

South African Journal of Maritime Education and Training

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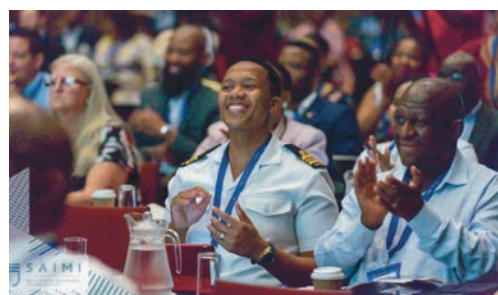
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Foreword

In October 2019, the South African International Maritime Institute (SAIMI) hosted the *Forward Thinking for Maritime Education and Training Excellence* conference in Durban. The event was hosted in partnership with AMSOL, the John Langalibalele Dube Institute, the eThekweni Maritime Cluster, eThekweni Municipality, the University of KwaZulu-Natal and the Moses Kotane Institute.

The conference offered a novel opportunity to kickstart collective forward thinking about the skills and education needed to continue growing the oceans economy in South Africa, and on the continent of Africa. A pivotal focus of the conference was to match the output and capacity of our education and training system to the skills in demand in all sub-sectors of the maritime economy.

I am proud to present a major output from the robust and well-represented conference in the shape of the first volume of the *South African Journal for Maritime Education and Training*. As an institute carrying a research mandate, the South African Maritime Institute (SAIMI) will continue to publish this journal annually to ensure the conversation evolves and to support knowledge generation for the sector. In this, our first volume, we highlight some valuable and interesting research from our esteemed contributors.

Ensuring our graduates are 'future-fit', as the fourth industrial revolution transforms all industries, is a collaborative task that needs commitment from all role players, including academia, government, industry, SMMEs and the community. As a developing nation, we need everyone moving in the same direction to achieve the exponential economic growth set by Operation Phakisa targets to move the oceans economy forward in South Africa.

These targets are, indeed, achievable as we collaborate to adapt skills to digital and technological advancements, automation, industry-specific requirements and internationally benchmarked standards. In upskilling our workforce, we not only empower the people living in Africa, but we also provide the sought after technical requirements of the trade and professional categories,

growing in demand in most sectors of the maritime industry across the globe.

To contribute to building sustainable livelihoods and providing ecosystem services in the maritime industry, entrepreneurship and enterprise development are fundamental to matching the skills and demand in the oceans economy, and to enrich the future-proof growth of the sector.

As a country that is well positioned, geographically, to take advantage of the oceans economy, we should ensure that we also provide and continuously develop the human capital for this critical endeavour.



Professor Sibongile Muthwa
SAIMI Advisory Board Chair

Editorial

In this era of digitalisation, South Africa has the potential to become a leader in the maritime industry. On 14 –15 October 2019, the South African International Maritime Institute (SAIMI) hosted the conference, *Forward Thinking for Maritime Education and Training Excellence* in Durban. The conference attracted 270 attendees and delegates, and discussed the key question: ‘Does the maritime skills supply match industry demand and offer entrepreneurial opportunities?’ The rationale for this question is the South African maritime industry’s recent strong strategic focus on maritime skills.

As a first of many to come, the conference prompted the South African International Maritime Institute to continue providing platforms for such critical conversations. One of the key outcomes of the conference is the publication of the first volume of the *South African Journal for Maritime Education and Training*. In this first volume, we address the focus of the conference discussion and papers presented there.

The Growing South African Maritime Industry and its Strategic Vision

The South African maritime sector has been showing some gratifying growth recently. In 2020 the total fleet capacity was 499 000 deadweight tonnage (or DWT), which is 6.7 times more than that of 2015 (74 000 DWT).¹ South Africa offers rich maritime resources and business opportunities, such as offshore oil and gas, marine manufacturing, aquaculture, maritime transport, ocean governance, coastal and marine tourism and small-boat harbours. Eight major South African seaports facilitate trade and cargo handling and hundreds of smaller ports and harbours are dotted along its coastline. As such, this growing industry requires skilled personnel and capacity development, underpinned by evidence-based decision-making through research.

South Africa implemented a National Qualification Framework (NQF) to address the country’s education and training needs although this is being hampered by the triple socioeconomic challenges of high unemployment, inequality and poverty, as identified in the National Development Plan (NDP), Vision 2030.

While industries evolve and innovation accelerates, there is a need to increase the efficiency and effectiveness of NQF implementation. Foreseeing the demand for quality maritime education and training, Operation Phakisa was launched in July 2014, to address the need for appropriate skilled labour in order to facilitate the growth of the maritime sector. This led to the establishment of a coordination and supporting body, the South African International Maritime Institute, to support skills development, research and innovation across the sector. With the above-mentioned triple socioeconomic challenges and the country’s unemployment rate amongst the highest in the world and with youth unemployment rate at 41% (official definition) and 52% (expanded definition), solutions must be sought domestically and beyond national boundaries. Therefore, the timely SAIMI-hosted conference, *Forward Thinking for Maritime Education and Training Excellence*, focused on discussing future technologies and international skills development.

About this journal

Higher education cannot thrive without research. Building research capacity is a necessary condition to excellence in maritime education and training. This journal is an important outcome of the SAIMI conference, *Forward Thinking for Maritime Education and Training Excellence*, showcasing a breadth of knowledge and expertise in the South African maritime sector.

¹ UNCTADStat ‘Maritime Profile: South Africa’ (available at <<https://unctadstat.unctad.org/countryprofile/maritimeprofile/en-gb/710/MaritimeProfile710.pdf>>, accessed on 30 November 2021).

The journal opens with an introduction by Professor Sibongile Muthwa, SAIMI Advisory Board Chair, who provides a forward-thinking message to readers by setting the scene where the sustainable use of oceans and African entrepreneurship lie in education and research.

There are a total of eight selected papers in this first volume. The first paper discusses maritime skills in the context of ocean governance, focusing on five aspects, namely maritime knowledge, maritime awareness, maritime safety, maritime security and maritime integrity. Professor Vrancken brings these aspects together in a regional approach to skills development infrastructures and programmes that should be systematically designed to scale up economies. The second paper authored by Dr Mapadimeng and Ms Mncwango reports the key findings of the Labour Market Intelligence Partnership (LMIP) study undertaken by the Human Sciences Research Council (HSRC). The authors carefully examine labour market theories behind the framework, involving skills supply, demand and imbalance. The LMIP study has produced useful knowledge to support solutions for skills development, which is further elaborated on in the paper authored by Ms Davidson. Her paper presents a case study on skills development for marine manufacturing by reviewing the progress of Operation Phakisa and four relevant studies, including her own research on the South African boat building leadership. The paper addresses the importance of leadership in developing an education-industry partnership for marine manufacturing and coherent training and specialised work contexts. Mr Zulu and Mr Ndlozi apply a systems thinking approach to enterprise development in their paper and detail three causal loop diagrams and systems thinking archetypes to deepen our understanding of enterprise development. A comprehensive empirical study of the South African aquaculture sector by the Department of Forestry, Fisheries and the Environment (DFFE) offers evidence of a specific skills gap among the professionals in the sector. The study applied the triangulation of three methods, namely a desktop review, questionnaires and focus groups, to validate its findings. This empirical study demonstrates evidence-based decision-making and recommends a number of interventions at medium to high levels of priority.

The next paper, by Ms Matoti, further discusses the need for skills development and capacity building in

South Africa as a way to develop the oceans economy. Her paper highlights existing oceans economy policies in Africa and adjoining the Indian Ocean countries. She revisits the role of Operation Phakisa in increasing skills development, while addressing socioeconomic problems such as unemployment, inequality and poverty. In his paper, Mr Zimmerman analyses maritime skills by adopting a forecasting model and discussing supply and demand of maritime skills in South Africa. He identifies a gap between the supply and demand of maritime skills in different categories over a 20-year timeframe. He also went on to use the SAIMI 2019 conference as a platform to receive feedback from participants and to validate his research findings. Despite identifying a number of skills-related issues, the paper holds that modern technologies in the era of the fourth industrial revolution could be an opportunity for South Africa to increase skills development, and concludes with eight tangible recommendations. Finally, the journal concludes with a paper by Dr Kitada, who advocates for human-centred approaches, rather than techno-economic approaches, to put the focus on humans, who should decide what subjects to learn, what jobs to choose and what careers they want to follow. In her view technology and skills debate often proceeds without considering the dignity of human beings who have autonomy to design our future.

Mr Odwa Mtati, CEO of SAIMI provides a concluding remark, with a strong spirit of ‘forward thinking for maritime education and training excellence’.

I would like to thank the various authors for their scientific contributions and the SAIMI staff who made this conference output possible; in particular, Mr Odwa Mtati for his leadership and guidance, Ms Soraya Artman, Dr Tanaka Mugabe and Ms Nwabisa Matoti, for their patience and generous support. Finally, I extend my special thanks to Dr Cleopatra Doumbia-Henry, President of the World Maritime University (WMU), who is a leader in capacity building in the maritime and ocean industries. Dr Doumbia-Henry will be playing a key in facilitating future collaboration between the South African maritime and ocean sectors and the WMU.

Associate Professor Momoko Kitada
Guest Editor



Overview of the Skills Required for Marine Protection and Ocean Governance

Patrick Vrancken[†]

This paper provides an overview of the skills required for marine protection and ocean governance by focusing on five aspects on a regional basis, namely maritime knowledge, maritime awareness, maritime safety, maritime security and maritime integrity. It is concluded that a focus on the development and retention of the skills required in these regards is necessary for the state to optimally govern the South African maritime domain in the interests of all South Africans, to ensure that South Africa protects its lawful interests on the high seas and to enable South Africa to make its full contribution to the integrated governance of the African maritime domain.

Keywords: ocean governance, marine protection services, maritime knowledge, maritime awareness, maritime safety, maritime security, maritime integrity, regionalism

1 Introduction

Forward thinking for maritime education and training excellence requires that one ensures that the maritime skills supply matches industry demand as far as possible. In view of the limited resources of the State, it also requires that one creates as many entrepreneurial opportunities as possible for non-State actors to make their contribution to skills development. The greater that contribution is, the more the State is in a position to focus its efforts on

its primary duties, namely: (a) to govern our maritime domain, which is the largest around the continent;¹ (b) to ensure that South Africa protects its lawful interests on the high seas that surround us;² and (c) to cooperate with neighbouring States in the integrated governance of the whole African maritime domain.³ To fulfil those duties requires that the State focuses on five aspects of ocean governance on a regional basis, namely maritime knowledge, maritime awareness, maritime safety, maritime security and maritime integrity.

[†] Incumbent of the SARChI Chair in the Law of the Sea and Development in Africa and chair of the Phakisa MPG Lab's capacity-building working group. The financial assistance of the National Research Foundation is gratefully acknowledged.

¹ The South African maritime domain consists of the internal waters, territorial waters, exclusive economic zone and continental shelf around the South African mainland and the Prince Edwards Islands. See the Maritime Zones Act, 1994 (Act 15 of 1994).

² These consist of the ocean space beyond the South African maritime domain up to, but not including the maritime domains of adjacent and opposite States.

³ The main policy instrument in this regard is the 2050 Africa's Integrated Maritime Strategy, which was adopted in January 2014 by the heads of State and governments of the African Union (see (2016) 1 *Journal of Ocean Law and Governance in Africa* 202–242). See V Nmeihelle & T Pasipanodya 'The African Union' in PHG Vrancken & M Tsamenyi (eds) *The Law of the Sea: The African Union and its Member States* (Cape Town, Juta 2017) 36–62.

II Maritime knowledge

In order to best govern one's maritime domain, one needs first of all to have adequate historical and contemporary knowledge of that domain and our interaction with it,⁴ not only in the natural sciences but also in the humanities and social sciences.⁵ This is no mean task in view of: (a) the great complexity and constant fluidity of the marine environment, especially in a part of the world where three oceans meet;⁶ (b) global phenomena, such as climate change and ocean acidification;⁷ and (c) the increasing range and intensity of human pressures on that environment.⁸ While our knowledge of our maritime domain is limited and new skills are required in several areas,⁹ such as aquatic animal health,¹⁰ fisheries management¹¹ and marine spatial planning,¹² South Africa can be proud of the human and other resources

that it has invested in the past, and continues to invest, to better understand the inshore and offshore elements of its maritime domain as well as the Southern Ocean and Antarctica.¹³ There is adequate expertise within the higher education system, which produces sufficient graduates in many fields of maritime knowledge. In fact, the problem in those areas is often that graduates do not find employment within the country and, as a result, they end up contributing to the ocean economies of other states. The challenge here is, thus, not to obtain the skills required, but to retain those skills by creating job opportunities within an expanded maritime knowledge system.

By contrast, while South Africa has a sophisticated marine and maritime law system¹⁴ and is among the world's leaders with regard to integrated coastal management and marine spatial planning legislation,¹⁵ for instance,

⁴ See N Funke, M Claassen, K Nortje & R Meissner *A Research, Innovation and Knowledge Management Road Map for the South African Maritime Sector: Charting a Course to Maritime Excellence by 2030* (2016) 16–17; J Sharfman, V Maitland, S Winton & R Parthesius 'The state of maritime and underwater cultural heritage research, legislation and technology in South Africa' in N Funke, M Claassen, R Meissner & K Nortje (eds) *Reflections on the State of Research and Technology in South Africa's Marine and Maritime Sectors* (Pretoria, Council for Scientific and Industrial Research 2014) 218–242.

⁵ See R Meissner 'A critical analysis of research paradigms in a subset of marine and maritime scholarly thought' in N Funke, M Claassen, R Meissner & K Nortje (eds) *Reflections on the State of Research and Technology in South Africa's Marine and Maritime Sectors* (Pretoria, Council for Scientific and Industrial Research 2014) 198–99.

⁶ See the White Paper on the National Environmental Management of the Ocean (NEMO), published in *Government Gazette* 37692 of 29 May 2014 at 11–13.

⁷ See the White Paper op cit note 6 at 14. See further K Mutombo 'Port infrastructure: A holistic framework for adaptation to climate change' in N Funke, M Claassen, R Meissner & K Nortje (eds) *Reflections on the State of Research and Technology in South Africa's Marine and Maritime Sectors* (Pretoria, Council for Scientific and Industrial Research 2014) 262–28.

⁸ See the White Paper op cit note 6 at 15.

⁹ Ibid at 19–21.

¹⁰ The recommendation in this regard is that 'additional content on aquatic veterinary problems and practices be included in the South African veterinary curriculum' (South African International Maritime Institute 'IOI Skills Audit and Needs Analysis for the Marine Protection Services and Ocean Governance Sectors of Operation Phakisa' (2018) Gqeberha: South African International Maritime Institute (available at <<https://saimi.co.za/resource/research-policy/>>).

¹¹ See IOI op cit note 10 at 49–50. In view of the very small number of experts required, the realistic approach appears to include: (a) creating career paths within DEFF; (b) upgrading the mathematics options in the relevant BSc programmes; and (c) combining postgraduate training abroad with short learning programmes rooted in the South African conditions.

¹² IOI op cit note 10 at 47 and 56. There is a SARChI Chair in Marine Spatial Planning hosted by the Nelson Mandela University as well as an NRF-funded community of practice focusing on marine spatial planning in Algoa Bay (see RA Dorrington et al. 'Working together for our oceans: A marine spatial plan for Algoa Bay, South Africa' (2018) 114(3/4) *South African Journal of Science* 1–6). While preliminary steps have been taken at Nelson Mandela University to develop a multidisciplinary MSc in marine spatial planning, funding is required to complete the process and launch the programme.

¹³ See, for instance, T Bornman et al. 'Long-term marine research platforms of the National Research Foundation' in N Funke, M Claassen, R Meissner & K Nortje (eds) *Reflections on the State of Research and Technology in South Africa's Marine and Maritime Sectors* (Pretoria, Council for Scientific and Industrial Research 2014) 66–99.

¹⁴ See PHG Vrancken *South Africa and the Law of the Sea* (2011); J Hare *Shipping Law and Admiralty Jurisdiction in South Africa* 2 ed (Leiden, Martinus Nijhoff Publishers 2011).

¹⁵ See the National Environmental Management: Integrated Coastal Management Act, 2008 (Act 24 of 2008) and the Marine Spatial Planning Act, 2018 (Act 16 of 2018), respectively.

more research needs to be undertaken and many more skilled individuals need to be available to tackle the administrative, legal, political and social challenges with which one is inevitably confronted when implementing

such legislation. This is especially so because of the vast range of stakeholders involved (see Figure 1) and the need to depart from the traditional sectoral approach to ocean management.¹⁶

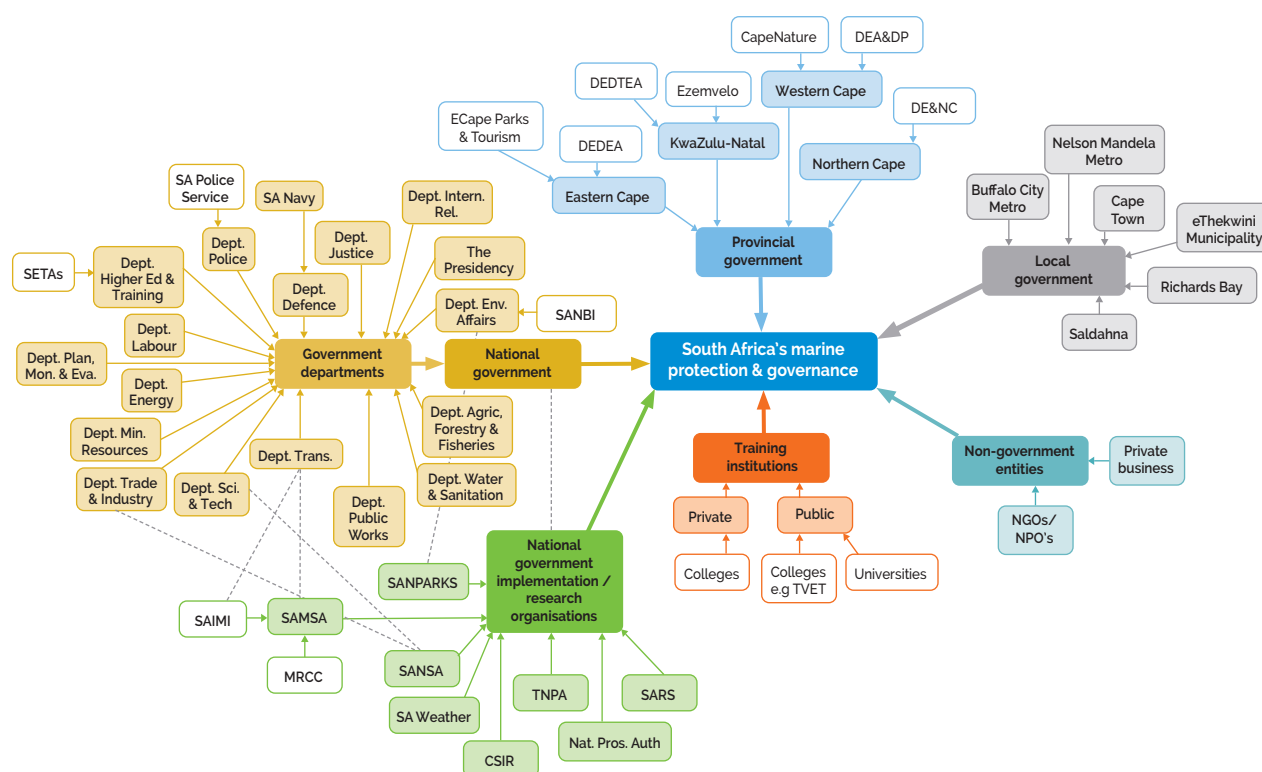


Figure 1: MPG Stakeholder Map¹⁷

The challenge here is, thus, to develop and sustain modules and programmes that, on the one hand, provide opportunities for the development of the legal skills required to give full and effective effect to the pieces of legislation in force and, on the other hand, provide the multidisciplinary skills required to explore and address the multifaceted challenges encountered when striving

for sustainability and transformation in coastal and ocean matters. There is a consensus in this regard that the way forward entails: (a) upgrading the skills of the individuals already in the system;¹⁸ (b) providing greater and more specialised exposure to the general pool of new individuals being trained;¹⁹ and (c) attracting to, and retaining in, the civil service a greater share of the available skills.²⁰

¹⁶ See the White Paper op cit note 6 at 25. See further PHG Vrancken & A Pike 'Marine and maritime law in South Africa' in N Funke, M Claassen, R Meissner & K Nortje (eds) *Reflections on the State of Research and Technology in South Africa's Marine and Maritime Sectors* (Pretoria, Council for Scientific and Industrial Research 2014) 18–42.

