An Exploratory Review of Maritime Education and Training Through Collaborative Innovation Ecosystems: A Case for South Africa

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ABSTRACT

The aim of the United Nations Decade of Ocean Science for Sustainable Development, the 'Ocean Decade' (2021–2030) is to trigger the maritime education, training and ocean knowledge revolution needed to promote sustainable maritime economies. Achieving sustainable maritime growth requires identifying critical ocean priorities and promoting training, research capabilities and knowledge that will unlock the potential of science, education and innovation. The maritime industry is vast, complex and everchanging, and requires innovative, collaborative and solutions-oriented maritime education and training (MET). The need for engagement and communication between the various stakeholders and institutions, and the promotion of integrated and collaborative MET approaches, research and innovative activities for sustainable MET can never be overemphasised. South Africa is a country that has a vast coastline, stretching more than 3 900 kilometres, with access to the Atlantic and Indian Oceans, providing abundant opportunities for maritime activities. According to the Human Resource Development Council (HRDC) Annual Report 2020/2021 (HRDC 2023), it is crucial, now more than ever, for South Africa to promote the cutting-edge MET needed to develop the economy and ensure much higher rates of employment from all key sectors, including the maritime industries. A collaboration paradigm in which several training and research institutions collaborate in an ecosystem for the mutual benefit of all members and stakeholders is needed for growing a sustainable maritime economy.

Keywords: maritime education and training (MET), collaborative innovation ecosystems (CIEs), South Africa

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I INTRODUCTION AND BACKGROUND

Maritime transport remains the lifeblood of the world economy, with vast opportunities for effective domestic demand and employment, which make a great contribution to a country's economic development (World Economic Forum [WEF], 2014). At the end of 2023, there were around 68 000 vessels in the world trading fleet, with a total deadweight tonnage of 2 224 million tonnes, transporting more than 80 per cent of world trade (United Nations Conference on Trade and Development [UNCTAD], 2023). If shipping is the lifeblood of the world economy, the approximately 1.65 million seafarers who crew and manage those vessels, and the other professions contributing to the maritime industry, may be said to be the 'lifeblood of shipping' (International Association of Maritime Universities [IAMU], 2019:2). The maritime industry, specifically fishing, shipping, ports and other related services have an exceptionally long history and a rich tradition. The skills required by the maritime sector are diverse, including technical, technological, scientific and engineering categories (Grimmet & Mzileni, 2023). Although there are many overlapping skills, there are also many sector-specific training requirements that are not necessarily provided by one training institution and necessitate the need for collaboration.

Everywhere in the world, especially in areas where large bodies of water are found, maritime trade and other related activities have existed for centuries (WEF, 2014; UNCTAD, 2023). According to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), with its amendments prompts, maritime education and training (MET) providers must improve their teaching skills, capabilities and innovation and keep up with the constantly evolving trends in the maritime industry (Boulougouris et al., 2019). Careers associated with the maritime industry were primarily developed by means of on-the-job training and, to some extent, shore-based education. Over time, a degree of balance between some form of school-based education and onboard training became standard in all jurisdictions (Abila, 2016). However, the curriculum of MET remains under the jurisdiction of individual nations, in line

with International Maritime Organisation (IMO) regulations, specifically STCW certification and other industry norms and standards. According to UNCTAD (2023), maritime training expenditure as a percentage of payroll remains low (ranging from 0.3 per cent to 1.1 per cent between 2016 and 2022), with the lowest value recorded in 2022. While some maritime training shifted online, the overall level of collaboration and investment appears insufficient given the transformative trends in the industry.

Maritime transport is not only faced with rapid growth in demand and pressure for transport services but also technical challenges, including outdated infrastructure, which results in congestion and causes delays (Boston Consulting Group, 2021; Matekenya & Ncwadi, 2022). Decarbonisation and digitalisation are also transforming the shipping industry, necessitating MET to be swift and innovative. 'Smart' ships will increase, as will platforms that must support the smart ships and other digitalisation and decarbonisation efforts needed for a competitive maritime industry, creating demand for a new generation of competent, highly skilled maritime professionals. Young maritime professionals are entering an industry and labour market caught in a rapid state of change (Ngcobo, 2018; IAMU, 2019 & Bolmsten et al., 2021). The ship is but a single link in the supply chain and multiple links of that chain are part of the maritime world. To address MET in a collaborative and holistic manner, all of the relevant dimensions within the maritime value need to be considered. These include:

- transportation economics
- shipping finance
- ship design, construction and repair
- ship crewing, operation and agency
- port design, construction and operation
- freight sales, consolidation and forwarding
- customs documentation and administration
- intermodal coordination.

