providing recommendations for defining sector-specific R&D gaps through analysis and expert working group collaborations as well as ranking priority topics for postgraduate attention. Understanding that collaboration between universities and the sectors is necessary, the study contributes a model for infusing academic scientific prowess with practical industry insights. It also defines the critical building blocks necessary to reshape postgraduate studies and ensure that the maritime sector is provided with not just targeted research initiatives, but graduates trained in advanced problem identification, research, and skilled execution.

Keywords: Maritime Sector; Postgraduate Education; University-Industry Collaboration; Research and Development (R&D); Needs Analysis; Maritime Management.

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1. INTRODUCTION

The global maritime sector is a cornerstone of international trade and economic activity, characterized by complex logistics, significant capital investment, and increasing technological sophistication (Stopford, 2009). Driven by forces such as digitalization, automation, decarbonization mandates (Bilgili and Olcer, 2024), and evolving global security challenges, the sector faces an unprecedented need for innovation and adaptation. This dynamic environment demands continuous research and development (R&D) to maintain competitiveness, enhance safety, improve efficiency, and ensure environmental sustainability.

Universities, as centres of knowledge creation and dissemination, play a crucial role beyond undergraduate education. Their mandate includes conducting cutting-edge research and engaging meaningfully with society and industry (Etzkowitz & Leydesdorff, 2000). Within the university structure, postgraduate programs (Master's and Doctoral levels) are the primary engines for advanced research, fostering in-depth inquiry and developing highly specialized expertise (Malfroy, 2005). Graduates from these programs are expected to possess advanced analytical, problem-solving, and research skills, making them vital contributors to R&D and prime candidates for leadership positions within industry.

However, a persistent challenge lies in ensuring that the focus of university-based maritime research, particularly at the postgraduate level, is effectively aligned with the real-world needs and priorities of the maritime sector. Without deliberate alignment mechanisms, there is a risk of duplicated effort, research with limited practical application, and a mismatch between the skills developed by graduates and the competencies demanded by employers (Perkmann et al., 2013). Furthermore, the sector requires not just technical specialists but also managers capable of navigating complex challenges using advanced research-informed decision-making skills.

This study addresses this gap by seeking to systematically identify the current and near-future R&D needs of the maritime sector. Based on this identification, it aims to propose a framework for strengthening and directing postgraduate maritime education. The common aim is to improve the education systems of seafarers to ensure safety and security at sea. With the new opportunities offered by technology and using advanced coordination methods, we can improve the quality of MET worldwide. International platforms that host a large number of MET experts create a favourable environment to initiate or launch international projects to improve the quality of maritime education and training (Erdogan & Demirel, 2017). The core objective is to establish mechanisms for effective university-industry collaboration that translate identified sectoral needs into prioritized research themes and relevant curricula, thereby enhancing the impact of postgraduate research and ensuring graduates are well-prepared to contribute significantly to the sector's advancement. This article outlines the rationale, methodology, and expected outcomes of this endeavor, proposing a system to bridge the gap between academic research capacity and industry requirements.

Kitack Lim, Secretary-General, International Maritime Organization (IMO) stated that "Digitalization and automation can be counted amongst the technologies that will help us on the voyage towards cleaner, greener and more efficient shipping but this does not mean that we ignore the human element (WMU and ITF, 2023).

2. LITERATURE REVIEW

2.1. Developments of Maritime Sector

Under the influence of technological developments, the maritime industry is undergoing a radical transformation. Digitalisation (Big Data analytics, IoT, Block Chain, Artificial Intelligence), Automation (remotely controlled and autonomous ships, smart ports), cyber security measures, stricter environmental protection measures (decarbonisation, energy saving, alternative fuels, GHG) are the first issues that stand out (Psaraftis, 2019). These trends take the form of maritime management, shipbuilding and marine technologies, logistics management, maritime law and acquis, and the expansion of the use of information technologies. In order to follow these developments and rapidly apply them to the maritime sector, research and development (R&D) activities should be emphasised and investments should be made for this purpose. Failure to follow the new legislation leads to loss of competitiveness. While countries with high technologies are busy with invention, other countries need to focus on innovation.