¹⁷ From IOI op cit note 10 at 14.

¹⁸ By means of the recognition of prior learning as well as short courses and self-standing credit-bearing modules for continued professional development at all levels.

¹⁹ By means of LLB final-year electives as well as postgraduate diplomas and masters programmes that include components on criminal law, integrated coastal zone management and marine spatial planning (see IOI op cit note 10 at 54–56). A new LLM (Ocean Governance) programme, which will be launched in 2021 at the Nelson Mandela University, has been developed with the aim of meeting the needs in this respect.

²⁰ The challenges in this regard do not appear to be specific to marine-protection and ocean-governance positions.

III Maritime awareness

The greater one's knowledge of one's maritime domain and adjacent areas becomes, the more one understands the range and nature of the natural processes that are subject to constant or periodic changes and the human activities that constitute potential threats. Those changes and threats require permanent monitoring to ensure the level of awareness necessary to make possible early detection and the taking of measures aimed at mitigating or eliminating the negative impact of those changes and threats. As in the case of maritime knowledge, South Africa can be proud of the human and other resources that it has invested in the past, and continues to invest, in order to be aware of what is happening off its shores.²¹ The higher education system has adequate expertise and produces sufficient graduates in many fields of maritime awareness but, here also, the problem is often that graduates do not find employment within the country and, as a result, they end up contributing to the ocean economies of other states. The challenge here is, thus, not to obtain the skills required, but to retain those skills by creating job opportunities within an expanded maritime awareness system. However, such an expansion involves not only increasing the geographical and data reach of the structures and technologies already in place, but also developing the skills required in some basic areas, such as coastal water quality monitoring and analysis,²² as well as the skills required for the engineering innovations and the regulatory developments necessary to make smarter use of the seabed, the ocean waters, the airspace and outer space for monitoring purposes.²³

IV Maritime safety

Greater maritime knowledge and awareness of the ocean space around South Africa contribute to a better

understanding of the natural threats to human lives and property in that space, as well as the range of measures that need to be taken to ensure maritime safety. The technical specifications and processes that those measures involve have been developed and are now prescribed at the global level, primarily under the auspices of the International Maritime Organization.²⁴ This means that there is no sense in South Africa setting its own standards in this regard and that the focus now must be on developing, and ensuring the constant availability of, the skills required to: (a) implement and enforce the global standards already in place or to be developed in future;²⁵ and (b) meet search-and-rescue and disaster-management needs whenever they arise, especially because these needs are disproportionately experienced by poor and vulnerable coastal communities.²⁶ This is already a priority at this stage of the development of our ocean economy and this will have to keep pace with any future increase in human activities associated with the projected further development of that economy, as well as the effects of climate change.

V Maritime security

Greater maritime knowledge and safety have the effect of increasing the range and intensity of human activities at sea; an effect that calls for greater awareness to identify threats to maritime security. Some of those threats relate to human life and well-being or might have a direct impact on private or public property. Other threats challenge the policies adopted to reach the goals set by the Constitution. Because the regulatory arsenal against those threats is activated by many different state organs in terms of several pieces of legislation,²⁷ the task of protecting maritime security is not only complex, but often characterised by a debilitating lack of consensus and coordination.

²¹ An example is the National Oceans and Coastal Information Management System (OCIMS).

²² IOI op cit note 10 at 48–49. The consensus is that South Africa needs two single-curriculum comprehensive short courses offered at various locations: the one, aimed at laboratory staff, dealing with the actual analysis of samples; and the other, aimed at local environmental practitioners and managers, dealing with the implementation and management of coastal and marine environmental quality monitoring programme.

²³ See Funke et al. op cit note 4 at 35. While there appears not to be a shortage of individuals with GIS training, it is necessary to develop a course for data curators.

²⁴ See, for instance, the International Convention for the Safety of Life at Sea and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers.

²⁵ See Funke et al. op cit note 4 at 35–36. '[T]here is currently a shortage of Naval Architects, Ship Surveyors/Principal Officers and Harbour Masters for small/fishing harbours' (IOI op cit note 10 at 57). The issue is either being addressed or falls more appropriately within the brief of the Small Harbour Lab.

²⁶ See the White Paper op cit note 6 at 22.

The latter can prompt calls for integration, which would indeed probably make skills-development planning easier. It is doubtful, however, that such an approach is realistic. What has happened in practice points rather to a combination of skills development relating to: (a) the fullest and smartest use of a piece of the regulatory arsenal; (b) an awareness of the scope and requirements of related pieces of that arsenal; and (c) the ability to work in multi-departmental teams, especially at the managerial level. As a result, while there is value in research aimed at reaching the highest possible level of integration, skills-development efforts should continue to aim primarily at ensuring that all the individuals involved in the application of a specific maritime security-related piece of legislation have all the skills required to address the related threats, while being sufficiently cognisant of the scope and requirements of related pieces of legislation to contribute to multi-departmental maritime security initiatives at their respective levels.²⁸

VI Maritime integrity

The citizens of South Africa own the South African maritime domain and its resources, which must be held in trust by the state²⁹ and the integrity of which the state must protect.³⁰ At an internal level, this requires that the state's constitutional goals should never be lost sight of, its

constitutional structures never be departed from and its constitutional processes never be allowed to be hijacked by any individual or group of individuals for ocean capture purposes. The governance instruments and skills required to protect our internal maritime integrity are not specific to ocean governance. As a result, the latter's quality depends, to a large extent, on norms laid down, cultures developed, precedents set and practices followed, to a very large extent, in the context of land governance. This is in contrast to the position at the external level, where the defence of the integrity of the maritime domain against foreign threats requires many different technical, organisational and tactical skills than the defence of the land territory.³¹ As a result, the South African Navy has its own, well established and tailor-made capacity development system and partners,³² which could, however, only benefit from some degree of interface with the civilian system and vice-versa.

VII Regional approach

It is to be expected that efforts by national bodies to develop the skills required for marine protection and ocean governance would focus on South Africans and the South African context. However, one would be seriously mistaken were one to overlook the fact that the oceans are the theatres of natural processes and human activities that cut across state boundaries.³³ In a sense,

²⁷ Including: the Marine Living Resources Act, 1998 (Act 18 of 1998) as far as the fisheries control officers are concerned; the National Environmental Management Act, 1998 (Act 107 of 1998) as far as environmental management inspectors are concerned; the Criminal Procedure Act, 1977 (Act 51 of 1977), as far as peace officers are concerned; the Merchant Shipping Act, 1951 (Act 57 of 1951) as far as principal officers are concerned; the National Ports Act, 2005 (Act 12 of 2005) as far as ISPS officers are concerned; the South African Police Service Act, 1995 (Act 68 of 1995) as far as police officers are concerned; the National Prosecuting Authority Act, 1998 (Act 32 of 1998) as far as prosecutors are concerned; the Customs and Excise Act, 1964 (Act 91 of 1964) as far as customs officials are concerned; the Intelligence Services Act, 2002 (Act 65 of 2002) as far as the members of the State Security Agency are concerned; provincial legislation as far as provincial traffic officers and other enforcement officials are concerned; and municipal by-laws as far as metro traffic officers and other enforcement officials are concerned. See E Witbooi & P Snijman 'Law enforcement facilitated by a fisheries crime approach: The South African example' (2017) 2 *Journal of Ocean Law and Governance in Africa* (2017) 1-55.

²⁸ This is also a goal of the new LLM (Ocean Governance) programme mentioned above.

²⁹ See s 11(1) of the National Environmental Management: Integrated Coastal Management Act, 2008 (Act 24 of 2008).

³⁰ See the White Paper op cit note 6 at 16-17 and 25.

³¹ See, for instance, M Vego 'On naval warfare' (2010) 1 *Tidskrift I Sjöväsendet* 73-92 at 74 ('Naval warfare is in its very essence identical to the nature of war [on land]. Yet there are also some significant differences in emphasis due to the characteristics of the physical environment in which war at sea is conducted').

³² See further, for instance, CK Wainman et al. 'Maritime technology support to the South African Navy' in N Funke, M Claassen, R Meissner & K Nortje (eds) *Reflections on the State of Research and Technology in South Africa's Marine and Maritime Sectors* (Pretoria, Council for Scientific and Industrial Research 2014) 281-303.

³³ This is the reason why, for instance, Angola, Namibia and South Africa concluded the 2013 Benguela Current Convention (adopted: 18 May 2013; EIF: 10 December 2015; available at <https://www.benguelacc.org/index.php/en/component/docman/doc_download/695-signed-benguela-current-convention-english>).

the ocean environment is a global environment and, for that reason, maritime knowledge and awareness should have a worldwide reach. It is doubtful, however, that South Africa, as a middle-level regional power, has the financial and human resources or that our national interests require of us to aim so high.³⁴ At the same time, our efforts at developing the skills required for marine protection and ocean governance in our own maritime domain would be seriously flawed were they not grounded, at least, on a regional foundation encompassing the south-eastern Atlantic Ocean, the south-western Indian Ocean and the Southern Ocean.³⁵ This means that the skills required include the skills that allow the individuals concerned to contribute, together with nationals from neighbouring states, to marine protection and ocean governance up to ten times beyond the outer limit of our exclusive economic zone to the east, south and west. This is already the case in some respects.³⁶ More deliberate and systematic efforts are, however, required to coordinate and possibly harmonise skills development infrastructures and programmes across the board; an approach that would also create economies of scale and generate the critical mass of expertise, equipment and funding necessary to tackle the existing ocean governance challenges.

VIII Conclusion

A focus on the development and retention of the skills required for maritime knowledge, maritime awareness, maritime safety, maritime security and maritime integrity is necessary for the state to optimally govern the South African maritime domain in the interests of all South Africans, to ensure that South Africa protects its lawful interests on the high seas and to enable South Africa to make its full contribution to the integrated governance of the African maritime domain. This requires targeted interventions aimed at filling the existing gaps, maximising impact and reaching the highest possible level of coherence and integration. Without such interventions, South Africa runs the risk of missing significant opportunities to improve the lives of its people and to take its rightful place as a maritime nation.

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³⁴ See, for instance, JF Clark 'South Africa – Africa's reluctant and conflicted regional power' (2016) 1 *ASPJ Africa & Francophonie* 30–47; D Trachsler (translated by C Findlay) 'South Africa: A hamstrung regional power' (2011) 102 *CSS Analysis in Security Policy* 1–4.

³⁵ See the White Paper op cit note 6 at 26; Funke et al. op cit note 4 at 21 and 37.

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Patrick Vrancken



Human Sciences Research Council's Labour Market Intelligence Partnership Study and Lessons for the Maritime Sector – A Labour Market Theoretical Perspective

*Mokong S. Mapadimeng**

To best understand the changing nature of labour markets and how they function, it is necessary to base our analysis on both the empirical evidence and appropriate theoretical frameworks. This is particularly so as theory is about real-life situations and enhances our understanding of how the world around us works and changes.

Theory also guides inquiry into social questions for a better understanding of how they can be resolved. With this in mind, this paper examines the findings of the Human Sciences Research Council's (HSRC) Labour Market Intelligence Partnership (LMIP) studies, and specifically the 2016 report on Skills Supply and Demand in South Africa. This it does through the deployment of the contemporary labour market theories. In doing so, lessons for the maritime sector, which is presently seeking to implement its skills planning and employment creation plans, are discussed. The paper finds that while the LMIP lays foundation for future skills planning, its analysis is, however, not explicitly and adequately anchored into contemporary labour market theories. This is a major shortcoming as these theories alert us to issues that LMIP is not adequately giving attention to, i.e., the socially structured and segmented nature of the labour markets under the competitive pressures of globalisation and technological changes.

Keywords: *South Africa, HSRC, LMIP, skills, contemporary labour market theories*

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I Introduction

South Africa has been described as a maritime nation. The country's coastline is more than 3 000 kilometres long and a sea-land area that is three times bigger than its land area.¹ It is estimated that 58 per cent of the country's gross domestic product (GDP) is based on trade and 98 per cent of trade volumes moves by ship, part of the ocean-based transportation system. The oceans economy is anticipated to grow its contribution to the country's GDP from R54 billion in 2010 to about R177 billion by 2033. Similarly, employment creation in the oceans economy is estimated to triple from 316 000 jobs in 2010 to 1 million jobs by 2033. The oceans economy has, thus, been flagged as one of the priority sectors targeted for contribution to economic growth and job creation in the country. However, to fully unlock and exploit the growth potential of this sector, it is imperative that there is better planning for the skills required by this labour market, as well as how best to grow and use those skills productively. The oceans economy's skills needs are succinctly captured in the South African International Maritime Institute (SAIMI)'s priority statement that 'activating the economic potential of the maritime domain depends on the availability of skilled people needed by industry – delivered by quality training informed by credible market intelligence on current and future skills needs'.²

This statement, considered within the national context of South Africa characterised by high unemployment and inadequate supply of required skills, is a clear acknowledgement by the maritime sector of the skills challenges it is faced with and which can severely constrain its contribution to national economic development and employment creation. In recent years, better understanding labour market needs and attempting to better match skills supply and demand have featured high

on the policy agenda of many countries and regions.³ This is driven by both rapid technological advances and global competition. It is also driven by increasing awareness that more proactive skills planning is needed to address societal needs.⁴

In line with these international developments and driven by the concern about high unemployment and the implications this has for economic growth and development, similar research efforts were initiated that were aimed at generating assessments and models designed to anticipate skills requirements and how best to meet them. This manifested through the multi-year Labour Market Intelligence Partnership (LMIP) study initiated by the Department of Higher Education and Training (DHET), which was commissioned to the Human Sciences Research Council (HSRC) and its research partners at universities in South Africa. The study was necessitated by the need to address and overcome an evidently perennial problem of a skills shortage in South Africa and, therefore, the need for a coordinated, coherent and responsive skills planning system. This was in line with the government's National Skills Development Strategy (NSDS) III (2011 to 2016) and its observation of the absence of an institutional mechanism for the supply of credible information and analysis on the supply and demand of labour market skills. The government's Medium-Term Strategic Framework (MTSF, 2014–2019), consistent with the government's priority outcome 5.1,⁵ also required of the Minister of Higher Education and Training (now renamed Minister of Higher Education, Science and Technology) to generate a credible mechanism for skills planning.

The LMIP has since conducted numerous studies and produced reports meant to inform national skills planning. These reports include the 2016 report titled Skills Supply and Demand in Labour Market in South Africa.⁶ Drawing

¹ See N Funke et al. *A Research, Innovation and Knowledge Management Road Map for the South African Maritime Sector: Charting a Course to Maritime Excellence by 2030* (2016) at 16–17.

² SAIMI Conference Concept and Planned Outcomes (2019). 'Forward Thinking for Maritime Education and Training Excellence: Does the maritime skills supply match industry demand and offer entrepreneurial opportunities?' Durban, South Africa.

³ See ILO 'Approaches to anticipating skills for the future of work' *Report prepared by ILO and OECD for G20 Employment Working Group* (2018) Geneva, Switzerland. See also OECD *Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies* (2012).

⁴ See OECD op cit note 3.

⁵ Department of Higher Education and Training (DHET) 'Outcome 5: A skilled and capable workforce to support an inclusive growth path' *The Medium Term Strategic Framework (MTSF) (2014-2019) Delivery Agreement 5* (Pretoria, DHET 2014) (available <<https://www.dhet.gov.za/Outcome/MTSF%202014-2019%20Outcome%205%20Skills.pdf>>)

⁶ V Reddy et al. *Skills Supply and Demand in South Africa* (2016).

from previous attempts and on international experience, the report represents one of the first attempts to analyse how skills supply and demand interact in the South African context and the implications for a future skills policy in support of inclusive growth. The report presents national trends about

skills supply and demand and provides insights into national and sectoral trends, as well as skills imbalances in the country. The report was anchored in a conceptual framework with four key elements, namely the economy, skills supply, demand and skills imbalances, as represented in Figure 1.⁷

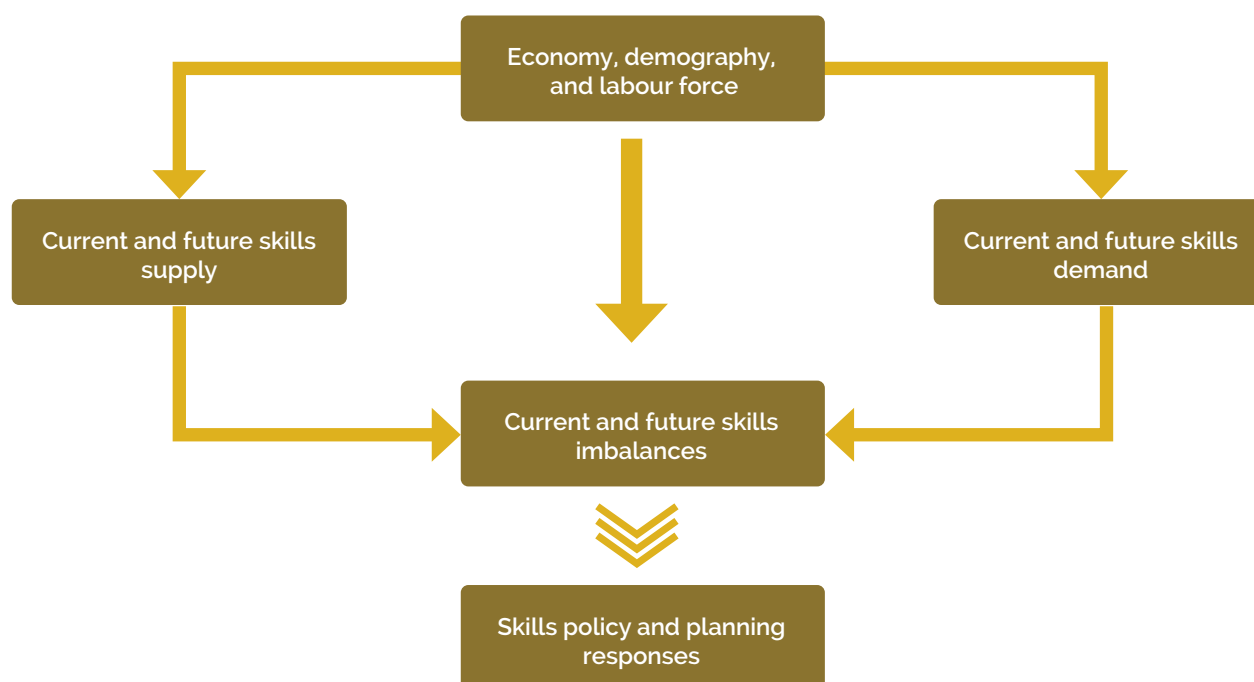


Figure 1: Framework for the Analysis of Skills Supply, Demand and Imbalance

This inclusive planning framework recognises a need to understand factors driving the skills demand in the economy, taking into consideration the country's triple challenges of poverty, unemployment and inequality. Specifically, the report examined the following key themes: a) skills in demand within the South African labour market; b) the sectors within the economy in which those skills are in demand and those sectors that are not absorbing labour or have a reduced demand for labour; and c) the graduates produced by post-schooling educational training and the relevance, or lack thereof, to the skills in high demand within the labour market.

The LMIP reports have, thus, been insightful in highlighting trends at the national level. These may be of benefit to the maritime sector, while being cognizant of the sector's unique needs, challenges and context.

Notwithstanding the commendable framework generated by the LMIP studies, and in particular the 2016 report, an interest of the present paper is in subjecting the study's findings (as in the 2016 report) to a further theoretical analysis. This is done in order to help determine the extent to which the report and its analysis engages relevant labour market theoretical perspectives, especially with respect to the contemporary labour markets. It is important to recognise how these markets function and how they have changed in the context of global competition and the attendant technological innovations. This is especially so as a better account of skills, their demand and supply for the labour market, requires an understanding of the nature of labour markets and how they function. This cannot be adequately addressed with only empirical evidence but also requires consideration of theoretical perspectives of contemporary labour markets. As Wallace and Wolf⁸ aptly

⁷ Ibid.

⁸ RA Wallace & A Wolf *Contemporary Sociological Theory* (1980) at 3.

pointed out, social theory concerns itself with real life situations and experiences, enhancing an understanding of how the world around us works. Calhoun et al.⁹ too argued, with reference to sociological theory, that it not only guides inquiry towards generating answers to social questions, but also helps the researcher to pose a new set of questions under changing circumstances, leading to further inquiries and development in the theory itself for improved knowledge of the social world.