This list, although undoubtedly incomplete, spans a wide range of disciplines, such as business and finance, computer sciences, engineering, law and marine science. Moreover, maritime professionals must possess specific technical knowledge in areas like navigation, ship stability, trucking, rail, power plants and labour relations.

Although change has always impacted the maritime industry, current social, economic, environmental and technical changes are happening at a rapid rate (Bolmsten et al., 2021; Notteboom, Pallis & Rodrigue, 2021). The predicted global shortage of 150 000 seafarers by 2025, and the exponential pace of technological development, will produce serious MET and skills development challenges, and opportunities, for the South African maritime economy (Masuku, 2020; South African International Maritime Institute [SAIMI], 2022). A crucial transformation to be achieved between 2021 and 2030 is the design and implementation of MET that is centred on user needs and employs appropriate mechanisms for adoption. Its scale will be unprecedented, which will require MET development to be rapid and innovative, considering the limited resources and challenges experienced in South Africa. Various MET institutions and stakeholders are expected to engage with each other and start collaborating outside their traditional communities. Knowledge generators and users need to engage in an iterative process of codesign and codelivery of MET in order to promote sustainable maritime economies. This will create new groupings of actors from across multiple jurisdictions and from the natural science, social science and humanities disciplines; from business, industry, governments, international entities (eg United Nations (UN), the IMO and UNCTAD), intergovernmental organisations (IGOs) and nongovernmental organisations (NGOs); from civil society, educators, early career maritime professionals, ocean sports and recreation organisations, arts and cultural communities; and from indigenous and local knowledge holders. Collaborative MET built on solid partnerships and active communication will be at the heart of the ocean decade.

South Africa remains the gateway to Southern Africa, with a coastline of more than 3 900 kilometres, good MET institutions, a rich coastal and marine biodiversity and a well-developed port network (Operation Phakisa, 2014; Ngcobo, 2018; Grimmet & Mzileni, 2023). Additionally, owing to its geographical and strategic position, approximately 1 500 vessels traverse the South African exclusive economic zone (EEZ) every day (South African Maritime Safety Authority [SAMSA], 2021). South Africa is an example of a rapidly developing country attempting to constantly improve in the maritime space, and continuously undertakes developments to shape its training and educational systems to meet current and future maritime demands. In the past, South Africa had well-developed maritime research, education and training activities and employment opportunities, which were reflected in tonnage on the country's ship registry and a strong shipping industry (Ngcobo, 2018).

The paper from which this article originated, used a desktop analysis approach using Google Scholar, previous SAIMI journals and large language models, artificial intelligence (AI), AI-generated text – specifically ChatGPT, to demonstrate an exploratory case indicating how South Africa, by means of collaborative innovation ecosystems (CIEs), can position itself as a regional leader in MET, contributing to the growth of the global maritime economy. This article does not only focus on MET for seafarers or shipping officers but explores the broader MET offerings spanning across all disciplines and maritime related careers, both for sea-going and land-based careers.

II MARITIME EDUCATION AND TRAINING IN SOUTH AFRICA

The need for MET focused on innovation for young people entering the labour market is indicated by, for example, the Organization for Economic Co-operation and Development (OECD) in stating that fostering critical thinking and creativity is important to succeed in both the contemporary and future labour markets, where skills are required to contribute to and integrate innovation (Vincent-Lancrin et al., 2019; Bolmsten et al., 2021). South Africa has several institutions that offer MET, and of the prominent institutions include:

• South African Maritime Training Academy (SAMTRA): SAMTRA is located in Simon's Town, Cape Town, and offers educational programmes and simulation skills enhancement training courses in navigation and ship handling, refrigeration engineering and marine engineering, as well as professional maritime short courses for all disciplines.