2.2. The Role of Universities in Support of Maritime Sector

Universities are increasingly seen as key players in regional and national innovation systems (Etzkowitz, 2003). The role of universities extends beyond producing skilled graduates to generating new knowledge through research, facilitating technology transfer and fostering entrepreneurial activities. These functions of universities are located at the intersec-

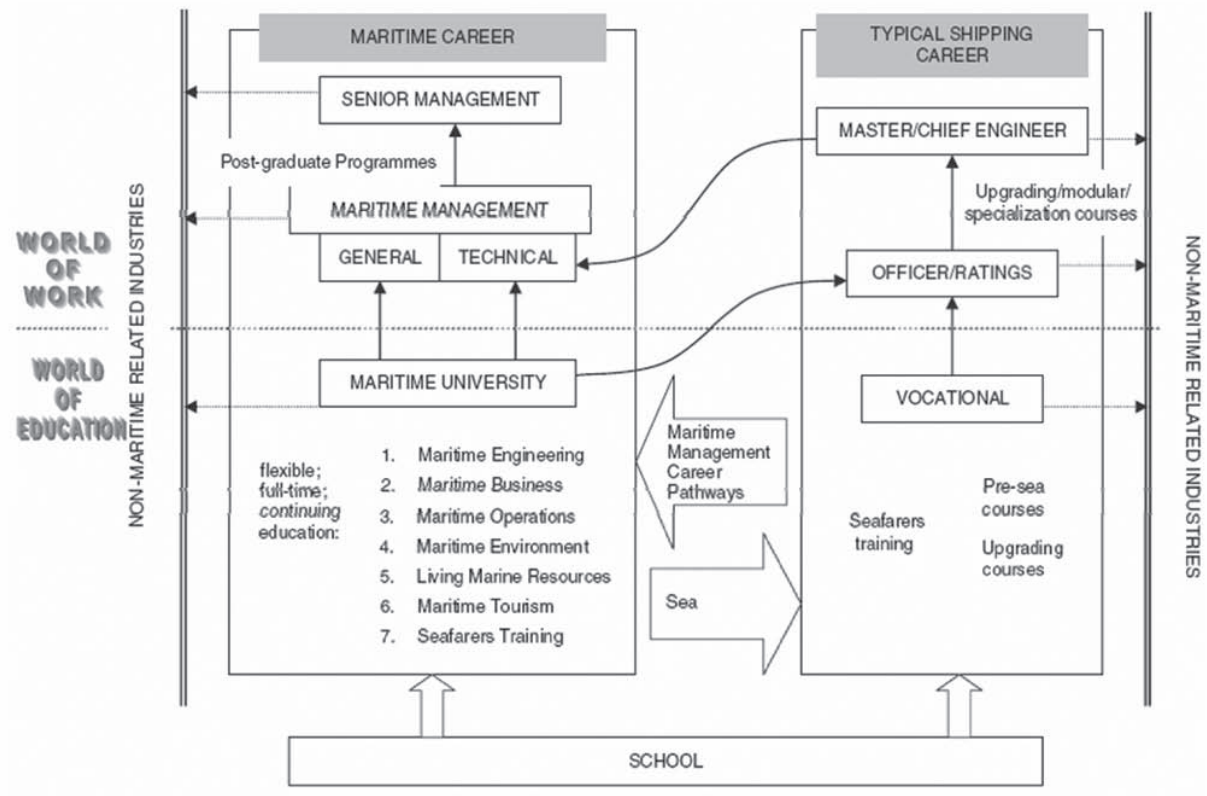

Figure 1. Dynamic Personnel flow in Maritime Industry (Ho et al., 2008)

tion of education and knowledge creation, making them a critical component of this innovative ecosystem.

Universities are also part of Lifelong Learning programmes. They need to strengthen their continuing education centres. This requires the development of e-learning and the provision of specific vocational courses and certificate programmes to meet the needs of relevant business sectors.

The provision of postgraduate programs in maritime education is called to meet the requirements of 'more-than-monolithic' types of skills/knowledge from different stakeholders within the industry as shown in Figure 1 (Ho et al., 2008).