As with social life in general, an account of labour markets and the dynamics around them can best be achieved through the creative deployment of both the empirical evidence and the theoretical perspectives. Guided by this as a point of departure, this paper provides a theoretical analysis of the labour market with respect to the current body of knowledge on skills supply and demand in South Africa, as captured in the 2016 LMIP Report. An analysis of this report will be done with a view to identifying lessons for the maritime sector, in particular, as well as to guiding future studies. To this end, the paper begins with a brief outline of labour market theories, from classical to contemporary theories, in order to outline a framework for the subsequent analysis of the 2016 report. Based on the analysis, it is argued that, while the LMIP study's findings affirm key strands of labour market theory, it does not, however, explicitly and fully anchor its analysis within this theoretical context. Consequently, the analysis provided pays insufficient attention to the socially and structurally segmented nature of the labour market, specifically in the context of the influences of technological innovations and widening social inequalities. Given that the maritime sector has both national and global dimensions, such a nuanced analysis would be necessary. It would not only help in highlighting lessons for the sector, but also in enabling the sector to strategically position itself in order to contribute to the development of an effective skills planning strategy that would, in the long run, contribute meaningfully to the reduction of youth unemployment.

II Labour market theories in brief

Hopkins¹⁰ provides a comprehensive review of labour market theories from the classical to the contemporary approaches. The orthodox labour market theory of Adam Smith and David Ricardo, and its adapted version in the form of neoclassical labour market theory in our contemporary period, holds that the market forces have a determining influence on the behaviour of the labour market with respect to levels of employment and unemployment, as well as with respect to wages. They are of the view that an increase in capital accumulation (high profits) would lead to an increase in wage levels.¹¹ According to Smith and Ricardo, high economic growth rates result in higher rates of labour absorption and, therefore, higher employment levels. Hence, market forces, and specifically prices, are understood as being able to bring equilibrium to the labour market in terms of demand and supply of products, capital and labour.¹²

Other market determinants are what workers bring to the labour market (the supply side), i.e. their attributes, and that these determinants have an influence, not only on demand, but also on wage structures. Their assumption is that individual employees are free to make choices about preferred jobs from a wide range of options, based on their attributes and tastes, abilities and skills, and still be rewarded accordingly. These attributes are shaped by workers' educational and social class status prior to entering the labour market.

The classical and neoclassical perspective on the labour markets was, however, challenged by Karl Marx¹³ in his labour theory of value in which he identified two main classes, namely the capitalists, who own capital, and the workers, who own nothing but their labour power sold in return for a wage. The capitalist class, Marx argued, will always seek to maximise profits through the accumulation of surplus value, while paying workers a subsistence wage.¹⁴ In so doing, the owning class ensures that there is a reproduction of cheap labour that is solely dependent on waged employment for survival. This implies that, contrary

⁹ C Calhoun et al. *Classical Sociological Theory* (2012) 3 ed.

¹⁰ M Hopkins 'An Overview of Major Theories of Labour Market Mismatch' in M Hopkins *Labour Market Planning Revisited* (2002) 35–60.

¹¹ Ibid.

¹² Ibid at 41.

¹³ K Marx *Capital* (1967) Vol 3.

¹⁴ Marx cited in Hopkins op cit note 10.

the neoclassical theorists' assertions about the primacy of market forces, it is the capitalist owning classes that 'dictate both employment and wage levels'¹⁵ Consistent with this Marxist perspective was the contribution by Lord Keynes,¹⁶ for whom an equilibrium within the labour market is dependent on the aggregate supply function, the propensity to consume and the volume of investment. Unlike the neoclassicists, who believed in the self-corrective influences of market forces, Keynes was of the view that for such equilibrium to be reached, the state would need to actively intervene to help grow levels of employment.¹⁷

A further and, indeed, subsequent critique of the neoclassical theory was led by Leontaridi¹⁸ in his argument that there is no direct link between workers' productivity capabilities (their attributes) and wages. Rather, he argues, firms are agents that structure the system of employment through institutional constraints pertaining to pay formation. Leontaridi further argues that a labour market is not a single competitive market but has varieties of non-competing segments. Within these segments, rewards differ due to institutional barriers which prohibit all parts of population from benefiting equally based on educational and training levels.¹⁹ Leontaridi's critique builds on the earlier Marxist critique led by John Stuart Mill and John Cairnes, who placed greater emphasis on institutional rules as substituting for market processes, wherein institutional factors put a brake on pay and employment levels.²⁰

This criticism is in line with the segmented labour market theory pioneered by Doeringer and Piore, in terms of which there are two distinctive segments. These are the primary labour market segment, in which workers characterised by skilled and semi-skilled jobs

with security, job mobility opportunities and higher wages; and the secondary labour market segment, characterised by low or unskilled jobs, less security and low wages.²¹ This theory alerts us to the socially structured nature of the labour markets, which further discredits the notion that an equilibrium can be reached through the work of market forces. Worth noting in this critique of the neoclassical theory is the reference made by Hopkins in support of Ben Fine's views on the contemporary labour market theory.²² Fine dismisses the notion of labour market equilibrium by mounting five criticisms. The first such criticism is where Fine argues that 'it is inappropriate to examine labour markets in terms of equilibrium economics since there is no reason to presume that the forces that operate within labour markets interact more or less harmoniously and efficiently to grind out equilibrium levels of employment and associated working conditions'.²³ The second and the third criticisms are Fine's affirmation of the segmented nature of the labour markets, wherein the segments are shaped by both the 'horizontal' factors (differentiation prevalent across the economic sectors) and 'vertical' factors (where differentiation occurs within particular sectors of the economy). This point about the horizontal and the vertical forces influencing the labour markets was echoed in Pigou's²⁴ argument that labour markets are segmented due to the competence, experience and skills differentials, as well as the restructured movement of labour between and within industries, giving rise to divergent wage rates; hence, dismissing the view that workers are always engaged in competition for jobs.²⁵ His fourth and fifth criticisms emphasise the *socially structured nature of labour markets*, where the structures are shaped by socioeconomic factors 'that arise out of the division between capital and labour and out of the profit imperative'.²⁶

¹⁵ Hopkins op cit note 10 at 40.

¹⁶ JM Keynes *The General Theory of Employment, Interest and Money* (1936).

¹⁷ Hopkins op cit note 10 at 44–45.

¹⁸ MR Leontaridi 'Segmented Labour Markets: Theory and Evidence' (1998) 12(1) *Journal of Economic Surveys* 63–101.

¹⁹ Ibid at 64.

²⁰ Ibid at 66.

²¹ Ibid; Hopkins op cit note 10 at 55.

²² B Fine *Labour Market Theory: A Constructive Reassessment* (1998).

²³ Hopkins op cit note 10 at 58.

²⁴ AC Pigou *Lapses from Full Employment* (1945).

²⁵ Leontaridi op cit note 18 at 67.

²⁶ Hopkins op cit note 10 at 58.

What is evident in this critique is the emphasis on the socially structured nature of labour markets, whereby *institutional barriers* (both horizontal and vertical as noted in the foregoing) exert great influence. This points to the existence of two components of the labour market, i.e., the *internal labour market* (ILM) and *external labour market* (ELM), that are separated by institutional factors.²⁷ The ILM is said to have arisen from the notion of skills specificity, which requires specialised training, recruitment and screening costs to fill high skill content vacancies with appropriate candidates. This requires employers to, as much as possible, embark on practices that help to minimise high turnover-related costs.²⁸ The ILM applies to jobs in the primary labour market segment. It is considered crucial for employment stability. Leontaridi²⁹ argues that there is further segmentation into the upper tier of corporations or firms organised bureaucratically within the primary markets and lower tier organised in simple bureaucracy that operate within the secondary market segments.

Another dimension of the labour market revealed within the theoretical discourse is that of what is referred to as *career labour markets* (CLMs) through which firms employ personnel strategies, i.e., rules on recruitment methods, reward and discipline procedures and monitoring of work. This is very similar to ILMs. CLMs are characterised as institutionalised hierarchical structures outside the ELM and are instrumental in wage setting, hiring and training of labour, in line with stable product demand. They are designed to protect career-oriented employees from external competition through on-the-job skills training, through internal promotion and through incentive systems for a high degree of loyalty and high performance. As a result, new recruits tend to only be absorbed in lower-level jobs.³⁰

Worth noting within the labour market discourse, and closely tied the foregoing observations, is the notion that became popular since the 1980s; the notion of *labour market flexibility*. While Meulders and Wilkin³¹ recognise that the concept has been presented as not easily definable by some writers, they, however, also note that, for others, it is precise and refers to 'adjustments of the labour force and hours of work to an economic situation which has become unstable and which fluctuates – or the possibility of bringing wages into line with the 'demands' of the economic situation ...'. The concept of flexibility, Meulders and Wilkin³² argue, drawing from earlier reflections on it by other scholars such as Boyer³³ and Atkinson,³⁴ pertains to or was necessitated by the imperative to respond and adapt to rapidly changing conditions. They identified four typologies of flexibility, namely *wage flexibility*, *numerical flexibility*, *technical-organisational flexibility* and *working time flexibility*. *Wage flexibility* refers the adaptation of wages to cyclical fluctuations in inflation, productivity and performance of firms, as well as to external shocks such as terms of trade. *Numerical flexibility* pertains to an adjustment in response to structural variations in demand and/or technological changes giving rise to new forms of employment aimed at reducing labour costs while boosting profits such as temporary work, fixed-term contracts or task-specific contracts. There is also *technical-organisational flexibility*, which refers to the adaptation of the management and organisational methods for renewal of products and the adoption of new technologies that may require new ways of using labour and human resources, such as job rotation, retraining and the reskilling and multitasking of workers. Finally, *working time flexibility* refers to the improved working and living conditions of workers through reorganisation of, e.g., hours of work, various forms of staggered work, overtime and compensatory leave and weekend work.³⁵

²⁷ Leontaridi op cit note 18.

²⁸ Ibid at 70–71 citing Doeringer and Piore (1970).

²⁹ Ibid at 72–74.

³⁰ Ibid at 76.

³¹ D Meulders & I Wilkin 'Labour market flexibility: Critical introduction to the analysis of a concept' in *International Labour Organization – International Institute for Labour Studies' International Symposium on Labour Market Flexibility Discussion Papers* (1991) 1–13.

³² Ibid at 2.

³³ R Boyer 'Labour flexibilities: Many forms, uncertain effects' (1987) 12(1) *Labour and Society* 107–129.

³⁴ J Atkinson 'Flexibility or fragmentation? The United Kingdom labour market in the eighties' (1987) 12(1) *Labour and Society* 87–105.

³⁵ Meulders & Wilkin op cit note 31 at 4–6.

In the final analysis, Meulders and Wilkin argue that flexibility measures within the labour market have resulted in increased unemployment because they resulted in the removal or easing of regulations regarding dismissals, thus 'indicating not a temporary or transitory imbalance between supply and demand but rather a phenomenon of a basically structural nature which has cast serious doubts of the availability of new jobs in which workers displaced from traditional sectors or from sectors in crisis could be employed.'³⁶

This theoretical framework, as already indicated in the introductory section, is going to be deployed in the analysis and critique of the HSRC's Labour Market Intelligence Project (LMIP)'s findings on the labour market situation in South Africa today, and especially the question of unemployment and skills-jobs mismatch. Of interest is to identify which of the various theoretical strands within the labour market theoretical discourse, as outlined above, best explains the South African situation today, i.e., whether it is the neoclassical perspective, which has been severely critiqued, the Marxist structuralist account or the extended versions of the latter in the form of the ILM, ELM and CLM? Or does the South Africa's labour market scenario depict a complex combination of all these, where some may predominate over others? To begin this analysis, it is necessary to present a summary of the LMIP's skills supply and demand report and its findings, which is done in the section below.

III HSRC'S Labour Market Intelligence Partnership (LMIP) Study's key findings

The LMIP study, referred to earlier in the introductory section in a brief overview, made observations about the skills mismatch within the South African labour market through its key findings. These findings are discussed in this section and then later analysed in the next section from the labour market theoretical perspectives.

In terms of skills in high demand and the economic sectors in which those skills are required; the study found that, for the most part, management, professional and

technical skills are in greater demand. Management skills in high demand are those for positions of chief executive officers; senior officials and legislators; administration and commercial managers; and production and specialised services managers. Those with post-schooling qualifications in areas of physical sciences, mathematics and engineering sciences, as well as those with qualifications in areas of health and teaching, are said to find it easier to join professional jobs, while technicians and associate professionals tend to find employment in the fields of sciences, engineering, health, business and administration.

The report found that basic education remains a challenge, where learners continue to leave school with poor levels of maths and language literacy. This means that skills supply is severely affected by low quality basic education because many of the programmes leading to occupations in high demand in the economy require graduates who are proficient in languages, maths and sciences.³⁷ The lower matric pass rates in mathematics and natural sciences, which is attributed to poor foundation laid for learners throughout schooling, was noted with concern. For instance, the study reports that each year, of the 140 000 matriculants or Grade 12 learners who pass, only just over 50 000 pass mathematics with grade higher than 50%. In 2014, specifically, the matric pass rate for those candidates with bachelor passes is said to have increased by 9%. Of the 130 000 matriculants who passed during this academic year, only just over 51 000 had mathematics and natural science subjects. The LMIP study found that this situation is exacerbated by the post-schooling educational training offered at universities and technical, vocational and educational training colleges (TVETs), which produce graduates with skills that are not congruent with those in high demand by the labour market. This was so despite a reported expansion in enrolments in both universities and TVETs. University graduates were found to be largely employed in high skilled jobs, such as managers, professionals, technicians and associate professionals, as well as in community, social and personal services, while only few TVET colleges graduates obtained similar high skills jobs.³⁸

³⁶ Ibid at 12.

³⁷ Reddy et al. op cit note 6.

³⁸ Reddy et al. op cit note 6.

Also observed was that, while female enrolments were higher than those for males, only a few female students registered for science, technology, engineering and mathematics (STEM) subjects and more females tended to register for health, education and social sciences subjects. Of all university graduates in 2014, 27.2% graduated with humanities degrees, 30% of the degrees were in science and technology studies and 42.8% of the degrees in business and commercial studies. All of this, the study concluded, points to a qualifications and skills mismatch with what is required in the labour market, since the greatest demand from the market seems to be for graduates in physical science, mathematics and engineering science.

The study demonstrated that the country is caught in a low growth trap. As far as economic sectors and their labour and skills demands are concerned, the study confirmed the previously made observations that revealed a general decline in the traditional economic sectors that historically served as the backbone of the economy, i.e., mining, construction, transport and personal services, and their share of the GDP. Rather, the sectors that showed double-digit growth are the wholesale, retail, manufacturing, financial and government sectors.

The study also revealed evidence of a skills mismatch, where half the graduates are employed in the community, social and personal services sector within the broader public sector. A high proportion of the science and engineering graduates work in financial services, rather than manufacturing. STEM qualifications are found to be versatile, enabling graduates with these qualifications to work in diverse other fields. The financial sector employs mainly managers, professionals, technicians, associate professionals, clerical support, service, sales and elementary workers. The wholesale and retail sectors were found to employ mainly clerical support staff, service and sales workers and elementary workers.

All this is found within the context of the growing crisis of unemployment in South Africa, exacerbated by the inherited apartheid-related racially skewed skills shortage. A recorded increase in employment was made between 2010 and 2014, with those employed having increased from 13.8 million to 15.1 million; however, the unemployed were recorded as having increased from 4.6 million to

5.1 million, while the number of discouraged work seekers was recorded at 2.4 million. Official unemployment increased from 24.9% in 2010 to 25.1% in 2014, while the expanded definition of unemployment stood at 35.3%. The youth are clearly the most unemployed, with 54.8% of youth being unemployed, most of whom with limited educational training. Of the unemployed youth, 60% had less than Grade 12 education. Only 42% of youth within this educational category are in employment. Of the unemployed youth, 89% are black Africans, while only 8% are coloured. An equal number of unemployed youths are either male and female.³⁹ Importantly, the study suggested that the skills policy needs to grow both high and low skills in the labour market. Whilst high skills are central to the country being able to compete in the global market, there is also a need to consider the skills developments of those in low skilled employment.

Based on the above findings, the LMIP study observed that it is difficult to make a forecast of how the demand for labour will evolve in future, as people constantly change jobs, learn new skills, relocate and move in and out of the labour force, as well as a change in working hours. Similarly, new firms are born, while others die out, altering the size and skill sets of the required workforce, necessitating the recruitment of employees with new strategic skills, as well as the upskilling of existing employees. This is attributed to ever increasingly complex and dynamic economies, influenced by different mega forces, such as the adoption of new technologies and changes in governmental policy frameworks. Hence the study's recommendation that, rather than planners trying to match vocational education and training to projected skills needs, planners should, instead, focus on identifying skills that are in growing demand and those categories in which replacement vacancies are likely to be large. This, the study proposes, can be done by acquiring local information from employers' associations, graduate destination surveys, recruitment agencies and other similar sources.

IV A theoretical response to LMIP findings

The HSRC's LMIP skills supply and demand report findings lead us to varied observations with respect to the relevance of various strands of the assertions of

³⁹ Reddy et al. op cit note 6 at 12–14.

labour market theories being confirmed, while also pointing out some missing insights from the study. The very notion of skills in demand versus skills not in demand lends credence to the neoclassical labour market theory's assertion about the primacy of the market forces in determining the behaviour of the labour market, including the skills needs and how they should be crafted to meet those needs. Similarly, the idea of sectors said to be growing at double-digit rates, within which there is high demand and labour absorption, especially of those with specific required skills, clearly points to a reaction to prevailing demand (both global and local) for the services and products produced by those sectors, as well as costs cutting considerations (i.e., running those economic sectors at minimal costs for maximised profit outcomes). This, once again, suggests the influence of market forces on the labour market.

An important question though is, is it only market forces at play here or are other factors active within the labour market influencing demand and supply, as well as employment and wage levels? What is missing in the LMIP study is a lack of attention paid to the role of structural and institutional factors, the role of the employers and the role of the changing nature of the labour markets, i.e., flexibility and segmentation dimensions, and the implications for skills requirements, employment and unemployment. This is so despite the evidence of the presence of these factors and dimensions, as revealed by the LMIP's empirical data. For instance, the study reports on economic sectors that have both experienced moderate to significant growth, and stagnant growth (i.e., neither did they collapse nor did they grow, but remained steady) between 1994 and 2014. These are, as presented by the Statistics South Africa's 2016 survey outcomes to which the study refers, the financial and business services (16% to 22%), wholesale and retail trade (14% to 15%), transport (6% to 9%) and construction (3% to 4%); all of which experienced single-digit growth. The Statistics South Africa survey also shows stagnation in agriculture (3%), personal services (6%) and utilities (3%); with declines recorded in the mining sector (16% to 8%), the manufacturing sector (16% to 14%) and the government services sector (20% to 17%) in the same period.⁴⁰

Notwithstanding, the recorded growth within some of the economic sectors, which are clearly in the majority compared to those that experienced decline and stagnation, occurred without the creation of new jobs. Any new jobs that were created were mainly in highly specialised and skilled categories. The Marxist perspective on the labour market would, and probably rightly so, attribute this to the profit imperative of capitalist economic business enterprises, where a greater emphasis is placed on profit maximisation and costs reduction. Such an analysis invokes strands within the labour market theory that point to the existence of the ILM and CLM practices through which employers and businesses employ recruitment rules that enable them to target specific skills that may only be realised through specialised training, recruitment and screening processes.

There is some concern, though, with some of the conclusions reached by the LMIP study with respect to the prescriptions proposed to remedy the skills mismatch within the contemporary South African labour market. That is, that educational and training institutions should enrol students in higher numbers and enrol students in the fields of STEM, as well as in the fields of building and construction, metal machinery and related trades programmes.⁴¹ The problem with this approach is its underlying assumption that if educational and training institutions can adjust their offerings in line with the requirements of the industries and therefore produce graduates with skills considered in high demand, this would necessarily result in higher labour absorption. Such an assumption, however, fails to draw on the insights shed by contemporary labour market theories that alert us to the responses of industries to competitive pressures presented by globalisation and new technological innovations. Such responses often took the form of labour market adjustment measures geared towards cost cuttings. What we learn from the contemporary labour market theories is that these new measures, termed flexibility measures, have resulted in increased unemployment because they remove and/or ease regulations regarding dismissals.⁴² Indeed, the LMIP study does note this reality in recognising a sharp rise in the use of temporary employment services (TES) within the South African labour market.

⁴⁰ Reddy et al. op cit note 6 at 9.

⁴¹ Reddy et al. op cit note 6 at 28.

⁴² Meulders & Wilkin op cit note 31.