- Cape Peninsula University of Technology (CPUT): Located in Cape Town, CPUT offers various maritime-related programmes, including maritime studies, maritime engineering and navigation.
- **Durban University of Technology** (DUT): Located in Durban, DUT offers maritime studies programmes focusing on areas such as maritime law, maritime logistics and maritime management.
- University of KwaZulu-Natal (UKZN): UKZN is located in Durban and offers maritime law programmes focusing on the legal aspects of the maritime industry.
- Nelson Mandela University (NMU): Located in Gqeberha, the NMU offers ocean sciences qualifications in several faculties, ranging from business and law (maritime studies and maritime/marine law), maritime logistics and natural sciences to marine engineering.
- University of Stellenbosch: The university hosts the Maritime, Ports, Transport and Logistics Academy (MPTLA), which offers short courses and management development programmes that have been developed based on local and international curricula and best practices tailored to the local maritime and logistics situation in Southern Africa. Several faculties also offer maritime related qualifications and research.
- University of Cape Town: The university offers undergraduate and postgraduate options in marine biodiversity, oceanography, fisheries, aquaculture and shipping law for those looking to chart a career based on maritime research and professional expertise.
- Transnet Maritime School of Excellence (MSoE): Located in Durban, the MSoE provides premier marine training programmes that prepare students for important roles in Southern African ports. The MSoE was specifically established to provide the necessary skills for Transnet Port Terminals (TPT) and

Transnet National Ports Authority (TNPA) in the Transnet Academy. In addition to TPT and TNPA, the MSoE provides maritime skills for the broader industry, the country and the Southern African region by engaging in various local and international collaborations.

- South African International Maritime Institute (SAIMI): Based in NMU (Gqeberha), SAIMI is an national entity established to help unlock the socio-economic potential of South Africa's maritime environment and develop South Africa's maritime sector by means of research, education, skills development and advocacy,
- SA Maritime School and Transport College (SAMS): SAMS was founded in 1986 and is the longest operating maritime school in South Africa, with over 30 years of history, and with branches in Durban and Cape Town. SAMS offers qualifications in either freight handling or freight forwarding and customs compliance (includes a forklift drivers' licence or a code 08 or 10 drivers' licence) or shipping practice at NQF04 level.
- 2 Oceans Maritime Academy: Located in Cape Town, the academy is a Royal Yachting Association (RYA)-recognised training centre offering all the RYA sailing and theory courses, which cater to the first-time leisure sailor, more experienced yachtsman or those looking to earn a commercial skippers license. The academy offers RYA sail and theory courses, fast track sailing programmes and adventure sailing courses.
- The Maritime School: Located in Durban and established in 2005, the Maritime School is a quality-assured training provider and is fully accredited with the Transport Education Training Authority (TETA). The school delivers worldclass service, with best practices, procedures and systems, and provides skills development and training to the shipping industry.
- Gymnasium Maritime Studies/Project Maritime Training/Survival Offshore Training: Located in Saldanha on the West Coast of South Africa and established in May 2002, the company co-sources with other designated

persons (training group of facilitators) to provide a cost-effective maritime training facility. The company offers offshore oil & gas training; STCW training; emergency response and crisis management training; fire, safety and survival training; and competency consulting. In addition to the 41 maritime courses offered, the company has also developed a flexible structure for businesses that require maritime training in order to meet the differing requirements of our diverse client base.

• Siyaloba Training Academy: The academy has its headquarters in Gqeberha and serves clients and coastal communities in the area between East London and Mossel Bay. Siyaloba is a fully accredited training provider with the Transport Sector Education and Training Authority (SETA) and SAMSA. Siyaloba presents and coordinates various training courses for the maritime industry, and skills development initiatives for community development programmes. The academy is approved with Services SETA to present various learnerships and skills programmes.

While not exhaustive, the aforementioned list of 14 MET institutions or service providers clearly indicates that most offer a diverse array of programmes. These programmes address various facets of the maritime industry, such as vessel or maritime navigation, engineering, marine biodiversity, logistics, law and management. MET does not only happen in public universities and private colleges but also in technical vocational education and training (TVET) colleges. Of the 50 TVET colleges in South Africa, more than half offer maritime-related training, whether in hospitality, tourism, artisan or technical skills and capabilities, feeding into the maritime value chain.

These institutions have entered into partnerships and agreements to collaborate with each other; however, this is not focused as they continue to independently attract, educate and nurture new and diverse talent, empowering them with the knowledge and skills required to navigate the challenges and opportunities of the future. As stipulated in the National Skills Development Plan (NSDP), SETAs have critical roles to play as intermediaries between education and training and the workplace (Department of Higher Education and Training [DHET], 2019). SETAs submit an updated Sector Skills Plan (SSP) to DHET annually, in accordance with section 10(1)(a) of the Skills Development Act 97 of 1998. At the time of writing, it could not be established to what extent MET institutions incorporate TETA's sector planning framework and the various collaborations in place between the institutions to deliver innovative and collaborative training and skills development in response to national and international advances and challenges in the maritime industry.