Major skill gaps were identified regarding digital and systems analysis skills as well as technical skills related to *immature technologies* (e.g. alternative fuels, electrified propulsion systems, wind-assisted technologies). Moderate skill gaps were observed with technical skills related to *existing/emerging technologies* (e.g. energy efficiency measures, real-time monitoring system, and advanced navigational equipment) as well as with critical soft skills (e.g. critical and analytical, active learning, communication, problem-solving) (WMU and ITF, 2023).

2.3. Postgraduate Education: Developing Advanced Skills and Research Capacity

The ability to make decisions based on data, with its inherent uncertainties and variability, is a complex and vital skill in the modern world. The need for such quantitative critical thinking occurs in many different contexts, and although it is an important goal of education, that goal is seldom being achieved (Pole, 2015). Postgraduate studies aim to develop students' abilities to conduct independent research, engage in critical thinking, synthesize complex information, and contribute original knowledge to their field (Boud and Lee, 2009). These programs provide the intensive training required for specialized R&D roles. Furthermore, the rigorous process of postgraduate research cultivates advanced problem-solving skills, analytical capabilities, and project management experience – competencies highly valued in middle and senior management positions across various industries, including maritime (Golde & Dore, 2001).

2.4. University-Industry Collaboration (UIC)

UIC is recognized as a vital mechanism for enhancing the relevance and impact of academic research and education (Perkmann et al., 2013; Bruneel et al., 2010).

Collaboration between industry and universities includes joint research projects, consultancy, staff exchanges, permanent or ad hoc industry advisory boards, workplace internships and graduate studies with industry. Universities could keep abreast of the latest developments in the business world, to combine theory and practice, and to have access to real industry knowledge, while industry has access to cutting-edge research, scientific expertise, potential solutions to technical challenges, and easy access to highly skilled human and information resources capable of conducting scientific research. An effective university-industry collaboration, especially in postgraduate education, ensures that research topics are tailored to the needs of the industry and that students are familiar with the expectations of the industry and its real-life applications.

2.5. Challenges in Alignment of Existing Maritime Graduate Education

The effects of rapidly developing technology are felt intensely in the maritime sector. When maritime universities offer graduate programs, they should pay attention to better align research with the often rapidly changing industry needs. Maritime management, utilizing numerous technological developments, especially digitalisation, is gradually approaching the era of unmanned vessels (Theotokas et al., 2024). It is crucial for universities to identify the educational needs arising from these developments in a timely manner and reflect them in their curricula. However, research has shown that the maritime management sector's needs, particularly those related to new technologies, are not fully reflected in curricula (Ariwibowo et al., 2024; Pangaribuan et al., 2024; Suparman et al., 2024; Lopes et al., 2025), and that curricula are deficient in acquiring the skills needed to meet developments in the maritime sector (Thanopoulou et al., 2022; Garay-Rondero & Issa-Zadeh, 2025). Especially taking into account the developments regarding autonomous ships and MASS levels, new educational and training topics that the maritime sector will need should be included in the curriculum (Munim & Haralambides, 2022; Meštrović et al., 2024). These problems are unlikely to be solved by coordination alone; collaboration and structured systems to facilitate harmonization are needed to ensure that both parties work in harmony.

3. METHODOLOGY

This is a multi-phase, preliminary study centered on expert consultation and analysis to achieve its objectives. The phases of the study are described under the following subheadings.

3.1. Phase 1: Identification of R&D Needs of the Maritime Sector

This first phase includes a comprehensive review of existing international regulations, scientific literature, industry reports, strategic documents of internationally recognized maritime organizations (IMO, classification societies, industry associations such as BIMCO, ISF, INTERTANKO, INTERCARGO), government policy documents and technological forecasts of research organizations and sub-organizations of the United Nations (UNCTAD, OECD, IMF, World bank etc.). The aim is to understand the current and future challenges of the maritime sector and to identify the immediate, medium- and long-term R&D needs to address them. R&D activities require extensive manpower and investment. This will be a multi-disciplinary study covering technological, operational, regulatory, environmental and human element aspects. Therefore, suitable, applicable and acceptable choices need to be made.