It is on the basis of flexibility measures used by industries that contemporary labour market theorists, such as Fine, Pigou, Hopkins and Leontaridi, emphasise the socially structured and segmented nature of the labour, dismissing the notion of equilibrium being attainable only through self-corrective market forces. Instead, they advocate for State interventions with the view to correcting the flaws of market forces. This point is recognised by the LMIP study in its recommendation for a labour-intensive growth path to be led by the State through a revised industrial policy,⁴³ yet without vigorously pursuing this through a more qualitative in-depth analysis. It, therefore, seems necessary to initiate new studies on how business enterprises in South Africa have adapted their strategies and operations to the changed conditions imposed by globalisation and the new technologies. Such studies would also need to examine the impact of technological innovations introduced by the so-called the fourth industrial revolution (4IR) and the real possibilities and constraints to a much more labour-intensive industrial growth path.

V Concluding remarks

Before the LMIP, South Africa did not have a comprehensive system to assess and anticipate skills trends. The LMIP has successfully developed a foundation for undertakings that seek to identify and anticipate skills needs, as well as how best those needs could be met. While noting the significance of this contribution to skills planning initiatives, this paper, however, found some theoretical gaps in its analysis. For instance, while the LMIP report's findings address and affirm various strands of the labour market theories, its analysis has not, however, been fully and explicitly anchored within those theoretical frameworks and their rich insights into contemporary labour market dynamics and realities; specifically, and missing despite some cursory references made in the 2016 report, the inadequate attention paid to the nature of labour markets in the contemporary times, i.e., how labour markets have been restructured under the influences of globalisation and new technological innovations. These include the new forms of segmentation

within contemporary labour markets. Thus, the socially structured nature of labour markets and how these, together with what is referred as ILM and CLM, influence and explain labour market behaviour such as employers' recruitment practices and prioritisation of certain skills and subsequent implications for creation of new employment opportunities is inadequately addressed.

Notwithstanding, the LMIP study's important contribution to understanding of skills and labour markets, its inadequate application of and engagement with contemporary labour market theories remains its major shortcoming. The lesson the maritime sector may draw from the foregoing analysis, as the sector seeks to implement skills planning and employment creation plans, is to ensure that any such endeavours are guided by research and studies that aim to not only generate empirical data on skills in demand, but also on the intricacies of labour markets and especially within the maritime sector both globally and locally. The 2018 SAIMI report titled *Oceans Economy Skills Development Assessment for South Africa*,⁴⁴ which found a mismatch between the types of skills being produced and those required by industry, clearly addresses the imperative of skills in demand. The challenge now would be to work out strategies that would strike a balance between addressing this mismatch, while not placing obstacles to entry into the sector for the young and inexperienced graduates, especially if the sector is to make a meaningful contribution to the reduction of the worsening problem of youth unemployment in South Africa. Such strategies need to be anchored in an understanding of how contemporary labour markets function, i.e., in retaining and upskilling the current workforce for improved productivity and performance, while also providing opportunities for new entrants through targeted training as a joint effort to deliver high quality and relevant training programmes with educational institutions. Such an approach would enhance the realisation of the goals set out for the Operation Phakisa in the Oceans Economy⁴⁵ of successfully unlocking the economic potential of the sector and its job creation capacity.

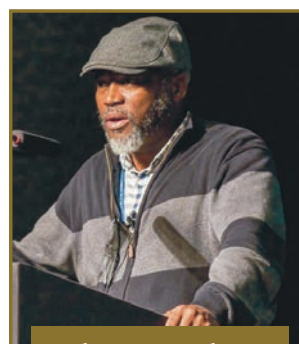
⁴³ Reddy et al. op cit note 6 at 30.

⁴⁴ SAIMI op cit note 2.

⁴⁵ SAIMI Conference Concept and Planned Outcomes 'Forward Thinking for Maritime Education and Training Excellence: Does the maritime skills supply match industry demand and offer entrepreneurial opportunities?' (2019) Durban, South Africa.

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A Proposed Education-Industry Partnership for Skills Development in the Marine Manufacturing Sector

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The marine manufacturing sector is a diverse and multi-faceted industry with a wide range of different skills sets that often overlap with other sectors. A few specialist qualifications have been developed but a disjuncture exists between industry and education who have difficulty in finding a common language to talk about skills partnerships.

Four studies between 2016 and 2018 focused on marine manufacturing and skills provision are reviewed and their key findings elucidated. The paper forefronts different conceptual frameworks underpinning skills planning, it questions who is responsible for the development of qualifications and curricula and lastly raises the divergent views of industry and education with respect to skills responsiveness and changing production contexts and innovations.

The paper concludes there is a need to narrow the gap between training provision and industrial work contexts. It is proposed that this could be achieved through strong leadership and well-resourced training provision that is responsive and flexible. The need for a mutual understanding needs to underpin any interventions such as group training models and relevant partnerships between industry associations and training providers.

Keywords: *marine manufacturing, skills planning, partnership, specialisation, upskilling, downskilling, innovation, reproduction, market demand, qualification*

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I Introduction

When examining skills development in the marine manufacturing sector, it is vital to have an accurate and mutually agreed upon definition of marine manufacturing. One of the challenges is that the sector is diverse and comprises different subsectors, including maintenance, repair, refit and overhauls, as well as ship and boat building. There is no distinct subset in the Standard Industrial Classification (SIC) codes and activities are spread across different SIC divisions. In addition to this, many companies

operating in the marine manufacturing sector also operate in other core sectors, for example, stainless steel fabricators, seating manufacturers and valve manufacturers and others, and the marine sector is a small part of their business.

Under the SIC division 30 for Manufacturing, there is 30110: Building of ships and floating structures and 30120: Building of pleasure and sporting boats.

Table 1 illustrates the exclusions of related activities which are still marine manufacturing related in nature.

Table 1: SIC Codes for Ship and Boat Building¹

SIC Code	Includes	Excludes	SIC Code
30110: Building of ships and floating structures	Building commercial vessels Building warships Building fishing boats Building fish processing factory vessels Building hovercraft Construction of drilling platforms Construction of floating structures Manufacture of sections for ships and floating structures	Sail manufacture Manufacture of ships propellers Manufacture of anchors Manufacture of marine engines Manufacture of navigation instruments Manufacture of lighting equipment for ships Specialised repair and maintenance of ships and floating structures Interior installation of boats	1392 2599 2599 2811 2651 2740 3315 4330
30120: Building of pleasure and sporting boats	Manufacture of inflatable boats and rafts Building of sailboats Building of motorboats Building of recreation type hovercraft Manufacture of personal watercraft Manufacture of pleasure and sporting boats (canoes, kayaks, rowing boats and skiffs)	Sail Manufacture Manufacture of anchors Manufacture of marine engines Manufacture of sailboards and surf boards Maintenance repair and alteration of pleasure boats	1392 2599 2811 3230 3315

A search of the SIC codes using the word 'marine' also reveals other marine manufacturing activities falling under different SIC divisions, namely:

- Marine spray painting 30110;
- Marine capstan manufacturing 28160;
- Marine hardware manufacturing 25930;
- Marine signal flare manufacturing 20291;
- Manufacture of lifejackets 1392.

A number of the skills needed in the commercial ship building industry also overlap with the oil and gas offshore

sector; boilermakers and welders being two common skill denominators. However, on the SIC code the extraction of crude petroleum and natural gas falls under the mining division.

Whilst recognising that SIC codes do not necessarily define the skills landscape for marine manufacturing, it does illustrate the complexity in reaching a commonly understood definition of marine manufacturing. Another factor influencing this definition is the production technologies employed. For example, at a rudimentary

¹ Source: Statistics South Africa StatsSA *Standard Industrial Classification of all Economic Activities* 7 ed (Pretoria, Statistics South Africa 2012) (available at <http://www.statssa.gov.za/classifications/codelists/Web_SIC7a/SIC_7_Final_Manual_Errata.pdf>, accessed on 6 January 2021).

level, ship building is a metal-based production process utilising what is termed 'frame and plate' processes, whilst the boat building industry largely builds from 'composites' and fibreglass using a 'plug and mould' process. In addition, for example, sail making, mast building, lifejacket manufacture and propeller manufacture use vastly different production technologies.

In 2005, the South African Boat Building Export Council, in partnership with the Manufacturing, Engineering and Related Services Sector Education and Training Authority (merSETA) initiated the development of a boat building learnership. This was registered in 2006 and underwent a substantive review in 2010, with False Bay College being the only training provider registered to offer the learnership at the time. Shortly thereafter, there was a call from industry to develop an 'apprenticeship' rather than a learnership, and boat building and ship building were gazetted as trades. Registration with the Quality Council for Trades and Occupations (QCTO) has been completed and awaits the successful registration of False Bay College as a trade test centre. Other generic artisanal skills training interventions, such as boilermaking, welding, joinery, spray painting and others, have continued to supply a generic skills set to the industry, with on-the-job learning offering the specialisation needed beyond the generic training. For specialist subsectors, such as sail and mast making and interior fit-out, on-the-job training has continued to meet the skills development needs. Current achievements, such as the Department of Trade, Industry and Competition (DTIC) pilot skills development intervention for the boat and ship building sector, funded by the National Skills Fund, are commendable and align with the Industrial Policy Action Plan (IPAP). So, at a systemic level within government, there is alignment of policy with some skills interventions for marine manufacturing. In addition, Nelson Mandela Bay University has developed a Bachelor of Technology in Marine Engineering. However, despite current interventions and the work of the South African International Maritime Institute (SAIMI) and others, there are still blockages in the skills provision pipeline in marine manufacturing.

The Operation Phakisa marine transport and manufacturing skills target in 2014 included the 'training of 18 172 learners as artisans, semi-skilled workers and professionals over the next 5 years'. As of 2019, SAIMI reported that 2 900 people had been trained in apprenticeships, learnerships and skills programmes for the marine transport and manufacturing industry, just 16% of the target. As chair of the Marine Transport and Marine Manufacturing Skills Development Working Group in 2015 and 2016, I noted an initial wave of industry participation but this rapidly waned. What stops the Operation Phakisa skills development working groups from being more effective and why does industry only participate in skills working groups for a short time, if at all? Is it possible to make the skills working groups more flexible and responsive to skills development needs and to implement training interventions in direct response to industry needs? Some of the answers to these questions lie in the complexity of the marine manufacturing value chain, locally and internationally, for both primary and secondary activities. This comes back to my opening point about the need for an accurate and nuanced understanding of the subsector and all the players, the high and low points of skills demand, the specificity of training interventions and industry uptake. There is also a need for a sustained effort and commitment to the long-term development of qualifications, as seen by Nelson Mandela University in the development of their marine engineering course that also paves the way for some form of naval architecture qualification being available in South Africa in future. This has not been an easy undertaking and has required significant allocation of resources.

Let us reflect back on the Operation Phakisa skills targets set in 2014 for marine manufacturing. For example, Initiative 9 set a target of 2 550 work-integrated learning (WIL) placements. This was based on assumptions such as a 6% gross domestic product (GDP) growth rate, three strategic integrated projects (SIPs) being implemented, the oil and gas sector strengthening and ship and rig repair increasing, along with an increase in boat repairs. Table 2 on the next page shows the following assumptions.

Table 2: Operation Phakisa Marine Transport and Manufacturing Assumptions²

ASSUMPTIONS 2014
6% GDP growth rate for marine manufacturing and transport (p. 7)
5 of 8 Strategic Integrated Projects (SIPs 1, 2, 3, 5 and 8) related to infrastructure projects in line with marine transport and manufacturing • SIP 1: Expansion of Richards Bay Port (p. 27) • SIP 2: New Durban Port (p. 27) • SIP 3: Saldanha Bay creation of a back of port industrial capacity (p. 27)
Strengthening maritime support for oil and gas on the African West Coast (p. 27)
Ship repair: Increase % of vessels calling from 13% to 38% (1650–3300) vessels, average vessel repair cost is R1.2m (p. 60)
Oil and Gas: # of African rigs is 80, 4 rigs repaired pa (5% of market), # of rigs increase by 20 each 5 years, average repair cost is R300m (p. 60)
Boat repair: Global boat repair is 10% of global ship repair value, ratio of boat repair to ship repair applies in South Africa (p. 60)

In 2017, as Deputy CEO, Strategic Projects, for SAIMI, I reviewed the marine manufacturing skills targets in light of these baseline assumptions (Table 2). The GDP growth rate had slowed to less than 3%, less than half

the projected growth anticipated in 2014, and other than maintenance and refurbishment of existing Transnet National Ports Authority (TNPA) facilities, less than half of the anticipated targets had been achieved.

Table 3: Performance of Marine Transport and Manufacturing Operation Phakisa Targets 2017³

RELATED OPERATION PHAKISA PROJECTS THAT MAY HAVE INFLUENCED SKILLS TARGETS	% achievement
Establish purpose-built oil and gas port infrastructure (Berth 205 and Moss gas quay)	0%
Maintain and refurbish existing facilities	87%
Implement strategic prioritised projects Richards Bay	0%
Implement strategic prioritised projects East London	9%
Create and implement a public procurement and localisation programme	45%

It is, therefore, clear that inaccurate baseline assumptions and slow progress on projects over the first three years of Operation Phakisa are a reality and this has an impact on skills development and the targets set and also illustrates a need for review.

II Studies

A number of studies have been done to date, which provides insights for possible solutions to skills development for marine manufacturing.

A 2016 study into the economic impact of marine manufacturing, commissioned by the then Marine Industry Association of South Africa (unpublished), had four key findings with respect to skills development in the sector. First, whilst we have the capacity for general skills training, there is a need for specialisation that relates to new industry equipment and machinery and to work processes that are constantly innovating. Secondly, companies train on-the-job for their own specific needs. Thirdly, there are cross-sectoral skills sets and, fourthly, there are skills shortages at a management and business

² Source: Department of Planning, Monitoring and Evaluation (DPME), Republic of South Africa. 'Operation Phakisa: Unlocking the Economic Potential of South Africa's Oceans, Marine Transport and Manufacturing' (2014) Powerpoint presentation 20140702_SAOc_MTM_FactPack_MS.pptx.

³ Source: Department of Planning, Monitoring and Evaluation DPME 'Operation Phakisa: Unlocking the Economic Potential of South Africa's Oceans, Marine Transport and Manufacturing' (nd) (available at <<http://www.operationphakisa.gov.za/operations/oel/marineTrans/MTMPerformance/Pages/default.aspx>, accessed 22 September 2017).

management level with marine specialisation and experience.

The second study was the Human Sciences Research Council's (HSRC) Labour Market Intelligence Partnership (LMIP) Theme 6 study by Gamble,⁴ which looked at understanding changing artisanal identities. The study used a sociology of knowledge approach and focused on the demand side of work and qualifications for the future. One of four artisanal focus areas in the study was boat building (one occupation in marine manufacturing). The study aimed to understand work sites as specialised contexts in terms of labour process, and large and small work sites were examined. What the study found is that there is a concomitant upskilling and downskilling process taking place with work of risk and work of certainty, respectively. It also found that on-the-job training is still the preferred mode of education and training, while supplier training is an emerging trend. A key finding of the study was that different levels and types of apprenticeship will be needed to serve this simultaneous upskilling and downskilling of artisanal work. This will not sit comfortably with education planning because it finds that a single artisanal qualification will not be sufficient, and multiple entry and exit points are needed, which is considered to be a challenge. On-the-job training will suffice for highly standardised work and short courses will need to be given space and acknowledged as part of artisanal training.

The third study is my own Master's thesis, which looked at the mix of theoretical and practical knowledge and examined whether the South African boat building learnership meets the dual demands of innovation and reproduction for increasing global competitiveness.⁵ The study found two different knowledge bases underpinning skilled and semi-skilled work in boat building and that the competency based modular training (CBMT) format of the qualification favours procedural knowledge over principled or theoretical knowledge. The qualification gives a level of technical language and, during workshop learning time, there is a limited craft methodology taking place.

The last study was the Ernst and Young Employer led partnership proposal commissioned by SAMSA

and SAIMI, which starts to elucidate some practical solutions for an education industry partnership for marine manufacturing.⁶ The study proposed recruiting standard artisans into the industry and training them with the requisite specialisation skills. Recruits could also be brought in from other sectors and be provided with customised training for marine manufacturing. A third proposal was to recruit new learners into specialised apprenticeships in boat and ship building and structure quality on-the-job learning, whilst using suppliers to support training and drive innovation in the industry. The strategic focus areas identified by the Ernst and Young study were the sourcing of experienced artisans from other sectors, incentivising large employers to train for the market, supporting small employers to provide structured WIL and provide support for specialist on-the-job modules and learning. It is important to highlight that there are differences between large and small employers and skills development proposals need to be tailored to their respective needs in order to accommodate the differences. Lastly, the budget outline proposed for the partnership illustrates that a significant financial commitment is needed to make such a partnership work.

III Discussion

A number of solutions to an education industry partnership for skills provision in the marine manufacturing sector are presented in the above-mentioned four studies. It triggers key questions: Is there a need for a labour forecasting model?; What conceptual framework is best suited to marine manufacturing?; and Does it look substantially different to other sectors?

The Ernst and Young study locates itself strongly in a market demand-driven skills planning model, which says that the market must determine the skills shortage. This model strongly forefronts the key role of basic education and puts a high value on data collection. One must ask how effective we are in collecting data to predict a market demand. In fact, the Organising Framework for Occupation codes are often not aligned to job titles in industry and many small companies are not submitting annual training reports and

⁴ J Gamble 'Work and qualifications futures for artisans and technicians' (2016) Labour Market Intelligence Partnership Report 19.

⁵ V Davidson 'Facing Both Ways' an Investigation of the Mix of Situated Knowledge and Formal Knowledge in Boat Building (Master of Philosophy in Education dissertation, University of Cape Town 2019).

⁶ Ernst and Young 'How can the marine manufacturing industry release the binding skills constraints facing the sector? Industry and skills research report' (2017) Study commissioned by the South African International Maritime Institute.

work skills plans (WSPs) to their relevant Sector Education Training Authority (SETA). If we do not have strong data on skills training in the marine manufacturing sector and if our basic education system has challenges, can we effectively implement a market demand-driven skills planning model?

The LMIP, on the other hand, proposes an inclusive socio-economic skills planning approach for South Africa. These two studies, undertaken by Ernst and Young and LIMP, locate themselves at different points along a spectrum; the first being entirely market-driven and the second driven by socioeconomic imperatives. This raises the first question of where the marine manufacturing sector locates itself conceptually in terms of skills development. Is it just a market imperative driving skills intervention or is there a social development imperative, or both? And, if so, what are the respective weightings of these two imperatives?

A second question is what needs to change if the current skills being produced do not meet industry demand? This locates us back in the market-driven approach, but should industry be the ones writing qualifications and developing curriculum when we have credible education and training institutions, underpinned by globally recognised quality assurance bodies? It seems that current training institution skills provision is too generic and training institutions are not keeping up with new industry developments as they struggle to deliver under budgetary restrictions. There is a myriad of complexities when considering what to change to meet industry demand.

Thirdly, what is industry's participation in skills development when their focus is on production? In my experience, this devolves to an industry association representative, unless there is a crisis and then industry gets involved; however, industry are often uninitiated into the structures and jargon of training, unless they work in the human resources department. I have seen, first-hand, attempts by training providers and industry representatives to find common ground in understanding learnerships, apprenticeships, work-integrated learning, different quality assurance bodies, logbooks, portfolios of evidence and more. It is difficult just getting a common understanding, let alone taking the next step of curriculum development and institutional planning. As an example, in a recent study done for the merSETA into the plastics sector,⁷ I observed

the divergent positions of higher education and industry. Higher education sees their core focus as principled learning and developing higher-level analytical skills, and they feel that industry does not appreciate the generic skills of graduates. Industry, on the other hand, says graduates do not have relevant industry exposure and business acumen.

IV Conclusion

To develop an education industry partnership for marine manufacturing, strong leadership is required to drive the processes. This leadership must be well-resourced and able to respond swiftly with training interventions, yet without onerous qualification development processes and quality assurance mechanisms. The leadership must have the respect of industry, and a true partnership will require industry to commit to understanding and investing in the education and training of people in their employment and in their prospective employment pipeline.

It is quite possible that a group training model that mobilises and utilises lead employers could work. For example, Robertson and Caine, who manufacture recreational catamarans and employ 1 700 people, could partner with other entities, such as Harambee, who help bridge the divide between training and gainful sustained employment. An opportunity exists to link with industry associations and State-owned enterprise training divisions, to develop specialist training in order to address the higher-level skills shortages. It is also vital that there is a better geographical spread of training interventions for marine manufacturing. The partnership must be flexible but at the same time have regular monitoring and evaluation, as well as a review of baseline assumptions. In this way, four years after the planning for Operation Phakisa skills interventions, we are not left with unrealistic targets that no longer align with the reality on the ground. Dedicated resources and operational financial flexibility are critical for the success of a partnership along with key champions who have the sector's needs at heart.