The need for maritime education and training in South Africa to evolve

In 2021, a study on the state of innovation in TVET colleges in South Africa was conducted in order to better understand MET in country and how it compares to the rest of the world (National Advisory Council on Innovation [NACI], 2021). The object of the study was the set of 50 TVET colleges and their stakeholders. According to the NACI (2021) study, two discourses were identified that linked to MET, namely collaboration and innovation in South Africa. The study first revealed that the labour market and skills formation capability and lifelong learning put the individual at the centre of development and career opportunities, especially for the specialised industry that maritime is part of. Secondly, the study further revealed that the economics of innovation enable and allow only private enterprise to flourish, placing less emphasis on collaboration and innovation in the MET curriculum design and training approaches, with a strong emphasis on the dominant macroeconomic paradigm (NACI, 2021). A key finding from the study and interactions with broader maritime stakeholders on MET collaboration and innovation suggest a history of and a willingness to collaborate with the various role-players. However, collaboration and partnership efforts have been weakened by a breakdown in trust, both concerning the capacity and the willingness of the MET institutions to engage in a meaningful manner.

Collaboration and evolving MET in South Africa remains critical for the nation's maritime industry to

thrive and remain competitive globally. The following are key aspects of and potential strategies for this evolution:

- Modern curriculum development: Updating maritime education curricula to reflect the latest industry trends, technology advancements and international standards is essential. This includes incorporating subjects like maritime law, marine engineering, navigation, maritime economics and environmental sustainability in the curriculum.
- **Practical training facilities**: Investing in state-of-the-art training facilities equipped with simulators, ship handling equipment and laboratories for practical learning experiences. These facilities should mimic real-world scenarios to prepare students for the challenges that they may face in their careers.
- Industry partnerships: Collaborating closely with maritime industry stakeholders, including shipping companies, ports, maritime authorities, and international organisations, to align education and training programmes to industry needs. Establishing internship programmes and industry attachments can provide students with hands-on experience and networking opportunities.
- **Research and innovation**: Encouraging research and innovation in maritime-related fields in order to address emerging challenges and develop sustainable solutions. This could involve funding research projects, establishing research canters and promoting knowledge exchange between academia and industry.
- Quality assurance and certification: Implementing rigorous quality assurance mechanisms to ensure that MET institutions meet international standards. Accreditation by relevant regulatory bodies and certification programmes for instructors and students could enhance the credibility and recognition of qualifications.
- **Promotion of diversity and inclusivity**: Fostering diversity and inclusivity within the maritime sector by encouraging participation from underrepresented groups, including women and historically disadvantaged communities.

Providing scholarships, mentorship programmes and outreach initiatives could help attract a diverse talent pool to the industry.

- Lifelong learning and continuing education: Offering opportunities for professionals already working in the maritime sector to upgrade their skills and knowledge by participation continuing education programmes, short courses and professional development workshops.
- **Digitalisation and e-learning**: Embracing digitalisation and e-learning platforms to make maritime education more accessible and flexible. Online courses, virtual classrooms and mobile learning apps can reach students in remote areas and accommodate learners with busy schedules.
- Global collaboration: Engaging in international partnerships and exchange initiatives to benchmark best practices, share expertise and promote cross-cultural understanding in the maritime community. Participation in international maritime conferences, seminars and training programmes can broaden perspectives and enhance collaboration opportunities.
- Government support and policy frameworks: Securing government support by means of favourable policy frameworks, funding schemes and incentives to encourage investment in MET infrastructure. Coordinating efforts across relevant government departments and agencies is crucial for effective implementation and sustainable development.

By focusing on these aspects of this evolution and implementing strategic initiatives, South Africa could evolve its MET ecosystem to produce skilled professionals who can contribute to the growth and competitiveness of its maritime industry on a global scale.

III PROMOTING MARITIME EDUCATION AND TRAINING THROUGH COLLABORATIVE INNOVATION ECOSYSTEMS

The maritime sector is crucial for South Africa's economy, contributing to trade, employment and overall economic development. Key components of this sector include shipping, ports, fishing and marine tourism. The Blue Economy, part of the broader maritime economy, holds vast untapped resources that can drive sustainable development. Masuku (2020) and Grimmet and Mzileni (2023) highlighted the scarcity of MET relative to the needs of Operation Phakisa as being one of the key challenges in growing the local maritime economy and contributing to the global maritime economy. Insufficient training berths, employment opportunities and locally flagged vessels place even greater pressures on existing institutions with limited resources to train more student numbers, especially seafarers (Bonnin & Woods 2002; Bonnin et al., 2004 cited in Masuku, 2020).

