Decarbonisation in Shipping and Maritime Innovation Call for Readiness in Maritime Education and Skills Training in South Africa

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ABSTRACT

South Africa is a country lacking sufficiently mature readiness regarding the technology environment and business activeness visioned for a future low-emission economy. This lack of readiness is also reflected in the current maritime education and skills training at various levels, which is mostly focused on conventional seafarer programmes, and knowledge of socioeconomic and economic aspects of marine and maritime affairs.

Maritime transport plays a central role in global supply chains and many industries will use the shipping sector to facilitate their net zero goals. The industry's biggest challenge transitioning into a low-emission economy is the International Maritime Organization's decarbonisation targets associated with greenhouse gas emissions. Critical to decarbonisation in maritime transport is the increasing use of green energy-based fuel such as ammonia converted from hydrogen, which can be used in ship engines directly as fuel. In this regard, ports play a critical role in the hydrogen pipeline. Apart from clean energy, trends and innovation in the maritime transport-related economy include artificial intelligence, maritime robotics, maritime internet of things, big data and analytics, immersive reality and cybersecurity. The integration of the IoT, in particular, simplifies location data acquisition while enabling tracking of various other parameters such as emissions, machine conditions and propulsion data.

Trends and innovation in maritime transport clearly call for new skills in the use of digital systems and shipping automation. Upstream the skills pipeline, curriculum changes should be implemented, together with agile, rapid and effective approaches to maritime education and training. Such an approach is virtual mentored learning or VML, enabling content dissemination and simulation/experiential-learning, irrespective of location. This will significantly alleviate constraints in the availability of qualified teaching staff by means of e-based expert participation.

Keywords: maritime transport, digitalisation, decarbonisation, skills development, maritime innovation

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I INTRODUCTION

International shipping carries an estimated 90 per cent of the world merchandise trade by volume making the import/export of affordable food and goods possible (United Nations Trade and Development [UNCTAD], 2023). The greenhouse gas emissions of the sector have risen by 20 per cent over the last decade as it operates a largely ageing fleet that runs almost exclusively on fossil fuels. On the positive side, about 21 per cent of vessels on order will operate on cleaner alternatives like liquefied natural gas, methanol and hybrid technologies (UNCTAD, 2023). The transition to low-carbon economy thus represents the industry's biggest challenge, and the International Maritime Organization (IMO) has set an ambitious decarbonisation target, to reduce greenhouse gas emissions from ships by at least 50 per cent by the year 2050 (Balcombe et al., 2019; Serra & Fancello, 2020). This IMO's target calls for the widespread uptake of lower and zero-carbon fuels, in addition to other energy efficiency measures, including operational and market measures in which ports play a critical role. With commitments to sustainability, the 2050 targets and a complex global industry, shipping is positioned to be at the forefront of technological innovation (International Chamber of Shipping [ICS], 2021).

Seafarers, reported to total 1.89 million worldwide, represent the critical workforce of international shipping operating a fleet of over 74 000 vessels (Baltic and International Maritime Council [BIMCO] & ICS, 2021). These seafarers are the driving force to the estimated 90 per cent of the world trade by volume.

South Africa is not a major seafarer nation, with the number of South African seafarers estimated to be between 4 500 and 6 000, working in both the South African fleet and other global shipping lines (Grimett, 2023). Current maritime education and skills training in South Africa is mostly focused on conventional seafarer programmes, and the knowledge of socioeconomic and economic aspects of marine and maritime affairs. This is generally the case at both secondary and tertiary levels of education, including technical and vocational education and training known as TVET. South Africa is losing its status on the international convention on Standards of Training, Certification and Watchkeeping (STCW) for seafarers white list, affecting the employability of the South African seafarers across the world (South African Maritime Safety Authority [SAMSA], 2022).

This article argues that, apart from the need to improve standards, maritime education and skills training in South Africa requires alignment with developments in technology linked to the decarbonisation of the shipping industry.