For marine manufacturing, the TVETs and universities of technology (UoTs) are critical partners, as the majority of training required by industry is at the artisanal and technician level; whilst also acknowledging in the

⁷ V Davidson & C Garish 'What is the shortfall or lack of plastics technicians and plastics engineers in South Africa and what can be done to address the problem?' (2018) Study commissioned by the Plastics Chamber, merSETA.

longer term a need for university course developments for professionals, should there be sufficient demand to warrant the investment.

TVETs have a long history of vocational training and, systemically, they have a particular way of doing business; however, there is a need for continuous capacity building to stay relevant. Getting lecturers out of the college and into the workplace to upskill them, as industry innovates with processes, design and equipment, is key. So, too, is the transition back into the teaching and learning space and how lecturers incorporate that new knowledge into an evolving curriculum that becomes a living document and not a facsimile of a qualification. Likewise, if my thesis⁸ finding that CBMT favours procedural knowledge in boat building is also applicable in other occupational training programmes for marine manufacturing, how do we ensure that theoretical knowledge, problem-solving and craft knowledge have the requisite balance in artisanal training programmes?

Having run a marine industry association for a number of years, I acknowledge that this paper is, in all likelihood, biased towards industry and, therefore, has its limitations. However, the paper contributes to setting out the existing studies that have been done and the key questions they have raised. In this paper, some broader conceptual questions were asked to question where we position ourselves in the education debate. The paper highlighted the disjuncture between industry and education and the difficulty of finding a common language to talk about an education-industry partnership. Suggestions about ways to ensure that a partnership works, including leadership, were presented. Finally, in light of the changing nature of work and manufacturing, driven in large part by global influences, going forward, it is suggested that narrowing the gap between training provision (qualification and curriculum) and the specialised work context is important, even though education and work have different drivers.

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⁸ Davidson op cit 5.



Applying Systems Thinking Approach to Enterprise Development

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In an increasingly complex, turbulent and rapidly changing environment, enterprise development actors have their hands full in designing and delivering effective enterprise development programmes. While enterprise development is a complex system, it also interacts with the education system and labour market systems, among other systems, thereby increasing the number of actors/agents within these systems, their interrelationships and their connectedness. To address this increased complexity, this paper argues for a systems thinking approach to enterprise development. The authors will discuss systems thinking concepts, the structure of enterprise development and their related systems. Three causal loop diagrams and systems thinking archetypes are used to discuss enterprise development.

Keywords: *enterprise development, systems thinking, complexity, systems thinking archetypes, systems structure, causal loop diagrams*

1 Introduction

Enterprises, as employers, play a critical role in skills development, including in the maritime sector. Enterprises provide on-the-job and off-the-job training, are investors in learning and provide the workplace experience for trainees and graduates. As motivation for investing in skills development, enterprises seek to boost sustainable competitiveness, social fairness and resilience. The enterprises in the maritime sector play an important role in the absorption of skills provided by ecosystem players such as technical and vocational colleges, universities and other skills development providers. Enterprises also play

an important role in shaping the demand for skills, hence a systems thinking approach to enterprise development is necessary.

In its 2014 report,¹ the Maritime Sector Skills Technical Task Team (MSSTTT) identified that the skills supply within the maritime sector is inadequate. In respect of the demand for skills, the sector employed about 316 000 in 2010 and this number is expected to increase to about one million in 2033. However, this will only happen if there are adequate interventions made to address challenges within the sector to ensure growth. One of the biggest challenges in the sector is skills development.

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¹ Human Resources Development Council of South Africa HSRC *Maritime Sector Skills Technical Task Team (MSSTTT) Report: Advancing skills development in the maritime sector* (Pretoria, Human Resources Development Council of South Africa 2014) 4–9.

In an increasingly complex global market environment, enterprise development practitioners need to reassess their enterprise development strategies and design choices on a regular basis in order to effectively respond to their clients.² An enterprise development approach that adopts a holistic approach would be more effective when responding to contemporary challenges than the conventional approach that only looks at a part of the problem.

Through desktop research, this paper reviews features of systems thinking within the context of creating and growing sustainable businesses amid challenges brought by globalisation, uncertainty, rapid changes in technology and business models, amongst others. This paper also seeks to aid practitioners with an understanding of the systems thinking approach to enterprise development. First, systems thinking is defined with examples. Secondly, actors and agents in the enterprise development system are explained. Thirdly, systems structure and causal loop diagrams (CLPs) are discussed. Lastly, three systems thinking archetypes, namely fixes that fail, shifting the burden and drifting goals, are explained and coping mechanisms are discussed with the aid of CLPs.

II Defining enterprise development and systems thinking

Every State has the responsibility to identify ways to facilitate economic growth, and enterprise development is commonly identified as the greatest tool to stimulate the economy and create jobs. Given the need to design and deliver effective enterprise development programmes and

the huge amount of money put into these programmes, a greater understanding of the enterprise development system structure, the actors/agents, their interrelationships and their interconnectedness is essential as part of systems thinking.

(a) Enterprise Development as Complex Systems

Executive Education at Stellenbosch University³ defines enterprise development as ‘the act of investing time and capital to help individuals establish, expand or improve business’. The main goal of enterprise development is to create sustainable businesses that grow, which leads to job creation, which, in turn, contributes to the economic growth of the country.⁴

Systems thinking is an innovative way of seeking to understand the reality that emphasises the relationships between a system’s parts, rather than the parts themselves. Stakeholder participation is essential for system design, and the support and interaction of stakeholders would help to solve many societal problems.⁵ The sheer number of stakeholders and subsystems affecting enterprise development, such as education, labour, finance, regulator, and fiscal systems etc, makes enterprise development an extremely complex system and the connection between stakeholders and systems cannot be overlooked. Arnold and Wade⁶ argued that the ability of our world’s citizens to perform effective systems thinking should be encouraged and is extremely important to the world’s future. Bosch et al.⁷ posit that conventional approaches have become ineffective in addressing many complex problems that are facing the world today. Figure 1 on the next page is an example of an enterprise development actor drawn from many other systems.

² KE Maani & RY Cavana *Systems Thinking, System Dynamic: Managing Change and Complexity* 2 ed (Rosedale, Pearson Prentice Hall 2007).

³ Executive Education, University of Stellenbosch ‘The Impact of Enterprise Development in South Africa’ (2018) University of Stellenbosch Blog (available at <<https://usb-ed.com/blog/the-impact-of-enterprise-development-in-south-africa/>>).

⁴ A Elias & R Cavana ‘Stakeholder analysis for systems thinking and modelling’ Paper presented at the 2000 35th Annual Conference of the Operational Research Society of New Zealand, 1–2 December, 2000 Victoria University, Wellington, New Zealand.

⁵ N Nguyen & O Bosch ‘A Systems Thinking Approach to identify Leverage Points for Sustainability: A Case Study in the Cat Ba Biosphere Reserve, Vietnam’ (2013) 30(3) *Systems Research and Behavioral Science* 104–115.

⁶ RD Arnold & J Wade ‘A definition of systems thinking: A systems approach’ (2015) 44 *Procedia Computer Science* 669–678.

⁷ Nguyen & Bosch op cit note 5.

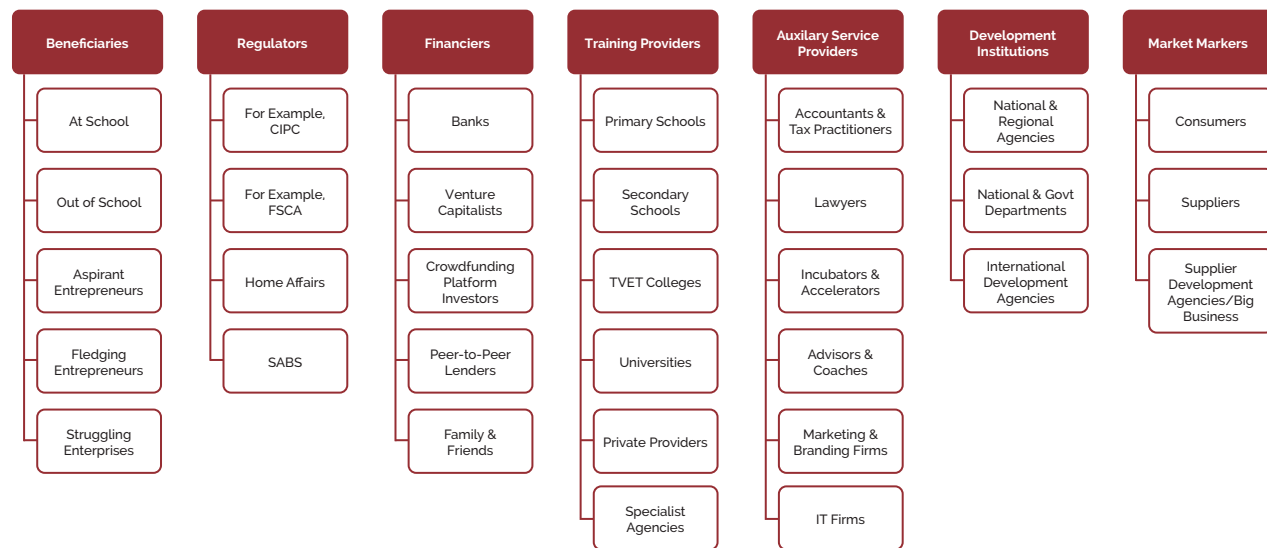


Figure 1: Actors Within the Enterprise Development System

(b) Systems Thinking Approach

There are many definitions of systems thinking. According to Senge,⁸ systems thinking is the ability and practice of examining the whole rather than focusing on isolated problems. Rebovich⁹ views systems as 'a framework for solving problems based on the premise that a component of an entity can best be understood in the context of its relationships with other components of the entity, rather than in isolation.'¹⁰ Nguyen and Bosch¹¹ define systems thinking as 'scientific methodology or an approach that consists of a set of principles and tools to deal with complexity, ambiguity and mental models underlying our most present social, economic, ecological, and political challenges'. It appears that engaging in systems thinking helps to identify points of leverage within the system that are likely to result in desired system change, for example, enterprise development system enabled by enhanced education system, relaxed regulations, accessible support agencies and funding.

(c) Systems Thinking Approach to Enterprise Development

The literature is limited when it comes to systems thinking in enterprise development. However, scholars

are beginning to realise the need to apply systems thinking in enterprise development programmes. It has become clear that solutions towards enterprise development that consider all the system elements and actors, as depicted in Figure 1, seeking leverage could result in the desired changes and impact. Applying the system thinking framework helps ask and answer the question: What interventions in the enterprise development system are likely to bring about the future most preferable? To effectively respond to this question requires an understanding of the enterprise development and related systems structures.

III Understanding system structure in the context of enterprise development

Gharajedaghi¹² describes system structure as 'the network of relationships that create behaviour and the essence of structure is not in things themselves but in the relationship of things'. In a typical enterprise development programme with many stakeholders, as depicted in Figure 1, the system structure, therefore, comes in various forms, such as education and training, conferences and networking,

⁸ P Senge *The Fifth Discipline: The Art and Science of the Learning Organization* (Vancouver, Langara College 1990).

⁹ G Rebovich *Systems Thinking for Enterprise: New and Emerging Perspectives* (Bedford, Mass, The Mitre Corporation 2005).

¹⁰ Ibid.

¹¹ Nguyen & Bosch op cit note 5.

¹² Gharajedaghi *Systems Thinking, Managing Chaos and Complexity, A Platform for Designing Business Architecture* 3 ed (Amsterdam, Morgan Kaufmann 2012).

business support services, access to markets interventions and access to finance and licensing, to mention but a few. Kwamie, Van Dijk and Agyepong¹³ assert that a lack of consideration of the context into which interventions are introduced minimises their effectiveness. Thus the education system and market systems are critical in enterprise development. Since structure is about the relationships and interconnectedness between actors in the system, therefore, a structural observation should include casual connection, not just a list of forces or elements of a system.

It is clear that each part of the systems within the larger enterprise development systems are first to be understood individually and in terms of their effects on the entire system. For instance, how would a change in entrepreneurship education approach likely affect the success of the enterprise development endeavours. Will such change require modifications to the enterprise development programme design? Within the enterprise development systems, are there larger systems that directly impact the enterprise development system? These systems are: the education system, labour market system and regulatory and policy system policy and regulatory system and markets system.

(a) Education System on Enterprise Development

Empirical research supports positive links between investing in entrepreneurial activities and economic growth.¹⁴ It has been shown that (i) the effect of general education as measured in years of schooling on entrepreneur performance is positive¹⁵ and (ii) business training is effective for the performance of people who applied for microfinance to start their business.¹⁶ For enterprise development outcomes to yield the desired outcomes, it is imperative that the education system

interventions are implemented. Teaching ‘about’ entrepreneurship means a content laden and theoretical approach that aims to provide a general understanding of the phenomenon. It is the most common approach in higher education institutions.¹⁷

Teaching ‘for’ entrepreneurship means an occupationally oriented approach aiming at giving budding entrepreneurs the requisite skills and knowledge. Teaching ‘through’ entrepreneurship means a process-based and often experimental approach, where students go through an actual entrepreneurial learning process.¹⁸ Gibb¹⁹ proposes that, in order for entrepreneurial education to be embedded into the education systems, it should be ‘child centred in primary education, subject centred in secondary education, vocational centred in further education and discipline centred at university’. The education system, particularly entrepreneurial education, is vital in improving business acumen and set the scene for enterprise development interventions.

From a practitioner perspective, entrepreneurial education is critical to the success of enterprise development programmes. The enterprise development reinforcing feedback loop shown in Figure 2 explains the continuous chain of influence or cause-effect. Today’s entrepreneurial education has become an important part of both industrial and educational policy in many countries.²⁰ This is a classic example of interconnectedness of the enterprise development system and the education system.

(b) Labour Market System on Enterprise Development

The labour market is a complex system made up of many actors, including education and training

¹³ A Kwamie, H van Dijk & IA Agyepong ‘Advancing the application of systems thinking in health: realist evaluation of the Leadership Development Programme for district manager decision-making in Ghana’ (2014) 12(1) *Health Research Policy and Systems* 1–2.

¹⁴ CM van Praag & PH Versloot ‘What is the value of entrepreneurship? A review of recent research’ (2007) 29 *Small Business Economics* 351–382.

¹⁵ Ibid.

¹⁶ S Karlan & M Valivvia ‘Teaching entrepreneurship: Impact of business training on microfinance clients and institutions’ (2006) 93(2) *Review of Economics and Statistics* 510–527.

¹⁷ ES Mwasalibwa ‘Entrepreneurship education: a review of its objectives, teaching methods, and impact indicators’ (2010) 52 *Entrepreneurship + Education* 20–24.

¹⁸ P Kyro ‘A theoretical framework for teaching and learning entrepreneurship’ (2008) 2 *International Journal of Business and Globalisation* 39–55.

¹⁹ A Gibb ‘Entrepreneurship and enterprise development in schools and colleges: insights from UK practice’ (2008) 6 *International Journal of Entrepreneurship Education* 48.

²⁰ U Hytti & C O’Gorman ‘What is “enterprise education”? An analysis of the objectives and methods of enterprise education programmes in four European countries’ (2004) 46 *Education + Training* 11–23.

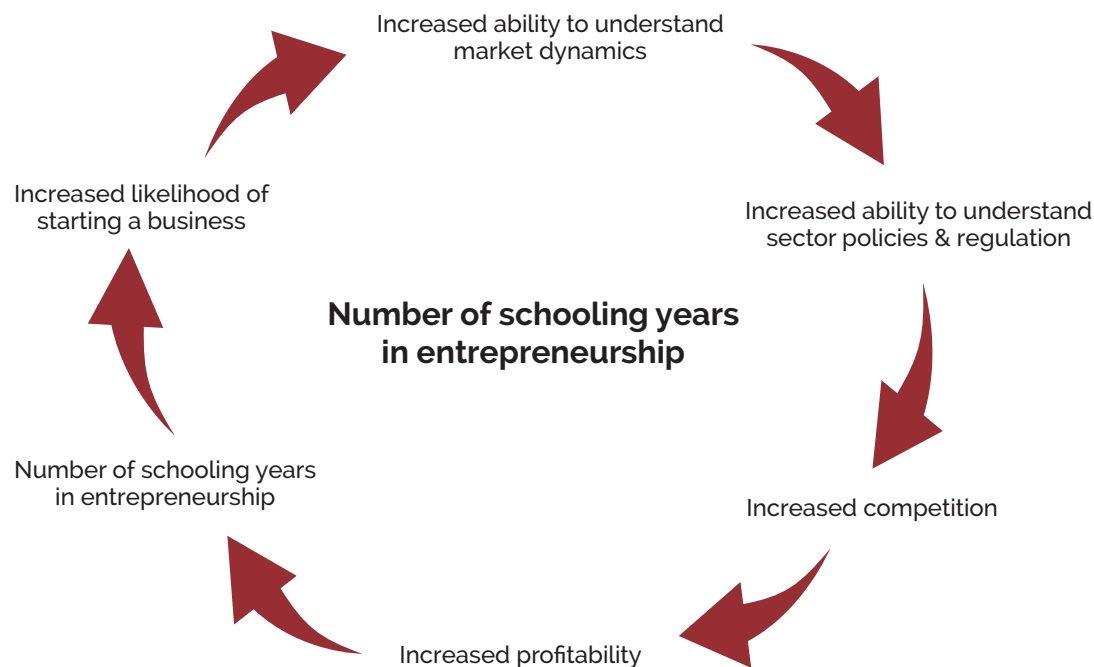


Figure 2: Causal Loop Diagram – Enterprise Development Reinforcing Feedback Loop

institutions, recruitment service providers, labour policies and remuneration structures etc.²¹ Enterprises being developed as part of enterprise development programmes will be operating within this complex, turbulent and uncertain environment. Kwamie et al.²² suggest support for longer term, more reflective and potentially unpredictable capacity strengthening approaches. It is required of labour market participants, including enterprise development practitioners, to have a futuristic view of the supply and demand mechanisms of the labour. Questions such as what kind of skills will be required into the future become relevant. According to Kwamie et al.,²³ enterprise development practitioners will inevitably need insights into future education and skills dynamics. This supports the systems thinking view that enterprise development should look at things from a 'whole' system view, with the view that education and

skills development is fundamental in producing positive enterprise development outcomes. Collaboration between enterprise development practitioners and education system actors is, thus, paramount.

(c) Policy and Regulatory System in the Enterprise Development

According to Botha et al.,²⁴ the regulatory environment and related legislation and compliance were identified as primary prohibitors of business start-up and growth. Research has shown that government policies relating to taxes and business regulations often affect entrepreneurial activities negatively.^{25 26 27}

The policies and regulations put by the government impact the entrepreneurial activities negatively from inception right through to the end. For instance, the

²¹ VB Zulu 'Enterprise Development in Coastal and Marine Tourism' (2019) Workshop and Experts Group Meeting on Coastal and Marine Tourism 06 May 2018, Durban, KwaZulu-Natal, South Africa.

²² Kwamie et al. op cit note 13.

²³ Ibid.

²⁴ A Botha et al. 'Challenges, barriers and policy development for South African SMMs – does size matter?' (2020) *Development Southern Africa* 1–22.

²⁵ ZJ Acs & L Szerb 'Entrepreneurship, economic growth and public policy' (2007) 28(2–3) *Small Business Economics* 109–122.

²⁶ WD Bygrave & J Timmons *Venture Capital at the Crossroads* (Boston, Mass, Harvard Business School Press 1992).

²⁷ SF Kreft & RS Sobel 'Public policy, entrepreneurship, and economic freedom' (2005) 25 *Cato Journal* 595.

time it takes to get company registration or licensing, to the tax system impacting on levels of investments and profitability and the cost of complying with regulations etc, is cumbersome. It is important that enterprise development practitioners and key stakeholders consider the implications of existing and proposed legislation/policies when designing or implementing enterprise development programmes. The relaxation of the policy and regulatory systems will affect the education and skills systems and the labour market systems, among other systems. The cost and ease of doing business will improve as a result. Where applicable, practitioners need to make an effort to shape the policies and incentives. Where there are capacity building elements of the enterprise development programmes, there needs to be content and services offered to entrepreneurs to enable them to better cope and, in some instances, take advantage of enabling legislation, policies and incentives.

IV Discussion: systems thinking enterprise development using a causal loop diagrams

Causal loop diagrams (CLDs) provide a language for articulating an understanding of the world. Understanding the factors affecting each of the subsystems and elements of a system, on one hand, and the motivations of each of the actors within the system, on the other hand, are becoming necessary. Leverage points are places within a complex system 'where a small shift in one item can produce big changes in everything'.²⁸ As Barile et al.²⁹ contend, there is a need to develop 'new tools and methods for making better decisions and aligning stakeholders in an increasingly interconnected world with numerous, complex, urgent problems'. CLDs are but one of the tools to understand the complex systems. In this instance, enterprise development, as shown in Figure 3.