CIEs are networks of various institutions, private companies, individual contributors and important technology providers that share a commitment to collaborative innovation in MET and the various role-players needed for a sustainable and thriving maritime economy. The rationale for promoting CIEs is to use technology and a community-based approach to tackle big problems by bringing together MET providers, national and international institutions, private companies, governments and start-ups. Private maritime companies, research institutions and startups benefit from this approach because they can learn and prototype more quickly. Governments benefit by assisting in the development of economically stable maritime innovative regions and helping to promote and procure sustainable maritime development and growth initiatives. Research institutions and academia win by helping to validate their scientific theories and by providing professors and graduates with real commercial, innovative and social problems to solve relating to innovative MET.

There are three basic types of CIEs that MET providers in South Africa and globally can consider, namely:

• Solo 'closed' innovation approach which involves a single organisation combining its resources, its knowledge and its capabilities to solve a problem or develop a new product/service, for example, the case of using simulators for seafarer training. At the time of this exploratory case analysis, it was evident that some of the seafarer training providers do have simulation platforms, which are not shared with other institutions because of resource constraints, geographical constraints and other procedural areas.

- **Partnership 'closed' innovation** consists of two or more MET providers or institutions that collaborate to solve a problem or develop a new product or service by pooling resources, knowledge and capabilities. This type of CIE is preferred over the solo approach as it can assist with pooling the already limited resources required to promote sustainable and competitive MET in South Africa.
- 'Open' innovation is a collaboration paradigm in which several MET providers collaborate in an ecosystem for the mutual benefit of all members and stakeholders. It is a group of institutions (ie existing MET providers, startups, governments, international universities, technical institutes and other entities) that collaborate to come up with ideas to solve problems and find innovative solutions, or to develop and test new technologies. This type of CIE is on the rise as more maritime testbeds and accelerators emerge and are growing in the South African and global context.
- 'CIEs': Because of the high cost of innovation and a drive towards promoting collaboration and sustainable MET, many MET institutions are starting to recognise that partnering with established or emerging institutions, locally or internationally, helps them accelerate their market entry, providing MET providers with a much-desired competitive advantage and an ability to meet international norms and standards.

Despite the highlighted types of CIEs and the potential for CIEs and the MET landscape, according to the HRDC (2023), the maritime sector in South Africa continues to face the following challenges:

• **Skills gap**: There is a significant shortage of skilled maritime professionals, especially in the areas of maritime digitalisation, marine renewable energy, maritime finance and marine and naval engineering, to name a few.

- Education infrastructure: Existing MET institutions lack modern facilities and resources.
- Industry-academia disconnect: Limited collaboration between industry and academia hampers the development of relevant curricula and training programmes.
- **Innovation deficit**: Insufficient focus on innovation in maritime education limits the sector's growth and competitiveness.

MET through CIEs are highly relevant in South Africa for several reasons:

- Economic growth: South Africa has a long coastline with significant potential for maritime economic activities such as shipping, fishing, oil and gas exploration, tourism and port services. Investing in MET can equip the workforce with the necessary skills to drive growth in these sectors, thus contributing to the country's economic development.
- Job creation: Developing a skilled maritime workforce can create employment opportunities for South Africans, particularly in coastal regions where job opportunities may be limited. The country can address unemployment and promote inclusive growth by investing in education and training programmes that focus on maritime skills.
- Global trade: As a major hub for global trade, South Africa relies heavily on its ports and maritime infrastructure to facilitate the movement of goods. Enhancing the skills of maritime professionals by establishing CIEs could improve the efficiency and competitiveness of South Africa's ports, thus attracting more trade and investment.
- Safety and security: Effective MET is essential for ensuring safety and security at sea. South Africa's maritime domain includes busy shipping lanes and potential maritime security threats such as piracy and illegal fishing. By investing in training programmes that focus on maritime safety and security, South Africa can protect its maritime interests and contribute to regional stability.

- Environmental sustainability: With growing concerns about environmental sustainability, there is a need for skilled professionals who can implement and adhere to best practices in maritime environmental management. CIEs can support research and development efforts aimed at finding innovative solutions to maritime environmental challenges such as pollution prevention and marine conservation.
- International collaboration: Participating in CIEsallowsSouthAfricatoleverageinternational expertise and resources in MET. By partnering with local institutions and institutions from around the world, South Africa can access cutting-edge knowledge and technologies to enhance its maritime capabilities.

Overall, MET, through the establishment of CIEs, is crucial for South Africa's socioeconomic development, competitiveness in global markets and sustainable management of its maritime resources.