II DECARBONISATION IN SHIPPING

Decarbonisation is an overarching term that describes acts, pathways or processes, by which countries, individuals or other entities aim to reduce and ultimately eliminate greenhouse gas emissions from human activities (Intergovernmental Panel on Climate Change [IPCC], 2018). Critical to decarbonisation in maritime transport is the increasing use of green energy-based fuels such as ammonia converted from hydrogen that can be used in ship engines directly as fuel. The process involves electrolysis of water, which, at its simplest level, is the use of an electrical current to split water molecules into hydrogen and oxygen. When paired with renewable electricity, electrolysis produces green hydrogen, hydrogen that emits only water and has a higher energy availability per unit mass than any other fuel source (Ironside, 2022). In contrast to synthetic hydrocarbon fuels, ammonia does not require carbon as an input in its production, resulting in a simpler supply chain. Ammonia can also be a near-term energy carrier option for long-distance transport of hydrogen, with existing experience in shipping and handling ammonia from the fertiliser industry (International Energy Agency [IEA], 2022). This green fuel is expected to outcompete fossil fuels as production capacity ramps up and cost decreases (IEA, 2022). Apart from engine fuel, decarbonisation in shipping also entails exhaust treatment technologies and alternative fuel bunkering. Treatment of exhaust gasses is another option to decarbonise ships, although the technology is still under development and includes ammonia slip catalysts and other technologies (Ölçer et al., 2023). The bunkering of alternative fuels, such as liquefied natural gas, ammonia, methanol and hydrogen, is considered

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an important contributor to the future decarbonisation of shipping (Balcombe et al., 2019).

Requisites for the decarbonisation of maritime transport include a reduction in energy consumption; the use of cleaner fuels such as liquefied natural gas, ammonia, methanol and hydrogen; and the electrification of ships. Ports play a critical role in the decarbonisation of the maritime sector by developing infrastructure allowing for bunkering alternative fuels, and developing hydrogen hubs by becoming international centres for hydrogen production, application, import and transport to other countries (Alamoush et al., 2022). A hydrogen hub can be defined as an area where various users of hydrogen from industrial, transport and energy markets are co-located. New fuels will require advanced training and safety measures at ports by 2027 or 2030, given the new risks associated with the safety of new fuels (Ölçer et al., 2023). Alternative fuels for shipping are already offered at the port of Antwerp-Bruges, which is strengthening its position as a bunkering port on a global scale to become a green energy hub and climate neutral by 2050 (UNCTAD, 2023).

III MARITIME INNOVATION

Current and future trends have been compiled by the World Maritime University (WMU) in the form of a Technology Road Map for the Shipping Industry (Ölçer et al., 2023). These trends include an increase in digital consumption and cybersecurity in the short term (up until 2026); the rise of new business models and ecosystems driven by technology with an increase in the use of smart ships in the medium term (2027–2030); and the rising importance of autonomous ships in the long term (2031–2040). Innovation in maritime transport and the related economy includes artificial intelligence (AI), maritime robotics, maritime internet of things (IoT), big data and analytics, immersive reality and cybersecurity (Ölçer et al., 2023). The integration of IoT, in particular, simplifies location data acquisition while enabling tracking of various other parameters such as emissions, machine conditions and propulsion data. Applying technologies such as AI, IoT and performance optimisation platforms (eg monitoring, routing, speed, predictive maintenance and crew training) can all help accelerate decarbonisation (UNCTAD, 2023). In a digital ecosystem, vessels can integrate applications and data models and leverage digital tools to unlock the power of advanced predictive analysis, including those for operations and maintenance. These trends will translate in increasing use of smart ships that will, in turn, require technologically trained seafarers to operate.

Digitalisation and automation are technologies that will help the industry move toward cleaner, greener and more efficient shipping, thus enabling seamless cargo and ship traffic while improving predictability and reliability, creating efficiencies and reducing delays at ports (UNCTAD, 2023). Recent research at the WMU indicates that South Africa is behind the Philippines, Singapore and Norway in technological readiness for autonomous vessel operations measured for preparedness of the legislative framework, human resources and infrastructure (WMU, 2020). The impact of digitalisation and automation on seafarers in South Africa is discussed by Grimett (2023).

IV MARITIME EDUCATION AND SKILLS TRAINING

Three categories of institutions are mandated to deliver the curriculum for seafarer education and training in South Africa (WMU, 2020):

1. High school institutions offering basic maritime-focused subjects. A well-established example of a maritime focus school is the Lawhill Maritime Centre, which is the maritime department of Simon's Town High School. Lawhill is accredited by South Africa's National Qualifications Framework and provides three maritime-focused subjects to its grade 10 to 12 learners, namely maritime economics, nautical science and marine science.
2. Maritime training institutions, often private companies, offering pre-sea cadet certificates of competency and STCW short courses.
3. Maritime higher education institutions, which include universities offering national diploma, undergraduate and postgraduate programmes, and TVET colleges. The maritime higher education landscape is dominated by three universities, namely Durban University of

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Technology, Cape Peninsula University of Technology and Nelson Mandela University.

Maritime education and skills training at the higher education institutions is mostly focused on conventional seafarer programmes and knowledge of the socioeconomic aspects of marine and maritime affairs. This can be seen from a cursory look at the diplomas/degrees and study topics offered at the institutions (Figure 1 and Figure 2, respectively).