3.2. Phase 2: Expert Group Studies and Prioritization

Establish Working Groups with a balanced mix of participants and ensure that they are composed of the necessary sub-working groups. Group members should consist of:

- Senior academics from maritime universities with expertise in relevant fields.
- Experienced professionals and managers from various segments of the maritime sector (e.g. transportation companies, ports, logistics providers, technology suppliers, shipbuilding and material manufacturing companies, classification societies).
- Representatives from relevant regulatory bodies or central and local government agencies.

Assessment Process: The Working Groups will be provided with initial lists of R&D needs, compiled in the first phase and supported by information from multidisciplinary expert groups. The Working Groups will evaluate these lists through discussion in structured discussion forums.

- Validate and refine the list of needs.
- Assess the relevance, urgency, potential impact and feasibility of addressing the identified need through postgraduate research.
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- Review and build on existing studies and ongoing research initiatives to avoid unnecessary

duplication of effort and to identify opportunities for consoling and citing real gaps.

3.3. Phase 3: Developing and Guiding the Collaborative System

This phase will assess the prioritized R&D needs and the barriers and facilitators to collaboration. The R&D organizations required for each activity will be identified and an Architecture Design Study will be conducted for large-scale projects. At this stage, the focus should be on identifying the basic principles and starting strategies rather than identifying the activities to be carried out.

- **System Design:** For ongoing university-industry interaction focusing on postgraduate education, joint platforms to facilitate collaboration should be established first. The issues to be fulfilled by the parties should be determined by agreements, and protocols should be drawn up for the execution of the activity. Monitoring and steering committees should be established to ensure that the Fall is carried out as planned, and these committees should be able to intervene in the course of the projects when necessary. In order to carry out very large projects, a company/companies should be established when necessary. Liaison should be established with project groups working on projects of the same nature and joint work should be carried out with these groups when deemed necessary.
- **Identification of Key Elements:** A project logic should be used to identify the basic principles or components necessary to guide graduate studies effectively. The steps of Organizational Requirements – Operational Requirements – Operational Requirement Analysis – Pre Project – Project – Test and Acceptance should be determined. To support cooperation, the university should make the necessary changes in the curriculum programs and the industry should take the necessary steps in policy and financial support to support this activity. Projects should be audited both scientifically, technically and financially for the steps identified, and re-orientations should be made by analysing the feedback from the audits.

3.4. Data Analysis

The qualitative data from the discussions (transcripts, facilitator notes, agreed outputs) will be analyzed using thematic analysis (Braun & Clarke, 2006). Decisions should be taken by the Monitoring and Steering Committees based on the information obtained from these analyses, such as reorienting the project, changing the methodology, etc. This will involve identifying recurring patterns, themes and key insights related to R&D needs, priorities, collaboration mechanisms and necessary adjustments to graduate programs.

4. EXPECTED OUTCOMES AND PROPOSED FRAMEWORK

A Study Group consisting of faculty members from Piri Reis University Maritime, Engineering, Administrative and Economics, Science and Literature, Law Faculties and representatives from the sector has been established to conduct a Preliminary Study on the subject. This group includes lecturers specialized in Maritime Management, Maritime Economics, Maritime Transportation and Management Engineering, Marine Engineering, Mechanical Engineering, Electronics Engineering, Computer Science, Chemical Engineering, Management, Economics, Maritime Law. From the sector, PhD and master's degree holders from Maritime Companies working in the fields of Operation, Crew Management, Technical Management, Surveyor participated in the study. A total of 11 faculty members from Piri Reis University and 8 representatives from AKMAR Shipping, BEKS Shipmanagement, Statu Shipping and DFDS Mediterranean companies representing the industry took part in these studies.

To update the knowledge of this group and to enable them to look at the subject from a broader perspective, a presentation covering current information in the maritime sector was made. This presentation was prepared by the authors and delivered during an online meeting. The documents used are below.