Concept of collaborative innovation ecosystems

CIEs involve the integration of various stakeholders, including educational institutions, industry players, government bodies and research institutions, in order to foster innovation and collaboration. These ecosystems aim to create a dynamic environment where knowledge, resources, and expertise are shared to achieve common goals.

MET is evolving to incorporate CIEs, leveraging cutting-edge technologies and methodologies to prepare current and future maritime professionals for the rapidly changing maritime industry. Here are seven key points highlighting the importance of collaborative innovation in MET:

1. **Digitalisation and automation**: The maritime industry is undergoing significant technological transformations, including digitalisation and automation. To address these changes, MET must adapt to incorporate emerging technologies like augmented reality (AR), AI and big data analytics.

- 2. Simulation and immersive technologies: Simulators have long been an essential component of MET. The integration of virtual reality (VR) and AR creates new possibilities for immersive and engaging training experiences, enhancing seafarer skills and competencies.
- 3. Data-driven decision making: The increasing use of data analytics in maritime operations means that seafarers must be equipped with the skills necessary to effectively manage and interpret data. This necessitates a shift in the focus towards data-driven decision making.
- 4. Innovative solutions for ocean sustainability (Blue Economy): MET must address the pressing environmental challenges facing the industry. Innovative solutions, such as e-learning platforms and simulation tools, are crucial for preparing seafarers to tackle these challenges and promote ocean sustainability.
- 5. Collaboration and knowledge sharing: Collaboration between maritime institutions, industry stakeholders and academia is essential for developing and implementing cuttingedge technologies in MET. This includes the involvement of IMO, UNCTAD, the Baltic and International Maritime Council (BIMCO), TETA, higher institutions of learning offering MET and shipping companies to provide incentives for technology integration and improve MET outcomes.
- 6. **Regional innovation ecosystems**: Regional innovation ecosystems, such as the European Marine Biological Resource Centre (EMBRC-ERIC) and the Indian Ocean Rim Association (IORA) play an important role in fostering research and innovation in the maritime sector. These ecosystems bring

together researchers, companies and institutions to develop new products and services, enhancing the socioeconomic potential of maritime regions.

7. Enhancing maritime innovation: Collaborative innovation in the maritime sector is critical for achieving sustainable growth and development. Engaging the networks of various institutions, private companies, individual contributors, and important technology providers in innovating ecosystems is a key ingredient and MET must adapt to incorporate these collaborative approaches.

By embracing CIEs, MET in South Africa can better prepare maritime professions for the challenges and opportunities arising from the rapid technological advancements in the industry, ultimately contributing to a more sustainable and efficient maritime sector.

The key aspect of CIEs is their emphasis on innovation, which is an important area for sustainable and competitive maritime education. By leveraging technology and fostering a culture of creativity and problem-solving, South Africa can develop cuttingedge solutions to address the challenges facing its MET sector. This could involve the development of VR simulations for training purposes, the use of AI for predictive maintenance in shipping or the implementation of blockchain technology for secure and transparent maritime transactions.

Figure 1 presents a simplified CIE model for MET provides a guide to the integration of various stakeholders, key components for integration an implementation strategy and the expected outcomes that can promote better collaboration and innovation in MET.



Figure 1: Simplified CIE model for MET Source: Author's own work.

Overall, promoting MET by establishing CIEs presents a unique opportunity for South Africa to unlock the full potential of its maritime sector. By fostering collaboration, innovation and inclusivity, South Africa could build a skilled and resilient maritime workforce capable of driving sustainable growth and development for years to come. With globalisation and MET providers increasingly under pressure to evolve and remain competitive and relevant for a sustainable maritime industry, continuously improving and fostering partnerships that will promote cuttingedge and relevant research, education and training services is one way to accomplish this. To maintain relevance and dominance in MET, institutions need to continuously commission research and development initiatives, establish innovation development divisions and develop new products and service offerings that they can commercialise in order to remain relevant, financially viable and impactful but this seldomly done in a collaborative approach. Most maritime organisations and institutions of higher education and training are required to keep their innovation processes and programmes undisclosed to avoid other local and international institutions stealing their ideas, which should not be the case with MET, which should strive towards promoting synchronised and harmonised education and training material that promotes good global maritime professional standards. Closed innovation programmes can be expensive for MET providers in terms of salaries and technology development, and they are often not as agile and fast as founder-driven maritime start-ups.