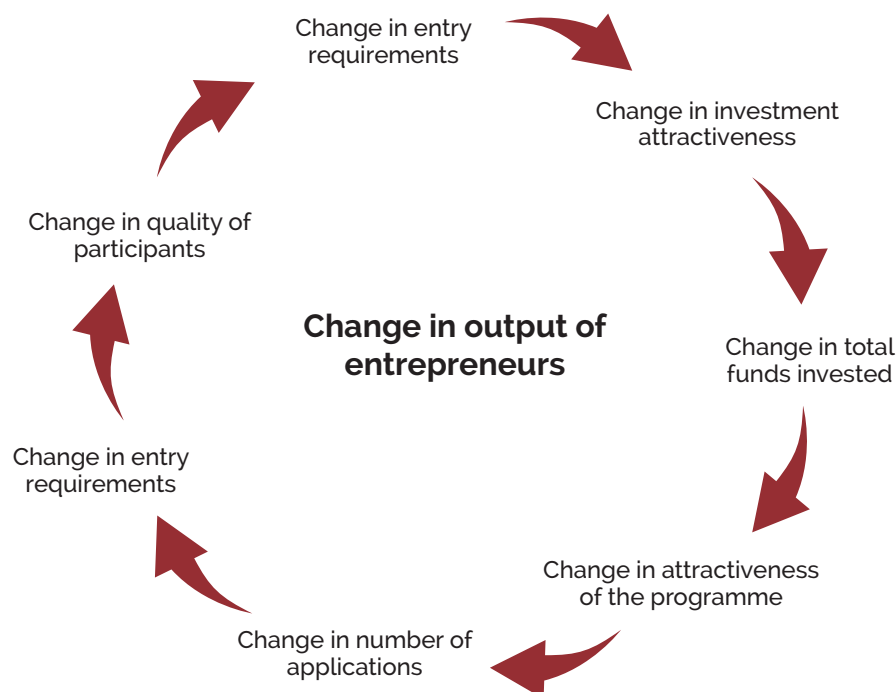


Figure 3: Causal Loop Diagram: Change in Entry Requirements of Enterprise Development Programme

²⁸ D Meadows *Leverage Points: Place to Intervene in a System* (Hartland Four Corners, VT, Sustainability Institute 1999).

²⁹ S Barile et al. 'Systems, networks, and ecosystems in service research' (2016) 27(4) *Journal of Service Management* 652–674.

The CLD in Figure 3 captures the factors that, if changed, would have the biggest effect on the intended outcomes of the issue at hand. The kind of questions that would require to be answered when drawing up CLD are, for example, What would happen overall if we change the entry requirements for entrepreneurs entering the enterprise development programmes? What would happen if we changed the support offered to entrepreneurs in the enterprise development programme? What would happen if there were changes to the funding of enterprise development programmes? What would be the effect of changes to the taxation of small enterprises (fiscal policy changes)? And what would happen if there was a change in the approach to the education system? After accessing each CLD archetype, enterprise development can be best explained by the three archetypes, namely fixes

that fail, shifting the burden and a drifting goals system. Each archetype is explained in detail in the following section.

V System archetypes in the enterprise development

(a) Fixes that Fail Archetype

The fixes that fail archetype is a fix, effective in the short term, has unforeseen long-term consequences which may require even more use of the same fix.³⁰ The archetype, which is shown in Figure 4, contains one balancing loop – the ‘fix’ – that decreases the problem in the short term. The unintended consequences of the fix often take longer to occur, which increases the problem in a self-reinforcing way in the long term.

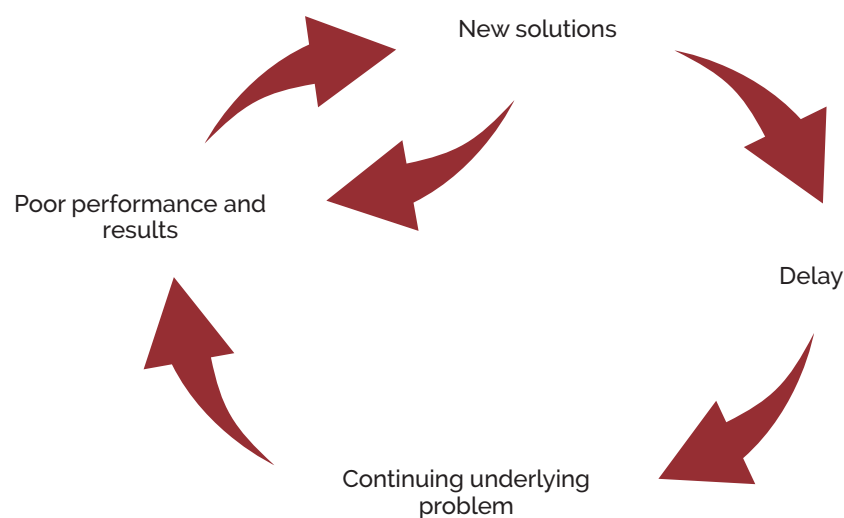


Figure 4: Fixes that Fail³¹

Suppose the perceived challenge within an enterprise development programme is that entrepreneurs lack entrepreneurial acumen. Enterprise development practitioners can incorporate the acumen in their training, however, this increases the costs of the programme and takes resources away from other actions necessary to ensure the success of the programme. Over time, as more resources move away from other points of leverage, say improving market

access, for example, the enterprise development programme can become less successful. It is important that solutions to possible problems in enterprise development are understood to potentially have short-term and long-term solutions. These need to be implemented simultaneously, with emphasis on understanding the potential unintended consequences of any fixes. As indicated, the use of CLDs to plot the factors affecting the enterprise development

³⁰ Senge op cit note 8.

³¹ Source: Adapted from W Braun 'The System Archetypes' *The Systems Modeling Workbook* (Published online <http://www.uni-klu.ac.at/gossimit/pap/sd/wb_sysarch.pdf> 2002).

programme can result in a better understanding of each of the factors and identify better points of leverage. For example, in the lack of entrepreneurial acumen element,³² (i) the effect of general education as measured in years of schooling on entrepreneur performance is positive, therefore, it will be systematically better to address entrepreneurial acumen by embedding entrepreneurship education as early as primary school, all the way through university.

(b) Shifting the Burden Archetype

The shifting the burden archetype is focused on how the systems deal with problems symptoms without

addressing the underlying problems. According to Mclean et al.,³³ 'this systems archetype is often seen when a problem is addressed by applying a symptomatic solution, which acts to divert attention from fundamental solutions'. The shifting the burden system archetype is often used to attempt to understand a problem in order to generate solutions. Similar to the fixes that fail system archetype, any attempt to define the root cause of the problem or intervention moves resources, the attention or the intervention away from a more suitable solution and, at a later stage, the situation deteriorates.

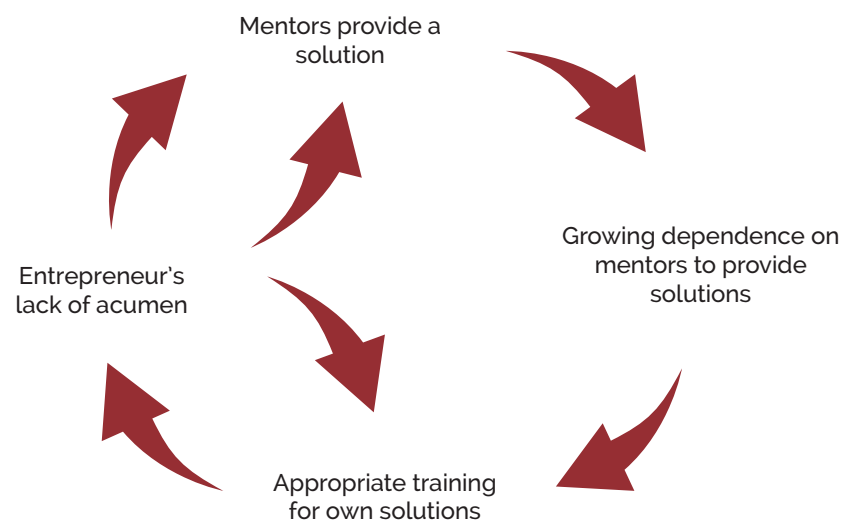


Figure 5: Shifting the Burden System Archetype³⁴

Looking at Figure 5 above from an enterprise development point of view, shifting the burden could be, for example, when entrepreneurs participating in an incubation programme fail to develop their product-market fit, mentors and other partners, such as accountants, for example, may end up doing or outsourcing the work that the entrepreneurs should be doing themselves, diminishing their ability to solve the challenge in the short-term. Over time, the entrepreneurs will be incapable of solving the problem themselves when they are no longer part of the incubation programme. Ultimately, when programmes

are evaluated further down the line, there could be 'failed' programmes. To address this archetype, it would be better for more capacitation and do-it-yourself kind of support made available to entrepreneurs. Entrepreneurs would be more resilient and the programme would have a longer-term positive effect on entrepreneurs who went through the programme.

(c) Drifting Goals System Archetype

The drifting goals archetype is classified as a theory-building archetype because it attempts to rethink how

³² J van der Sluis & M van Praag 'Education and entrepreneurship selection and performance: A review of empirical literature' (2008) 22(5) *Journal of Economic Surveys* 795–841.

³³ S Mclean et al. 'Beyond the Tip of the Iceberg: Using Systems Archetypes to Understand Common and Recurring Issues in Sports Coaching' (2019) 1 *Frontiers in Sports and Active Living* 49 at 6.

³⁴ Source: Adapted from Braun op cit note 31.

the structure of the system could be enhanced so that the intended goal does not have to be lowered.³⁵ First, a goal is set. When results are monitored or evaluated, the goal is not met. The simplest way to overcome this is to lower the goal. The lowered goal is then achieved, creating the impression

that the goal has been met. This has huge consequences, since, according to Kwamie et al.,³⁶ the gap between short-term and mid-term outcomes is particularly important given that decisions to scale-up interventions are frequently based on their success in the short term.

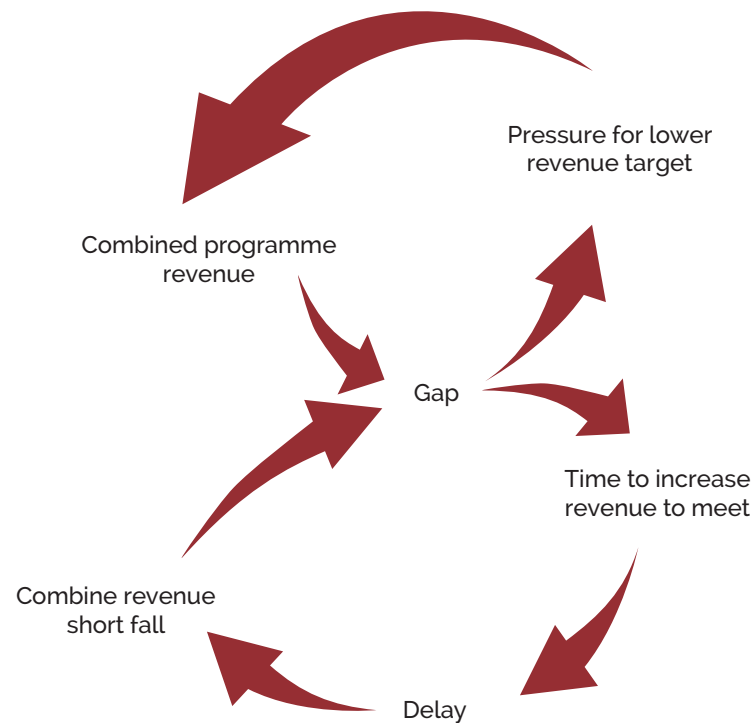


Figure 6: Drifting Goals System Archetype³⁷

The effect of the drifting goals system archetype on enterprise development programmes is poor performance over time. For example, if the target of the enterprise development programme was the combined enterprise value of all enterprises being a certain amount, or that the total number of jobs created is a certain number, as the goal is lowered, less efforts will be made and, over time, the programme can be killed by sponsors who may have had bigger goals in mind. Ultimately, when compared to other programmes, the programme could deteriorate further, and call to question the very existence

of the programme. There are no winners in that scenario. It would be far better for enterprise development actors/stakeholders/practitioners to revisit what was initially influencing the setting of the programme's goals, and to assess the appropriateness of those goals set.³⁸

VI Conclusion

Enterprise development is a very complex system that interplays with many other systems, such as the education system, the labour market system and the policy and

³⁵ DH Kim *Systems Archetypes I: Diagnosing Systemic Issues and Designing High-Leverage Interventions* (Waltham, MA, Pegasus Communications 1993).

³⁶ Kwamie et al. op cit note 13.

³⁷ Source: Adapted from Braun op cit note 31.

³⁸ Braun op cit note 31 cited in S Mclean et al. 'Beyond the Tip of the Iceberg: Using Systems Archetypes to Understand Common and Recurring Issues in Sports Coaching' (2019) 1 *Frontiers in Sports and Active Living* 49.

regulatory system, to mention but a few. This raises the question of how to create and grow sustainable businesses amid challenges brought about by globalisation, uncertainty and the rapid changes in technology and business models, among other challenges. Clearly, the education and training system becomes critical and, within itself further, questions arise as to what kind of talents and skills will be supplied by the education system. These are complex problems that require a systems thinking approach. To this end, this paper discussed enterprise development as a complex system. The related systems, particularly the education and labour market systems, were explained in the manner in which they relate to enterprise development. Three CLDs were presented, showing the systems thinking archetypes and how the systems thinking archetypes can be used to understand enterprise development from a systems structure perspective. It is clear that lasting solutions should be sought for more effective enterprise development outcomes from systems thinking.

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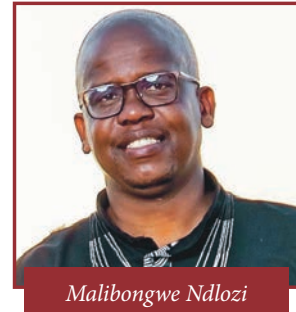
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What Skills and Capacity Building Interventions are Required to Grow the South African Aquaculture Sector?

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Aquaculture is a knowledge- and technology-driven sector that requires a diversity of skills. Such skills are often demonstrated by professionals, including those of veterinarians, biologists, oceanographers, chemists, economists, managers, engineers, artisans, environmentalists and researchers. Since the sector is still fairly small in South Africa, a limited number of institutions provide aquaculture training and their primary focus is on tertiary education. Extension support is also limited in terms of state extension officers, veterinarians and researchers (government does not have the capacity to service the entire sector) and there is little awareness of aquaculture farming as a career and education option.

In 2017, a thorough skills inventory and needs analysis of the sector was conducted, led by the South African International Maritime Institute (SAIMI) and the current Department of Forestry, Fisheries and the Environment (DFFE).¹ These research efforts were aimed at identifying the shortfalls and future needs in terms of skills and education and training, as well as determining the current age representation and race participation in the industry. Data collection was conducted using interviews and focus groups.

The study identified scarce skills and existing gaps, such as supervisory and management skills for middle and senior managers in the sector. Increased awareness of learnerships and funding opportunities through the Sector Education Training Authority (SETA) was flagged.

Keywords: *aquaculture, skills, training, capacity building*

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I Introduction

During Operation Phakisa, which focused on 'Unlocking the Economic Potential of South Africa's Oceans', which took place in 2014, various aquaculture stakeholders committed to ambitious aspirations in terms of job creation, production, contribution to gross domestic product (GDP) and inclusivity.² In order to reach these aspirations, it was acknowledged that it is imperative that the skills requirement of the existing and future aquaculture sector is addressed.³

Skills were identified as a constraint to the economic growth across all the Operation Phakisa Oceans Economy laboratories, a forum where over 180 stakeholder groups from public and private sectors, civil society, industry and academia participated. The Department of Higher Education and Training (DHET) was tasked with leading the skills development aspects across the sectors.⁴ The DHET subsequently appointed the South African International Maritime Institute (SAIMI) to facilitate and coordinate the various skills working groups for the laboratories. The Aquaculture Skills Working Group (ASWG) identified that there was a need to do a thorough skills audit and needs analysis of the aquaculture sector, an update from the benchmark study conducted in 2009,⁵ to further inform skills interventions holistically.⁶

II Aims and objectives of the study

The aim of the study was to identify the shortfalls and future needs in skills, education and training, as well as determining the current age representation and race participation in the aquaculture sector, in order to provide information for the detailed skills interventions required to realise the Operation Phakisa Oceans Economy aspirations.

The objectives of the research were to:

- Create a baseline to measure the impact of interventions on the aquaculture sector;
- Identify critical and scarce skills required for the aquaculture sector;
- Prioritise and guide the development of the qualifications that are required for the aquaculture sector; and
- Inform the interventions required to grow the skills base of the aquaculture sector to meet current and future demands.

III Methodology

(a) Overview of Research Design

The methodology used in the study was both qualitative and quantitative. A qualitative research methodology was used in the study to create an understanding of experiences from the stakeholder's perspective.⁷ The study included a desktop review of relevant documentation, as well as the use of questionnaires and focus group interviews.

(b) Desktop Review

The initial step included a desktop review to establish the best practice for the aquaculture skills inventory and needs analyses previously conducted in South Africa, other African countries and worldwide. The desktop review furthermore helped establish what education, training and skills initiatives are being advertised on the internet, via public sector providers and private companies, as well as by education institutions.

A total of 18 documents were reviewed and used as a guide to complete this survey. These documents included seven documents related to aquaculture needs analyses conducted in Africa; seven documents related to aquaculture needs analyses conducted internationally; and four documents related to education, training and skills (South Africa).

² Department of Planning, Monitoring and Evaluation (DPME), Republic of South Africa 'Operation Phakisa: Unlocking the Economic Potential of South Africa's Oceans, Aquaculture' (nd) at (available at <<https://www.operationphakisa.gov.za/operations/oel/aquaculture/Oil%20and%20Gas%20Documents/Lab%20Documents/OPOceans%20Aqua%20Final%20Lab%20Report.pdf>>, accessed 13 October 2020).

³ Ibid.

⁴ Ibid.

⁵ L. Botes, G. Thompson & R. Louw *Benchmarking survey of the South African Aquaculture Sector (Marine & Freshwater)* (Cape Town, Aquaculture Institute of South Africa 2009).

⁶ Department of Agriculture, Forestry and Fisheries *Operation Phakisa: Unlocking the Economic Potential of South Africa's Oceans. Department of Agriculture, Forestry & Fisheries Aquaculture Year One Review Oct 2014 – Oct 2015* (Cape Town, Department of Agriculture, Forestry and Fisheries 2016).

⁷ L. Palinkas et al. 'Purposeful sampling for qualitative data collection and analysis in mixed method implementation research' (2013) 42(5) *Administration and Policy in Mental Health and Mental Health Services Research* 533–544.

(c) Questionnaires

After the initial desktop review, four questionnaires were designed and sent to stakeholders to be completed and returned. Questionnaires were designed around the objectives of the study. The questionnaires were structured to elicit demographic data (gender, age, education and work experience in the aquaculture industry), followed by 11 questions relating to skills, education and training in the aquaculture industry.⁸

(d) Focus Group Interviews

The questionnaires made provision for focus group interviews. The four questionnaires were designed for aquaculture farm assistants and aquaculture farmers on farms; middle and senior managers; human resource managers; experts, education providers and others. The occupation levels reported on are according to the occupation with the associated Organisation Framework of Occupations (OFO) codes and are presented in Table 1.

Table 1: OFO Occupations Reported on in the Survey

BROAD GROUP	OCCUPATION	Excludes	SIC Code
MANAGERS	Aquaculture Farm Manager (131201)	Factory Manager	For the purpose of this survey, managers have been grouped together and reporting is based on the occupation Aquaculture Farm Manager (131201). Where relevant, specialist knowledge and skills have been dealt with separately. An Aquaculture Farm Manager, with OFO code 2015-131201, is described as performing the following duties: - Plans, organises, directs, controls and coordinates the operations of a small manufacturing establishment. - Plans, directs and controls farming operations to breed and raise fresh and saltwater fish and other aquatic stock.
		Abalone Farm Manager	
		Aquaculture Hatchery Manager	
		Fresh Water Aquaculture Farm Manager	
		Mariculture Farm Manager (sea-based)	
PROFESSIONALS	Agriculture Scientist (213202)	Animal Husbandry Scientist, Animal Nutritionist,	Studies commercial plants, animals and cultivation techniques to enhance the productivity of farms and agricultural industries.
	Marine biologist (213107)	Aquatic Biologist	Studies the anatomy, physiology, functions, characteristics, behaviour and environments of all forms of life living in the sea and connected water bodies.
	General Aquaculture Scientist (R&D)	No OFO code	
	Veterinarian (225101)	Animal Doctor Veterinary Epidemiologist Veterinary Parasitology Veterinary Pathologist Veterinary Surgeon	Diagnoses, treats and prevents animal diseases, ailments and injuries.
	Agriculture Consultant (213201)	Agriculture Extension Officer (213201)	Advises farmers, businesses, rural industries and government on the production, processing and distribution of farm products.