- UNCTAD (2024). Review of maritime transport: Navigating maritime chokepoints.
- WMU and ITF (2023). Transport 2040: Impact of Technology on Seafarers: The Future of Work.
- Global Maritime Trends Barometer (2025). Assessing the progress of the maritime energy and Digital transitions March 2025, LR&LR Foundation.
- Global Outlook (2025). Economics Intelligence EIU.
- IMF (2024). Global Economic Outlook.
- World Bank (2024). World Development Report 2024.
- IFC (2024). IFC Annual Report 2024 Accelerating Impact Mobilizing Investment at Scale.

A postgraduate level lecture on Technologic Development and Future of Maritime Industry covering Disruptive Development of Technology, Development of Maritime Industry, Industry 4.0 and its

impact on Maritime Field, Artificial Intelligence in support of Maritime Industry, New Direction of International Maritime Community, Development of Maritime Management Systems is delivered to the study group members.

This study group made a preliminary study on the subject and introduced the following results. These results represent a consensus view from academic and industry experts on the most critical areas where postgraduate research can make a significant contribution.

4.1. Maritime R&D Themes for Postgraduate Focus

The topics that are considered to make a significant contribution to the sectoral needs with postgraduate research are determined as follows.

- ***Digitalization & Autonomy:*** AI application in the maritime sector in particular safety at sea, Cybersecurity for ship and port systems, Autonomous vessel control systems, Digital twins between ships and ports.
- ***Maritime Management:*** Shipping Company management, Shipping company mergers, New liner routes, Block Chain for financial transactions and contractual work, Conversion from Shipping Company to Logistics Company, Predictive Maintenance.
- ***Logistics & Supply Chain Optimization:*** Data analytics for route planning, port call optimization, Overcoming port congestion, Hinterland connectivity improvements, Intermodal Operations.
- ***Decarbonization Pathways:*** Energy-saving, Alternative fuel adoption (ammonia, hydrogen, methanol, biofuels), decarbonization device optimization.
- ***Environmental Sustainability:*** Ballast water management technologies, SDGs' link with the maritime industry, Green shipping, Biofouling prevention, Vibration reduction, Underwater noise reduction.
- ***Ship Construction:*** Material science applications, Novel ship design for energy saving and cost reduction, ice-class ship design.
- ***Human Element & Safety:*** Man-machine interface (Human-Automation interaction), Remote operation, Fatigue and Mental Problems onboard.
- ***Maritime Law & Policy:*** Legal arrangements for frameworks for remote controlled and autonomous vessels, Governance of marine spatial planning, policy instruments for green shipping.
- ***Education and Training:*** Inclusion of AI, autonomy, etc. into curriculums of Maritime Universities, lifelong education, in-house education needs of shipping companies

4.2. Facilitation of University-Industry Collaboration in Postgraduate Education

This system aims to institutionalize the interaction between universities and the maritime sector concerning postgraduate studies and R&D activities. That requires firstly common platforms to handle collaborations successfully. The working group considered that it would be useful for both sides to organise a permanent coordination and cooperation platform.

- **Advisory Committee for UIC for Postgraduate:** This will be a standing committee composed of Maritime Industry and University representatives. Responsible for planning and direct postgraduate studies in support of the requirements of the maritime sector. The committee will define and prioritize UIC for postgraduate studies including funding opportunities. It will gather in definite periods as well as when required. The committee will establish sub-committees for each activity and Ad Hoc Committees as required. It also plans conferences, panels, seminars, expert panels, workshops etc.
- **Data Exchange Platform:** This platform will establish a data center for all related parties. The platform will establish a mechanism for regular interaction for all shareholders, gathering and dissemination of data under the supervision of Advisory Committee. The stakeholders will be able to reach all data required to handle the common projects.
- **Sub Committees:** Specific committees for management of different postgraduate programs in support of designated research activities under the supervision of Advisory Committee. These Committees will assist manning and funding of the programs. They may provide input for curriculum content developments, review emerging issues, and propose potential research projects. Sub Committees may create Ad Hoc Committees in support of their projects.

Standardized collaborative agreements for defining Master's/PhD projects should be designed including supervision, financial management, intellectual property rights, data sharing and dissemination issues. The legal protocols should be signed and applied by shareholders.

Personnel exchange is important to sustain a meaningful collaboration. Industry should be granted to

use university properties and industry should provide placement and/or internship for postgraduate students to work on relevant projects.