Summarised below are five reasons why the South African MET landscape and the various role players involved should look into CIEs and how they would benefit from this involvement (WEF, 2014; Vincent-Lancrin et al., 2019; Bolmsten et al., 2021; Open AI, 2024):

- 1. Collaboration promotes better efficiency: The maritime industry remains one of the most complex and highly regulated environment. CIEs involving maritime research, innovation and prototyping can reduce the risk of failure in terms of invention. Corporate innovation in the maritime industry, such as robotics and automation, can be costly and time-consuming to set up, especially when considering the time that individual MET institutions and private companies spend trying to solve challenges that arise when working on projects alone, and with limited resources and feedback. Collaborative platforms will create space and opportunities for MET institutions and various maritime stakeholders to team up with start-ups and other stakeholders that share the same vision or mission. Collaboration can help various MET role-players achieve their objectives faster and more efficiently, and they could tap into tangible and intangible resources not housed within a single institution.
- 2. Collaboration improves time to market: Collaboration enables MET institutions because they are also businesses or training service providers that need to remain relevant and promote a sustainable competitive advantage. MET institutions can swiftly bring innovative items to various stakeholders timeously and remain relevant to the economic prosperity and

success of innovative maritime and government. Iteration speed is largely determined by the ability to incorporate research, innovation and skills from the start of a product development cycle, and closer collaboration with MET partners and private businesses will promote synergies in terms of the maritime industry life cycle.

- 3. Collaboration accelerates learning cycles: When it comes to understanding complex problems or coming up with fresh and innovative cutting-edge maritime ideas, many brains are undoubtedly better than one. Working in a 'shared problem community', MET providers can obtain access to information and procedures that would normally take years to develop by tapping into the collective wisdom of their partners, international MET institutions and other specialists. Private companies, MET institutions and individuals can collaborate on common goals in ecosystems built around a certain topic or problem area (eg digitalisation and decarbonisation in the South African maritime industry), with all stakeholders building trust and better collaboration, and sharing expertise and information along the way.
- 4. Collaboration raises awareness of your brand or idea: A good collaborative platform or ecosystem may highlight the best maritime innovations from a variety of businesses as part of a greater whole and a constantly changing maritime landscape characterised by collaboration or a marketplace of products or services known and understood by the larger South African population will raise more awareness and identify areas for further collaboration timeously. This increased visibility could help create a buzz around a brand or idea.
- 5. Collaboration may help to reduce risk: Reducing risk could allow MET providers to diversify their innovation portfolios this could help them place bets across diverse products, markets and business models, while also helping them to navigate the unknowns of future maritime teaching and training technologies and business models especially in the advent of digitalisation and decarbonisation.

IV CHALLENGES WITH BUILDING A COLLABORATIVE INNOVATION ECOSYSTEM FOR MARITIME EDUCATION AND TRAINING

While the idea of collaboration may appeal to several MET institutions and stakeholders, there are a number factors to consider when building sustainable and mutually beneficial CIEs for MET in South Africa. Despite their many benefits, CIEs can be difficult to set up, administer and maintain, especially in a sector where trust and communication are key challenges (NACI, 2021; Boulougouris et al. 2019). Building an ecosystem of corporate business partners, start-up founders, government agencies and academia takes time and effort, and, considering the maritime education and landscape, academic institutions in South Africa are not as agile as international training providers are. A successful innovative ecosystem programme requires a set of conditions and professional proficiencies that are not key priorities for some MET institutions and role-players, and may be detrimental to the outcome of building trust and collaboration across the various maritime industry life cycles, and building a sustainable competitive advantage for MET institutions and roleplayers in South Africa.

V RECOMMENDATIONS FOR COLLABORATIVE INNOVATION ECOSYSTEMS IN MARITIME EDUCATION AND TRAINING: A CASE FOR SOUTH AFRICA

The purpose of the Ocean Decade (2021–2030) is to trigger the maritime education training and ocean knowledge revolution required to promote sustainable maritime economies (Intergovernmental Oceanographic Commission [IOC], 2022). Achieving sustainable maritime growth requires identifying critical ocean priorities and promoting training, research capabilities and knowledge that will unlock the potential of science, education and innovation. South Africa is doing well in growing and promoting a sustainable maritime industry that needs to be built on collaboration and competitiveness. Global MET remains primarily vocational and practically

orientated, driven by market demand and stakeholder requirements, rather than theoretically orientated (Masuku, 2020), and South Africa is still experiencing challenges in providing the required vocational and practical MET aspects. There is a great deal of emphasis on competence-based training, both in general and in specific seafarer education aligned to satisfying various international IMO and ILO/other conventions, code, and recommended guidelines and capabilities that will drive innovation and sustainable maritime growth. The South African government, institutions of higher learning and various other maritime industry players are currently investing in several maritime transport projects, and MET is one of the important sectors identified because involvement in this sector links to job creation. Maritime infrastructure is capital-intensive and, if not assisted with additional external funding, many universities cannot afford MET technology (Masuku, 2020). Promoting MET by establishing CIEs is crucial for South Africa, given its extensive coastline and strategic maritime location. By fostering collaboration between various stakeholders, including government agencies, educational institutions, industry players and research institutions, South Africa can harness the full potential of its maritime sector.