⁸ S Einarsson 'FISHFARM Project, Needs Analysis Report' (2013) Project No 2012-TR1-LEO05-35110 *Fishfarmeurope*.

TECHNICIANS AND ASSOCIATE PROFESSIONALS	Aquaculture Produce Manager (325704)		Analyse aquaculture produce for quality and conformance with technical produce standards and regulatory provisions.
SKILLED AGRICULTURAL, FORESTRY, FISHERY, CRAFT AND RELATED TRADES WORKERS	Aquaculture Farmer (622101)	Aquaculture Farm Foreman	Plans, organises and performs farming operations to breed and raise fresh water fish and other aquatic stock.
		Aquaculture Production Supervisor	
		Fish Production Foreman	
		Hatchery Foreman	
		Hatchery Manager (Fresh Water Fish)	
	Mariculture Farmer (622102)	Hatchery Manager (Marine Fish/ Aquatic Stock)	Plans, organises and performs farming operations to breed and raise salt water fish and other aquatic stock such as abalone, crayfish, mussels, oysters and prawns.
		Mariculture Farm Foreman	
		Mariculture Production Supervisor	
ELEMENTARY OCCUPATIONS	Education	Education and Training Service Provider	Provides education and training to the aquaculture industry, this can be an individual or an organisation.
		Aquaculture engineering/system design consultant	Provides advice to aquaculture farmers on the design, building and maintenance of aquaculture systems

(e) Stakeholder Sampling

Potential stakeholders were identified through various channels, such as the DFFE database; internet search for organisations and contact details; referrals and introductions through people who have an established relationship with potential stakeholders; and aquaculture-related associations. Associations were contacted and arrangements were made to present the project to the members at association meetings.

The following subsectors of the aquaculture industry were targeted, namely abalone, oysters, mussels, trout, ornamental farms, tilapia, koi carp, marine finfish and marron crayfish. A minimum of two farms/service providers in each subsector were sent the questionnaires. Farms were sent the senior and middle management questionnaire and the human resources questionnaire. Arrangements were then made to visit the farm and conduct interviews with aquaculture farm assistants and aquaculture farmers (in focus groups). Professionals, those who do not directly work on farms but who are working in the aquaculture industry, as well as stakeholders identified in education, training and skills development related to aquaculture, were sent the 'Experts/

Others' questionnaire to complete and return via email. A total of 65 farms from the freshwater (45) and marine (20) sectors were contacted to take part in the survey. The marine aquaculture sector represented 69% of farms visited, namely farms farming abalone, dusky kob, mussels and oysters, and a salmon processing factory.

Where possible, farms in different provinces on which the same species was farmed were visited and individuals were interviewed in focus groups (e.g., a trout farm in Western Cape and a trout farm in Mpumalanga). In terms of the value stream of the sector, two of each of the following service providers were targeted, namely (a) veterinary, (b) aquaculture, (c) feed manufacturer and (d) aquaculture engineering/system design services. Other stakeholders included aquaculture product marketing and distribution services, food safety and quality assurance. Education and training providers included public sector and private institutions, as well as independent service providers and academia.

Farms were visited and focus group interviews were conducted. Each focus group interview consisted of a group of 4 to 12 participants. The participants were, as

far as possible, interviewed in groups from a specific functional area of the farm on which they worked, such as hatchery, grow-out, processing, technical or maintenance. Where possible, aquaculture farmers/forepersons were interviewed in separate groups. A total of 36 focus group interviews were conducted with aquaculture farmers and aquaculture farm assistants.

Table 2 indicates the number of focus group interviews per subsector and occupation category. A total of

171 interviews were conducted across the 16 farms visited. A total of 21 managers in the marine and freshwater sectors, combined, were either interviewed or completed the middle/senior management questionnaire. A total of 12 service providers and industry specialists were represented in the study. Each focus group interview lasted approximately 45 minutes to one hour. Between two and five focus groups were interviewed per farm, depending on the number of employees per farm.

Table 2: Number of Focus Group Interviews per Subsector of Aquaculture and Occupation Category

Occupation Group	Abalone	Other Mariculture	Freshwater	Total
Aquaculture Farm Assistant	15	5	4	24
Aquaculture Farmer	6	3	3	12
Total	21	8	7	36

(f) Data Collation and Analysis

Focus group interview data and data from completed questionnaires were entered into Excel spreadsheets, where quantitative and qualitative data were included in the findings. Data from spreadsheets were used to create graphs to assist with data analysis.

IV Results and discussion

(a) Stakeholder Engagement

The abalone subsector was the most represented sector, with 55% of farms visited being from this subsector; 27% of the farms visited represented offshore oyster and mussel production; while 18% were represented by dusky kob production and a salmon processing factory. Freshwater farms visited where workers were interviewed represented 31% of the total number of farms visited. The freshwater sector was represented by koi, tilapia, trout, ornamentals and catfish; each sector had equal representation. In an attempt to better represent the freshwater aquaculture industry, individuals who are considered specialists in this field were contacted and requested to complete an 'Expert/Other' questionnaire. Among these experts were farmers who were not willing to have their workers interviewed but were willing to give their input. Responses from a total of seven freshwater industry specialists were received. The specialists represented the following subsectors:

trout: two; tilapia: two; koi: two; and ornamentals: two. The inclusion of industry specialists meant that there was better representation of the freshwater sector of the aquaculture industry, with marine and freshwater aquaculture industry responses representing 58% and 42% of all responses received, respectively.

(b) Demographic Data per Employment Category as per the OFO

When comparing the overall race figures, there is a correlation between the representation of the interviewees and the figure presented in the Agricultural Sector Education Training Authority's (AgriSETA) 2016 Sector Skills Plan. When the race figures are split into the various occupation categories, namely aquaculture managers and aquaculture professionals, on the one hand, and aquaculture farmers and aquaculture farm assistants, on the other, the figures suggest that racial transformation is slow in the categories of aquaculture farm manager and aquaculture professionals across all the subsectors of aquaculture, with mostly whites are in these positions (Figure 1). Racial transformation appears to be taking place at a more rapid pace among aquaculture farmers and aquaculture farm assistants, with mostly Africans or coloureds in these positions (Figure 1). The ratio of Africans to coloureds varies, depending on the specific subsector of the industry and is believed to be largely influenced by the geographic location of farms.

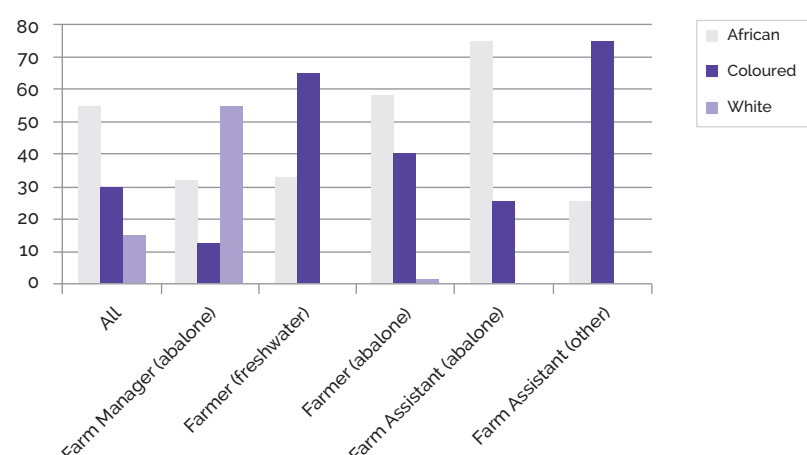


Figure 1: Demographic Data per Employment Category as per the OFO

(c) Gender Representation

Data representing all respondents in this survey indicates that 64% of the respondents were male and 36% were female. According to AgriSETA, the male to female ratio for agricultural labour is fairly consistently found to be 2:1 (Figure 2). The Statistics South Africa (StatsSA) data is corroborated by Workplace Skills Plan (WSP) data submitted by employers in 2016, which shows that 62.8% of the employees engaged in various occupations within the agriculture sector were male. The male to female ratio in this survey, thus, closely resembles the data from AgriSETA and StatsSA. This ratio presents an opportunity for initiatives to attract more females to both the marine and freshwater sectors of the aquaculture industry in South Africa.

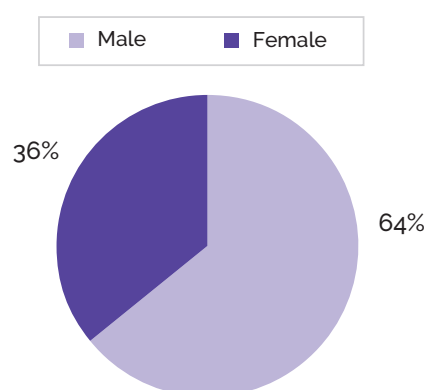


Figure 2: Gender Representation in the Aquaculture Sector

(d) Age Representation

The data from those represented in this survey is more closely related to the data from the agricultural sector, with 54% of the respondents being under 35 years old, 45% being 35–55 years old and 1% being over the age of 55.

Stakeholders commented on the need for skills transfer from those exiting the workforce to those coming up the ranks. The issue of unskilled youth presents a difficulty for skills transfer because some base level qualification is needed to enter the skilled workforce in the first place. This presents challenges for skills development, due to the double hurdle of experienced employees exiting at a rate not able to be matched by the numerous youth demographic who seek employment.⁹

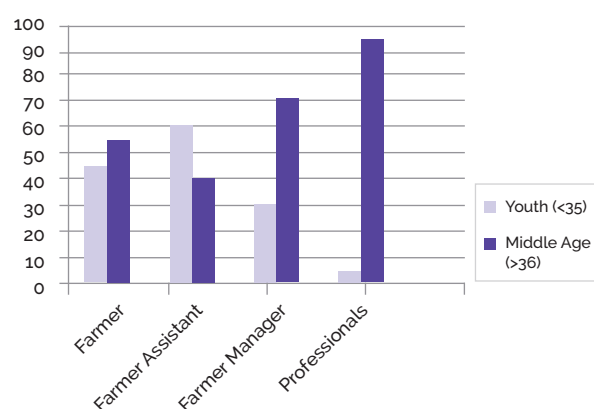


Figure 3: Age Representation in the Aquaculture Sector

⁹ Agricultural Sector Education Training Authority AgriSETA *AgriSETA Sector Skills Plan* (Pretoria, AgriSETA 2016) (available <https://www.agriseta.co.za/wp-content/uploads/2021/02/AgriSETA-Agriculture-SSP_DIGITAL.pdf>, accessed 13 October 2020).

(e) Level of Education Attained

Education level attained is reported as in StatsSA education reporting. General Education and Training (GET) indicates completed education attained from Grade R to Grade 9. Further Education and Training (FET) indicates education attained from Grade 10 to Grade 12 and any further education and training completed. Higher Education and Training (HET) indicates education attained at a tertiary institution.

The results illustrated in Figure 4 show that 14% of those surveyed had attended General Education and Training (GET); of these, 64% had completed Grade 9, with 36% having completed Grade 8 or less. Those having attended FET represent 67% of those surveyed, with 57% having completed Grade 12 or an FET qualification. Those who attended HET represent 19% of the respondents, with 33% of these having achieved a masters or higher degree.

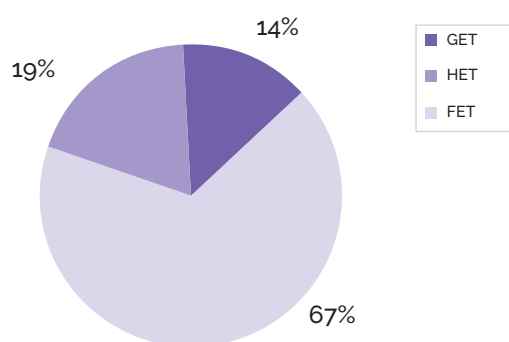


Figure 4: Education Level of all Respondents Surveyed in the Marine and Freshwater Aquaculture Sectors

(f) Education, Training and Skills Development

Of the organisational responses received, the majority of smaller farms do not pay the skills development levy (SDL) and are not affiliated with a sector education and training authority (SETA).¹⁰ When asked what their understanding of the SDL and SETAs was, most respondents were aware of the SDL but not of the minimum thresholds to pay the levy and how to access the SETAs' support services. The reason given for this was the perception that it is only for large organisations. There is very little to no formal training occurring in these smaller organisations. It was noted that most training taking place is training that is needed to comply with legislation, in order to meet occupational health and safety standards.

Larger organisations, particularly those in the abalone industry, pay SDL and belong to the AgriSETA. These organisations also complete WSPs and submit ATRs. Each of these organisations (farms) offer training opportunities to their employees. There are three types of organisations: (1) SETA accredited external training provider; (2) in-house training done by the farm; and (3) external providers that are not SETA accredited.¹¹ Organisations affiliated to a SETA have indicated approximately 55% of training interventions on offer are accredited. The study indicated that there are four private institutions, one non-profit institution, four government institutions, ten universities and four agricultural training institutes offering various forms of training in aquaculture.¹² In 2019, the DFFE published a brochure called the 'Aquaculture Skills Programmes (short courses) Available in South Africa', which provides an indication of the training providers who conduct training in the field of aquaculture.¹³

¹⁰ The Skills Development Levies Act (No 9 of 1999) (SDLA) established a compulsory levy scheme for the purposes of funding education and training as envisaged in the Skills Development Act (No 97 of 1998) (SDA). The levy became payable with effect from 1 April 2000. DHET, in conjunction with the various SETAs, is responsible for administering the Act, while the South African Revenue Service (SARS) is responsible for the collection of levies. Employers who are liable for payment of the SDL to SARS have to nominate the SETA related to their core business upon registration. SDL is paid monthly to SARS, together with pay as you earn (PAYE) and Unemployment Insurance Fund (UIF) contributions. SARS then allocates this money to the relevant SETA. Any employer exempt from SDL payment can apply for discretionary grants.

An employer is exempted from paying the SDL if the total leviable amount of all its employees over the next 12 months is less than R500 000.

Employers who are exempted from paying the SDL are also exempted from submitting an ATR or a WSP. For more information on SDL exemption, please contact your closest SARS office. For updated information, please refer to <<http://www.AgriSETA.co.za/>>.

¹¹ Department of Forestry, Fisheries and the Environment DFFE *Aquaculture Skills Programmes (Short Courses) Available in South Africa* (Cape Town, Department of Environment, Forestry and Fisheries 2019).

¹² Ibid.

¹³ Ibid.

During focus group interviews, aquaculture farm assistants and aquaculture farmers were asked about their awareness of training interventions offered by their organisations. The level of awareness was largely dependent on the emphasis that each organisation places on training and skills development. When comparing what the interviewees listed to what the organisations listed as training interventions, a general trend was, however, observed, with aquaculture farm assistants having the understanding that far fewer training opportunities were available than what were actually available. Aquaculture farmers were better informed, particularly with regard to training that was relevant to them. Aquaculture farm managers had the highest level of awareness of training interventions available.

Other training offered by organisations included firefighting; dealing with dangerous animals, e.g., snakes and spiders; and biosecurity. Subsectors with offshore activities, such as mussel and oyster farming, offered training such as obtaining a skipper's licence; first aid at sea; and survival skills at sea.

(g) How Skills and Knowledge are Gained

All aquaculture farm assistants and aquaculture farmers indicated that they had initially gained the knowledge and skills they have to do their work through on-the-job training received from their colleagues.

Aquaculture farmers and those leading teams indicated that they had been simply placed in the position and that they had learnt the skills required from their managers and through trial and error. Supervisory training is offered at three of the organisations where interviews were conducted. This training is notably offered at the larger organisations that pay the SDL and are associated with a SETA, mainly the AgriSETA.

Aquaculture farm managers have gained theoretical knowledge of aquaculture farming by attending courses or by completing an aquaculture related diploma or degree course offered by various universities. Practical skills have mostly been gained through on-the-job training and learning from colleagues, line managers and through trial and error. Knowledge is also gained from the internet.

(h) Skills Employed in Different Areas of Aquaculture

During the interviews and on the questionnaires distributed, respondents were asked to describe their jobs. These descriptions were then listed as different skills employed for the different job types. These skills provided a baseline of skills that are currently employed in the industry, as well as providing an indication of the perceived difficulty to gain the skill. An understanding of the perceived difficulty to gain a particular skill, or skill set, can assist to determine the National Qualifications Framework (NQF) level and credits that may be associated with the various skills sets when industry-focused qualifications are being developed. The tables presenting the skills employed in different areas of aquaculture can be found in the Operation Phakisa Aquaculture Skills Working Group report titled 'Aquaculture Skills Inventory and Needs Analysis 2017'.¹⁴

(i) Skills and Knowledge Needed to do the Job Better and to Gain a Better Position in the Future as Indicated by Respondents from the Different Occupations

Categories of skills were identified as follows:

Skills and knowledge needs common to aquaculture Farmers and aquaculture farm managers:

- People management
- Leadership skills
- Motivation of teams and individuals
- Management training
- Report writing skills
- Conflict management.

Skills and knowledge needs common to aquaculture farm assistants and aquaculture farmers:

- Work-related computer skills – particularly using programmes to write reports and capture data
- Communication skills
- Maths skills
- Time management
- Safety training
- Problem solving
- Working with people – values such as respect and understanding of diversity within the workplace
- Being an effective team member.

The following list of knowledge skills have been identified as a need by aquaculture farm managers and aquaculture

¹⁴ South African International Maritime Institute SAIMI *Aquaculture Skills Inventory and Needs Analysis 2017* (Gqeberha, South African International Maritime Institute 2018).

professionals. Aquaculture farm managers and aquaculture professionals cited the following as critical or scarce skills within the industry, these included:

- Veterinarians qualified for aquaculture
- Designing and building of efficient aquaculture systems
- Hazardous and Critical Control Points knowledge
- Quality assurance and food safety
- Brood stock selection
- Breeding and larval rearing
- Aquatic (aquaculture) specific laboratory skills
- Technical divers for building and maintaining offshore systems.

Addressing the above needs would assist in meeting the current needs of employees and planning for the future needs.

(j) Scarce or Critical Skills and Knowledge as Indicated by the Stakeholders

Managers and experts (professionals); and aquaculture farm assistants, farmers and managers in industry were asked to comment on what they perceived to be the scarce skills within the industry. These scarce skills included:

- Management skills
- Business skills
- Practical skills fish knowledge technical skills
- HACCP systems management
- Hatchery biological skills
- Technical skills (plumbing, electrical and welding)
- Industry packaging specialists
- Aquaculture veterinary specialists
- Aquatic animal health specialists
- Designing and building aquaculture systems
- Qualified skippers in the mussel and oyster industries
- Qualified divers in the mussel and oyster industries
- Feed manufacturing knowledge.

(k) How People Learn Best

The preferred learning style of the majority of respondents is a combination of practice and theory. This would be an essential consideration when planning interventions in the aquaculture industry. When asked where they would prefer to learn, 85% of aquaculture farm assistants and aquaculture farmers indicated that it would be preferable for training to take place in the workplace (aquaculture farms), with 15% indicating that they would prefer attending training away from work, at a training centre, college or university. However, this would be different

for learners not currently employed in the sector because their only option would be to undertake training at an external training centre.

(l) Perceived Barriers to Gaining an Opportunity for Learning or Training

The questionnaire results identified various perceived barriers to learning, which include: a lack of finances; limited time to conduct studies; lack of education; lack of communication skills (English reading and writing); age (many people feel they are too old to learn); a lack of knowledge on where to gain access to learning; no opportunities at work; and personal fears (lack of self-esteem).

Approximately 97% of participants who responded to the questionnaire cited a lack of funds as a major barrier to gaining knowledge and further education in the aquaculture industry. A lack of time to complete studies and meet family responsibilities was cited as a barrier by 75% of participants who responded to the questionnaire, since most of their time was spent at work. A lack of education was mentioned as a barrier to gaining further education and training by 60% of participants. This was especially evident among aquaculture farm assistants and aquaculture farmers. Participants who are not English literate (i.e., who lack reading and writing skills) said that a lack of English communication skills prevented them from gaining further education and training. Managers were asked what they look for when interviewing potential employees. Most managers mentioned that they are interested in the person having the right attitude, indicating that those candidates without prior training could be taught on the job; this was especially evident with regard to elementary occupations. For those candidates being interviewed for aquaculture farm manager or professional positions, an aquaculture related qualification is sought.