4.3. Directing and Management for Postgraduate Studies

These are essential principles for universities to embed industry relevance:

- Postgraduate programs/modules should allow specialization in prioritized R&D areas and incorporation of industry case studies. Additionally, it should be flexible to review and redesign to meet the developments and requirements of industry. In fact, it is strongly advised that postgraduate modules should be updated regularly based on the results of completed projects.
- University may provide critical and creative thinking into industry-leading projects. The important contribution of universities is to develop scientific methods and achieve methodological industry-relevant research.
- The projects generally require interdisciplinary studies which may be met by different departments of universities. Multidiscipline works such as engineering, economics, management, law etc. can be easily achieved in the university.
- The projects are perfect tools for transfer of skills and best practices. Universities generally lack of commercial awareness and industry has not research expertise. UIC for Postgraduate studies will assist mutual transfer of skills and experiments. It will also help to adopt postgraduate students' commercial management skills which will prepare them for their prospective roles as mid-level managers in the industry.
- Industry experts may assist the master and doctorate studies in their field as co-adviser and guiding student research in line with the expectations of industry.

4.4. Mutual Benefits

The most important thing expected from the management level in organizations is the ability to solve the problems encountered. Likewise, another need is the provision of specialized personnel to assist the management level. Master studies are aimed at training specialists in specific subjects. PhD programs provide the ability to develop methods to solve problems. Many companies are still in need of middle managers with advanced problem-solving skills and specialists to improve the competitiveness of the business. University Industry Collaboration is a great advantage in this regard.

Theoretical and practical work is different. This is because universities are far away from practical applications, especially managerial and commercial skills. Mutual cooperation in postgraduate studies will enable students to get acquainted with business life and to understand the relationship between theory and practice.

In research and development, industry has problems in terms of both human resources and financing. University-Industry Cooperation will provide an important opportunity for companies to move to a sustainable position in a highly competitive sector.

5. DISCUSSION

The following issues were discussed with the working group, taking into account the existing master programs related to the maritime industry.

The proposed framework directly addresses the identified gap between maritime postgraduate education and sectorial R&D needs. By systematically identifying priorities through expert consensus and establishing a durable system for collaboration, it moves beyond ad-hoc interactions towards a strategic alignment. This alignment promises several benefits: enhanced relevance and impact of academic research, improved employability and contribution of graduates, accelerated innovation within the maritime sector, and a more efficient use of research resources.

The emphasis on integrating scientific experience (universities) with work experience (industry) is crucial. It ensures that research is grounded in practical realities while benefiting from rigorous academic methods. Furthermore, explicitly linking postgraduate education to the need for middle and senior managers highlights the dual role of these programs: producing both specialist researchers and future leaders equipped with high-level analytical and problem-solving capabilities fostered through the research process itself.

Implementing such a system is not without challenges. Potential barriers include differing institutional cultures and timelines between academia and industry, concerns over intellectual property, securing sustained funding for collaborative activities, and ensuring broad participation from diverse industry stakeholders (Bruneel et al., 2010) and busy schedules of industry representatives. Overcoming these requires strong institutional commitment from both universities and industry partners, clear communication channels, mutually beneficial agreements, and potentially supportive government policies or incentives.