The training of seafarers in South Africa is lagging behind the current international requirements of the shipping industry, more so regarding future trends, particularly due to limited opportunities for cadets to be placed on merchant ships and training vessels (Grimett, 2023). There is. Therefore. a need for curriculum change in order to align maritime education and skills training in South Africa to current developments in shipping. Digitalisation in shipping requires that seafarers are able to use computerised information systems and understand the capabilities of automated programs in order to respond to existing and future requirements (Grancharova & Lutzkanova, 2023). A survey among South African seafarers found that those on the frontlines of work are witnessing the impacts of increasing technology on board vessels (Grimett, 2023).

Figure 1: Example of marine and maritime diplomas/degrees offered in South Africa, generated using WordClouds (The diplomas/degrees list was compiled from available programmes offered at South African institutions.)

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Figure 2: Example of marine and maritime study topics offered in South Africa, generated using WordClouds

While labour market opportunities for South African seafarers exist in the local maritime sectors, including coastal shipping, fishing, port operations and marine tourism, the number of South African seafarers employed in the global merchant shipping industry represents ~ 0.2 per cent of the global supply (WMU, 2020). Aligning the standard of seafarers in ports and onboard vessels with new trends is, therefore, a priority for maritime education and skills training in South Africa and, in doing so, emphasis should be placed on safety and health linked to new technologies and fuels (Figure 3). This is likely to stimulate international interest in seafarer supply from South Africa in an evolutionary employment market.

The reported lack of intermediate and advanced training experienced by many seafarers in South Africa could be linked to training vessel access (Grimett, 2023) but could also be indicative of a shortage of suitably qualified training staff. This is exacerbated by challenges in vessel availability for on-board training (Ölçer et al., 2023).

Faster and more effective approaches to maritime education and skills training should, therefore, be explored and implemented. Such an approach is the virtual mentored learning or VML, enabling content dissemination and simulation/experiential-learning, irrespective of location.

VML enables the exchange of information in the digital realm using one or more digital platforms (McReynolds et al., 2020). Mentors are experienced professionals who facilitate learning by means of assignments and case studies. Courses are also scheduled to promote professional development and team building. VLM programmes proved effective in training young professionals in upstream exploration fundamentals.

VLM will significantly alleviate constraints in the availability of qualified local teaching staff through international expert participation.

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Figure 3: Schematic illustration of the key areas of the future work of seafarers. The vessel shown is the RV SA Agulhas (Department of Forestry, Fisheries and the Environment photo); the seafarer illustration is from the IMO Day of the Seafarer 2020.

V CONCLUSION

Maritime transport is a complex global industry positioned to reduce its greenhouse emissions by using cleaner alternative fuels. Achieving this decarbonisation target is closely linked to technological developments in digitalisation and automation. The training of seafarers in South Africa lags behind current international requirements of the shipping industry, and more so when it comes to future trends. Aligning the standard of seafarers in ports and on board vessels with technological developments linked to decarbonisation is, therefore, a priority for maritime education and skills training in South Africa. Such alignment will ultimately enhance port performance and hinterland connectivity, with positive economic knock-on effects.

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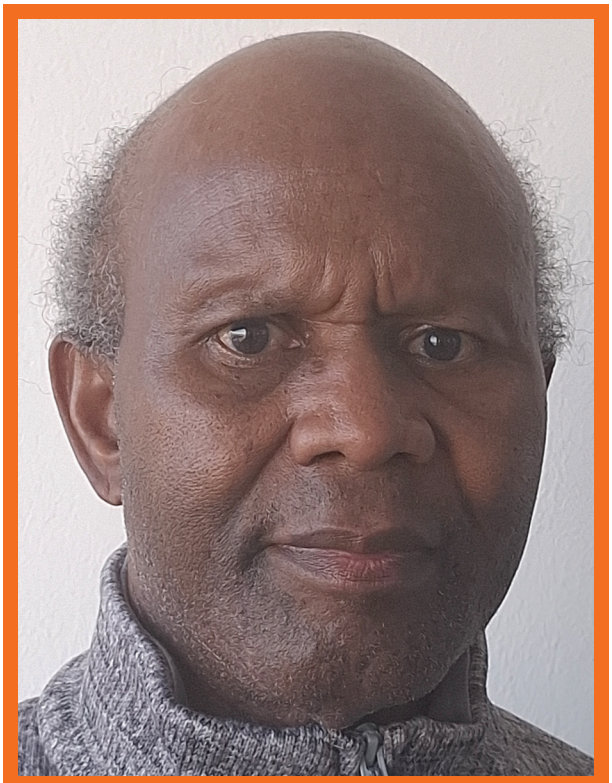

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