CIEs can facilitate knowledge sharing and capacity building across the maritime industry. By creating platforms for collaboration and exchange, South Africa can ensure that its maritime workforce is equipped with the skills and expertise needed to thrive in a rapidly evolving sector. This could involve the establishment of joint training programmes between universities and industry partners, the organisation of workshops and seminars on emerging trends and technologies, or the creation of online learning platforms accessible to maritime professionals nationwide. In addition, CIEs could play a crucial role in promoting diversity and inclusion within the maritime sector. By actively engaging with underrepresented groups, such as women, previously disadvantaged groups and minorities, South Africa can tap into a broader talent pool and foster a more inclusive maritime workforce. This could involve targeted recruitment efforts, the provision of scholarships and mentorship programmes or the implementation of diversity training initiatives within maritime organisations and higher education institutions.

The following four recommendations are key to promoting MET that is collaborative and competitive:

- 1. **Government support**: Strong governmental backing is essential for the success of CIEs. This includes policy support, funding and facilitating partnerships.
- 2. **Industry involvement**: Active participation from the maritime industry to ensure that training programmes are relevant and up-to-date is an imperative.
- 3. **International collaboration**: Leveraging international expertise and resources to enhance the quality and scope of MET is important.
- 4. **Continuous improvement**: Regular review and adaptation of the CIE model to keep pace with industry changes and technological advancements is crucial.

By adopting the CIE approach, South Africa can position itself as a leader in MET, contributing to the growth of the global maritime economy.

VI LIMITATIONS AND AREAS FOR FURTHER RESEARCH

A limitation of this study is its relatively narrow scope and the exploratory review research design, which did not unpack in detail the various sea going and landbased training requirements needed for a competitive and a sustainable MET in South Africa for the next five to 10 years. In addition, a detailed account and analysis of technical areas key for a sustainable and competitive MET was outside the scope of the study. The analysis put forward does, nonetheless, identify key MET providers in the South African context and build on previous studies in the MET setting, such as those by Boulougouris et al. (2019), Masuku (2020) and Grimmet and Mzileni (2023). In a similar manner to Boulougouris et al. (2019), the explorative paperfrom which this article was created—as a standalone area of research is not sufficient in understanding the development of collaborative e-learning approaches and systems in MET in the South African context. The preliminary findings from that paper open new cycles of action research and the need to collect primary data that can assist with the development of a comprehensive and an integrative collaborative e-learning approach that will be relevant and competitive for MET institutions. South Africa needs innovative action research and longitudinal research on MET and meaningful collaboration that will invite additional stakeholders, such as instructors and maritime technologies developers, to participate in the design and evaluation of the action research. In the context of capacity-building projects that will ensure MET instructors and institutions have the necessary human and intellectual capital, additional research is needed to understand the career lifespan of senior MET providers and the extent to which succession planning and the sharing of human resources across the various institutions is taking place.

VII CONCLUSION

South Africa, with its extensive coastline, strategic position along major global shipping routes and a rich maritime history, has significant potential in the maritime sector. However, to fully harness and recognise this potential, it is necessary to strengthen MET and leverage the existing resources to improve collaboration.

It is essential to establish and clearly define connections between various MET institutions and regional innovation systems to support the growth of South Africa's and the global maritime economy. This article proposes creating CIEs to enhance MET in South Africa. The partnership closed/open innovation and CIE types offers several benefits to MET providers, including increased efficiencies in time and cost, the ability to cover more 'innovation ground' and the opportunity to access resources and ideas outside of the corporation or a single maritime training organisation. CIEs further offer an alternative or complement to existing in-house innovation programmes, and a new way for MET providers to accelerate innovation aspirations and sustainable delivery. Establishing CIEs for MET is a strategic initiative that could address current challenges and unlock the potential of South Africa's maritime sector. By way of collaboration, innovation and targeted investments, CIEs can create a robust and dynamic maritime education framework that drives economic growth and sustainable development.

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