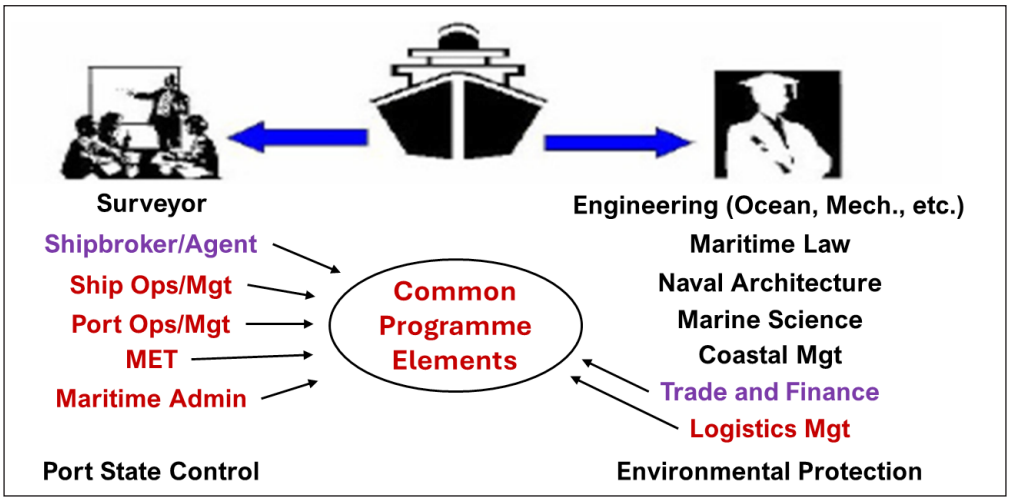

Figure 2. Common Program Elements

The postgraduate programs already exist in many countries such as:

- MBA: Terminal Management, Harbour Master, Logistics Management, Ship Management, Crew Management, Ship Agent, Ship Superintendency, Maritime Business Management, Shipping and Logistics, Logistics Management, Terminal Management, Strategic leadership for the global energy industry, Port Management, Marine Accident Investigation.
- MSc: Risk Management, Vessel Valuation, Global Energy Management Postgraduate Diploma in Maritime Energy Intelligence and Security Studies, Marine Insurance (Demirel, 2017).

EU MSc program development should concentrate on incorporating a variety of common elements from a number of maritime sector jobs to offer the graduate the broadest range of employment and advancement opportunities. Figure 2 illustrates this concept (Ketchum & Pourzanjani, 2014).

Indeed, the creation of awareness on what motivations and added values postgraduate degrees in maritime studies can offer is essential to develop a new generation of dynamic, well-educated and good quality human capital within the maritime industry (Ng et al., 2009).

6. CONCLUSION AND RECOMMENDATIONS

Strategic R&D, along with the existing skilled personnel in the sector, determines the innovation maritime industries heavily rely on for gap-free progression. Furthermore, innovation in the industry seems to equally depend on focused postgraduate education, which is sustained through meeting the sector's needs, resulting in a two-way street. The findings of this study outline the needs scenario and demonstrate the model features of strong university-industry partnership frameworks designed to support impactful postgraduate research.

6.1. Recommendations

To Maritime Universities:

- Fostering systematic collaborative engagement requires adoption of MPRC and IAPs, or tailored versions of them.
- Prioritized R&D themes and skills gap analyses should lead to postgraduate curriculum restructuring, accompanied by Basic Elements revisions.
- Faculty participation in collaborative research and industry engagement should be incentivized.

To the Maritime Industry:

- Active contribution as strategic and practical input providers to collaborative structures like Industry Advisory Panels is needed.
- Valuable research, data, and internship/placement access should be offered to postgraduate students.
- Invest in university-initiated collaborative R&D projects.

To Policymakers and Funding Authorities:

- Recognize and support university-industry collaboration in maritime postgraduate education through targeted funding schemes.
- Develop policy frameworks that encourage knowledge transfer and joint R&D initiatives.
- Promote the maritime sector as an attractive field for advanced research and careers.

6.2. Limitations and Future Research

This article outlines a methodology that has not yet been implemented. The next stage is the framework's execution and its subsequent testing. Possible limitations include the R&D or sector-specific context, which is geographically sensitive, and dependence on expert judgment, which requires stringent control during the workgroup phase.

Focus on future research entails:

- Applying and testing the proposed system in defined university–industry partnerships and analyzing the outcomes.
- Undertaking longitudinal impact assessments on the career trajectories of graduates from strategically aligned postgraduate programs.
- Analyzing the specific roles and relationships that stimulate interdisciplinary maritime research within the outlined framework.
- Evaluating the comparative effectiveness of various UIC models in the maritime postgraduate milieu in different countries or regions.

As we strive to cultivate a strong partnership between the maritime industry and academia, enhancing cooperation through strategically developed post-graduate programs, we can better tackle contemporary maritime challenges, steering towards an innovative, efficient, and sustainable future.

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