(m) Human Resource Recommended Interventions

Human resource managers, training managers and human resource practitioners provided the following recommendations: training of practical farm skills; mentorship programmes to be implemented for succession planning; more extension officers required; knowledge of basic chemistry; basic numeracy and literacy skills; basic biology; communication skills; computer skills;

mechanical skills; time management; laboratory skills; environmental impact assessment skills and knowledge; encouraging the development of new technologies; alternative sustainable feeds; and diseases knowledge.

(n) Recognition of Prior Learning

The persons responsible for human resources management and aquaculture farm managers were asked what they understood by recognition of prior learning (RPL) and whether they felt that this would be a useful intervention. Most of these respondents indicated that they understand what RPL was. The response as to whether it would be a useful intervention was mixed. Most of these participants responded that it would be beneficial to offer RPL to those who had been in the industry for a long time and who had worked across the various disciplines. They also indicated that, because most people work in a specific area on a farm and because most workers have likely had little or no exposure to the different areas of the aquaculture operations, there would be gaps in the knowledge and skill of workers. The solution put forward by the majority of these participants was a combination of RPL and training, where a person is given the opportunity to complete RPL in areas where knowledge and skills are established, and then to offer training and assessment in areas where there are gaps.

V Conclusions and recommendations

Taking into account the quantitative and qualitative data received in this study, nine interventions are recommended. These interventions include education, training and skills development across all the occupation groups targeted. The interventions are not listed in order of priority but suggested as high, medium or low priority.

(a) Adult Education and Training

High priority – Immediate implementation recommended: A large percentage of aquaculture farm assistants and aquaculture farmers have not completed formal schooling. It is recommended that the literacy and numeracy levels at all levels of the organisations be determined through an English language skills assessment (ELSA) exercise. This assessment would assist to determine the literacy and numeracy levels of an individual. From this assessment, a recommended programme could be made available to give workers the opportunity to improve their literacy and numeracy.

The recommended process is as follows:

- Secure funding for an adult education and training (AET) programme – AgriSETA, for example, has, in the past, made AET grants available.
- Determine the functional literacy and numeracy levels of employees in the industry using a tool such as ELSA. This tool is used to determine functional literacy and numeracy of a person and, in turn, the AET level of the person tested (Level 1 to Level 4).
- Level-appropriate AET training to be offered to employees based on their ELSA assessment.
- A communication and maths bridging programme is recommended for those who are above AET Level 4 but who may not cope with the literacy and numeracy fundamentals in the planned aquaculture qualifications.

The above is a broad overview of the recommended initiative. It would be recommended that a programme such as this be initiated as soon as possible, as this would ensure that when the process of developing the new aquaculture qualifications is complete, employees have the appropriate literacy and numeracy to gain access to the qualification.

(b) Supervisory Training

High priority – Immediate implementation recommended: Aquaculture farmers across all sectors of the industry indicated a need for supervisory skills. It is recommended that different supervisory training programmes be investigated and one that meets the needs of aquaculture farmers within the aquaculture industry be selected and, if needed, be adapted to meet the specific needs of aquaculture farmers in the industry. This training programme should address topics such as people management, business management and budgeting. Prioritising supervisor skills may also improve transformation throughout the different levels in the industry, especially manager category.

(c) Management Interventions

High priority – Immediate implementation recommended: Managers across all sectors of this industry indicated the need for management skills, with particular reference to people management and business management skills. It is recommended that various business management programmes be investigated and one that meets the needs of managers within the aquaculture industry be selected

and, if needed, be adapted to meet the specific needs of managers in the industry.

(d) Aquaculture Veterinary Courses, Qualification or Specialisation to be Investigated

High priority – Immediate implementation recommended: Aquaculture veterinary practitioners are scarce in South Africa. Currently, there is no channel for South African veterinarians to study or specialise in aquaculture veterinary. It is recommended that the possibility of including aquaculture-specific training or courses be investigated as part of a veterinary sciences degree. **Note:** This intervention has already been addressed by the training of veterinarians at the University of Stirling. The DFFE has sent five provincial veterinarians to the University of Stirling (Scotland, United Kingdom) to participate in a Master in Aquatic Medicine programme.¹⁵

(e) Make Information Pertaining to SETAs and Access to Funding Available to Organisations

High priority – Immediate implementation is recommended: It is recommended that a document be circulated to all aquaculture organisations informing them of the SDL about joining an appropriate SETA, preferably the AgriSETA; and about learnerships and funding opportunities available from the SETAs. **Note:** information has been circulated widely throughout the industry, including information provided in the skills training booklet.¹⁶

(f) Accessibility to the Aquaculture Qualifications Currently being Developed

High priority – Implementation recommended as soon as this qualification becomes available: It is recommended that the aquaculture qualifications currently being developed be made accessible to aquaculture farm assistants and aquaculture farmers in the aquaculture industry. Because there are a number of small aquaculture businesses that do not pay the SDL or are not affiliated with a SETA, it is recommended that those working in these organisations also have access to these qualifications. A recommended intervention is to source funds to make the qualifications accessible to all organisations in the aquaculture industry.

These qualifications can be sources from the following website: <<https://www.qcto.org.za/index.php/aquaculture>>.

(g) Research Funds for Feed Manufacturing

Medium to high priority – Aquaculture-specific feed manufacturing has been indicated as a scarce skill. It is recommended that research and development of feeds and feed manufacturing in South Africa be prioritised.

(h) Develop an Aquaculture-Specific Technical Qualification

Medium priority – Technical skills have been identified as a need for workers in the aquaculture industry. Technical skills have also been indicated as a set of scarce skills by managers and professionals in the industry. It is recommended that the viability of developing a qualification or skills programme for aquaculture technicians be investigated.

(i) Short Courses and Skills Programmes to be Made Available to Organisations in the Aquaculture Industry

Medium priority – The lack of finance for training was indicated by the respondents in this study as one of the major barriers to gaining knowledge and skills. A number of 'soft skills' were identified by the respondents as required in the aquaculture industry. It is recommended that funding be made available for the short courses and skills programmes needed by aquaculture farm assistants, aquaculture farmers and managers in the industry. Each organisation has different needs; however, universal needs should include diversity training, problem solving skills, budgeting skills and the other skills listed in section IV(i).

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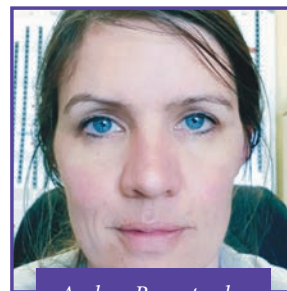
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Skills Development and Capacity Building within the Oceans Economy

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Skills development has been identified as one of the key contributors to the growth of the oceans economy. Capacity building in terms of ensuring that there are adequate resources, that is, human, physical and financial resources, to enhance the delivery of skills development initiatives is critical. The skills shortage challenge in South Africa mirrors global conditions, characterised by a mismatch between the supply and market demand for skills. South Africa's National Development Plan (NDP) emphasises the need for skills development in order to enhance the economic growth that could be brought about by an expanded skills base through better education and vocational training. The maritime sector workforce needs to be adequately skilled and be able to adapt to diverse environments and technological advancements. Inroads have been made into a bid to improve skills in the maritime sector through a number of initiatives that have been launched. This article will explore these initiatives as well as challenges that still need to be addressed within the skills development and capacity building focus area.

Keywords: oceans economy, skills development, Operation Phakisa

1 Introduction

Skills development and capacity building have been identified as critical in the growth of the oceans economy globally. The oceans economy has been recognised as a substantial contributor to economic output and employment in the world.¹ The oceans economy can generally be defined as the part of the economy that is dependent on the ocean as an input to the production

process or that takes place on or under the ocean by virtue of geographic location.² Other definitions, such as that of Dwyer, describe the ocean economy as the sum of the economic activities of ocean-based industries, as well as goods, services and assets of marine ecosystems.³ Initiatives aimed at ensuring that there is a skilled workforce to sustainably drive the various ocean-based activities are, therefore, key to the growth of the oceans economy.

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¹ CM Rogerson & JM Rogerson 'Emergent planning for South Africa's blue economy: Evidence from coastal and marine tourism' (2019) 30 *Urbanization* 24–36.

² T Walker *Securing A Sustainable Oceans Economy: South Africa's Approach* (Pretoria, Institute of Security Studies 2018).

³ L Dwyer 'Emerging ocean industries: Implications for sustainable tourism development' (2018) 13(1) *Tourism in Marine Environments* 25–40.



Globally, a number of trends and key issues in respect of skills development challenges have been identified in international maritime skills studies.⁴ These challenges include, amongst others, skills shortages in the oceans economy industry due to the mismatch between skills supply and demand, the increasing aggregate age of maritime professionals, skills retention challenges and the impact of technological innovation. Various initiatives, therefore, have been implemented in response to these challenges, including: establishing partnerships between maritime training institutions and maritime industries; launching maritime awareness campaigns; introducing various employee retention strategies and succession plans; identifying skills and training required to adapt to changing technological environment; and developing maritime education and training policies or strategies. The extent of implementation or progress made in the implementation of these initiatives, as well as their impact, need to be evaluated.

Inroads have been made in a bid to improve skills in the maritime sector through a number of initiatives that have been launched. This article will explore opportunities, as well as challenges, that still need to be addressed in respect of skills development and capacity building in the South African context.

II Oceans economy policy initiatives in Africa

On the African continent, as well as in the countries adjoining the Indian Ocean, there has been a great deal of interest in the development of the oceans economy through policy development and the implementation of various initiatives. The continent is made up of 38 coastal and island states spread over a 47 000 km coastline, with millions of livelihoods dependent on ocean-based resources, both for employment and for food security. The oceans economy, therefore, provides considerable potential for the continent, as well as for

individual African countries, to develop their ocean-based sectors.⁵ As a result of the increased recognition of the ocean's economic potential and maritime resources-related opportunities, in 2014 the African Union (AU) endorsed the 2050 Africa Integrated Maritime Strategy (AIMS),⁶ representing a long-term vision for the development of Africa's ocean economy. One of the key goals of AIMS is to ensure that there is synergy and coherence between the sectoral policies within and between the continent's regional economic communities (RECs) by the adoption of a standard and cooperative approach to maritime issues, thus contributing to the sustainable growth from ocean- or maritime-related activities. Furthermore, AIMS advocates for 'the need to have an integrated human resources strategy for the maritime sector to support the provision of skills taking into account gender balance in the entire maritime value chain,' as well as a 'strong maritime education and development capacity'.⁷

In 2016, the AU Extraordinary Summit on Maritime Security and Safety and Development in Africa adopted the AU Charter on Maritime Security, Safety and Development (also referred to as the Lomé Charter). The charter reinforced the commitment by African leaders to make the oceans economy one of the key drivers of economic and social development on the continent, emphasising the need for support and partnerships in areas such as education, training and business and industry development.⁸ In addition, the 2017 Jakarta Declaration on the Blue Economy provided a total of 26 recommendations and principles for the development and application of blue economy approaches to enhancing socioeconomic benefits and sustainable development, more specifically for coastal communities in the Indian Ocean region.⁹

In respect of the Southern African region, countries are divided into three geopolitical groups according to their natural comparative advantages and prospects in accelerating sustainable development through

⁴ South African Maritime Safety Authority *Maritime Sector Skills Development Study* (Pretoria, Department of Transport 2011).

⁵ US Engel cited in Rogerson & Rogerson op cit note 1.

⁶ African Union '2050 Africa's Integrated Maritime Strategy (2050 AIM Strategy)' (2012) (available at <www.au.int/maritime>).

⁷ Ibid.

⁸ United Nations Economic Commission for Africa *The 24th Session of the Inter-Governmental Committee of Experts (Senior Officials of Government) (ICE) Meeting of Southern Africa Addis Ababa, Ethiopia* 18 September 2018 (available at <<https://hdl.handle.net/10855.1/555>>).

⁹ Rogerson & Rogerson op cit note 1.

advancements in the blue economy. The first group is referred to as the group of Indian Ocean Coastal States and includes Mauritius, Mozambique and South Africa. The second group is made up of the Atlantic Ocean Coastal States, namely South Africa, Angola and Namibia. South Africa belongs to the two groups because of its unique position, spreading from the Indian Ocean, on its eastern coastline, to the Atlantic Ocean, on its western coastline. The third group consists of the landlocked countries, such as Lesotho, Botswana, Malawi, Swaziland, Zimbabwe and Zambia, which focuses on exploring the economic potential of the maritime sector through the use of inland waterways such as lakes, rivers and dams. Furthermore, the Southern African Development Community (SADC) Industrialization Strategy and Roadmap Strategy 2015–2063 advocates for the development of regional value chains (RVCs), including maritime value chains.

All these policies and initiatives mentioned above emphasise the need to explore the economic potential of the oceans economy and the broader maritime sector on the continent. These policies and initiatives aim to build an inclusive oceans economy on continent, with a view to achieving sustainable development in all member States. These initiatives also emphasise and recognise the need for skills development and capacity building in the region to ensure that there is a skilled workforce that will contribute to the growth of the oceans economy on the continent. In respect of capacity building, there is a need to ensure that the relevant institutions are strengthened to enable the delivery of identified initiatives, both at government and academic institution level. Capacity building also entails the strengthening of research and innovation systems in the maritime sector. These initiatives need to take cognizance of the changes in the technological environment, as well as recent developments with respect to COVID-19 which has emphasised the need for acceleration in the use of technology and the advent of the fourth industrial revolution (4IR), where it has been evident that the type of skills required have changed. Member States, therefore, are urged to take these developments into consideration during the implementation of the strategies and initiatives in the oceans economy.

III Skills and capacity building for the oceans economy in South Africa

South Africa is a signatory to the various strategy frameworks referred to above, as well as those in the international arena. These frameworks emphasise the country's drive to enhance its national interests, especially its maritime interests.¹⁰ The country's rich marine environment is evident in its location at the convergence of three oceans, namely the Indian, South Atlantic and Southern oceans, with a coast that 'extends for 3 924 kilometres, from the Orange River mouth in the West to the Mozambique border in the East and a distance of 370 kilometres from a defined coastal baseline (a line connecting mean low water marks) out into the Southern Atlantic Ocean in the West and Western Indian Ocean in the East, and includes the islands of Prince Edward and Marion'.¹¹ The country also has an exclusive economic zone (EEZ) of 1 553 000 km² and a 4 340 000 km² maritime territory, often referred to as an additional 10th province of the country.¹² The South African coast is, therefore, a national asset of considerable economic, social and cultural importance, since it provides food and jobs to people living in the country and brings revenue to the country from economic activities.

In an effort to unlock the economic potential of the country's oceans economy, the Operation Phakisa (Oceans Economy) programme was launched in 2014, based on the Malaysian Big Fast Results (BFR) methodology. The word *phakisa* means 'hurry up' in Sesotho, one of the country's official languages.

The focus on the oceans economy resulted from a study on the potential of South Africa's oceans economy conducted by the Department of Environmental Affairs in 2013, which found that the sector could contribute as much as R177 billion to the gross domestic product (GDP) of the country, and create up to 1 million jobs over a period of 20 years.¹³ According to the study, the ocean contributed approximately R54 billion to South Africa's GDP in 2010 and accounted for approximately 316 000 jobs. The study

¹⁰ J van Wyk 'Defining the blue economy as a South African strategic priority: toward a sustainable 10th province?' (2015) 11 *Journal of the Indian Ocean Region* 1–17.

¹¹ S Hosking et al. 'The Economic Contribution of the Ocean Sector in South Africa' (2013) 38(2) *Studies in Economics and Econometrics* 65–82.

¹² Van Wyk op cit note 10.

¹³ South African Government 'Operation Phakisa: South Africa's Ocean Economy' (2017) (available <https://www.gov.za/sites/default/files/gcis_document/201706/saoceanconomya.pdf>).

identified four key subsectors within the ocean economy that could make a substantial contribution to GDP and which became the focus areas for Operation Phakisa (Oceans Economy). Two additional focus areas were identified 2015. The six focus areas were:

- **Marine Transport and Manufacturing**, which focuses on maximising the potential of the country's nine major ports, as well as enhancing port infrastructure to unlock potential opportunities. The manufacturing element of the report focuses on promoting capabilities and opportunities in shipbuilding, boatbuilding and oil rig repairs.
- **Offshore Oil and Gas and Exploration**, which emphasises the need for creating an enabling environment for exploration of oil and gas wells in the country, with projections being the country has the capacity to produce 9 million barrels of oil and around 60 trillion cubic feet of offshore gas.
- **Marine Protection and Governance**, which aims to develop an integrated approach to the planning, monitoring and execution of ocean governance and enforcement, as well as develop an institutional framework to manage multiple users of the ocean space.
- **Aquaculture**, which is viewed as being underdeveloped, with a low production level. The promotion of the aquaculture sector, therefore, contributes to food security, job creation, stimulates the rural economy and provides opportunities for small, medium and micro-enterprises.
- **Coastal and Marine Tourism** was not the highest priority in the country's tourism policy in the past, hence, the need to look at this environment in an effort to improve coastal infrastructure for tourism and to tap into opportunities to grow coastal and marine tourism to promote local economic development.
- **Small Harbour Development**, which focuses on the improvement of infrastructure and in the economic potential of small harbours with a view to supporting the revitalisation of small towns and stimulating rural development, as well as the empowerment of coastal communities for enterprise development¹⁴ (Rogerson and Rogerson, 2019).

There are a number of opportunities that have come through these focus areas, driven by industry and government such as investments in infrastructure development and various projects which have resulted in job creation.

Skills development and capacity building, as well as research and innovation, were identified in the Operation Phakisa Lab process as key enablers, cutting across the different focus areas of the oceans economy. However, there is a mismatch between skills supply and demand because of the country's skills crisis, which mirrors the global situation. South Africa's National Development Plan (NDP), which aims to address issues of unemployment, inequality and poverty alleviation, identifies skills development and capacity development as key to economic growth. The NDP states that the transformation of the economy and the creation of sustainable opportunities for job creation could be brought about by an expanded skills base through better education and vocational training.

Skills development and capacity building have been identified as a pressing need in a number of industries, including the maritime sector. Various initiatives, including skills development studies and summits/conferences, have been introduced since 2011 and call for greater emphasis to be placed on skills development and capacity building in the maritime sector, and the effective coordination thereof. These initiatives formed the basis of discussions during the Operation Phakisa (Oceans Economy) skills labs in 2014. Operation Phakisa (Oceans Economy) outlines a number of initiatives aimed at developing skills and capacity with a view to developing a skilled workforce and developing capacity to produce those skills for the sector. The South African International Maritime Institute (SAIMI) was established subsequent to the launch of Operation Phakisa in 2014 to drive the Operation Phakisa (Oceans Economy) skills initiatives. Table 1 illustrates the oceans economy skills initiatives and progress made since 2014.

¹⁴ Rogerson & Rogerson op cit note 1.

Table 1: Progress: Operation Phakisa Oceans Economy Skills Initiatives (identified in the Operation Phakisa Skills 3-ft Plans)¹⁵

Focus Area	Initiatives	Progress made
Aquaculture	Formalise institutional framework structure for aquaculture; conduct comprehensive skills needs analysis (including current capacity, existing training – formal and informal); incorporate aquaculture into existing career awareness programmes; upscale the aquaculture element on the Department of Agriculture, Forestry and Fisheries (DAFF) bursary scheme; incorporate aquaculture into the existing mentorship/career development frameworks (internship and work-based learning); develop framework for higher education qualifications/specialisations for aquaculture.	Framework finalised and used as terms of reference (ToR) for the Aquaculture Skills Working Group; skills needs analysis (completed) and implementation in progress; National Qualifications Framework (NQF) Level 4 aquaculture qualification approved in 2018, curriculum and assessment tool developed; curriculum developed for aquaculture agricultural colleges; 56 bursaries for fisheries and aquaculture awarded between 2017 and 2019 and 130 candidates have placed at Department of Environment, Forestry and Fisheries (DFFE). Career awareness and marketing material developed. Ongoing engagements with universities on inclusion of aquaculture modules into existing qualifications. Research initiatives as well as a community of practice to be initiated. Aquaculture demonstration centres established and include training as well as research elements. Between 2017-2019 about 308 people were trained in aquaculture short courses at the Agricultural Technology Demonstration Centre in Gariep Dam. Process to expand aquaculture offering through integration of modules into existing qualifications at universities in progress.
Coastal and Marine Tourism (CMT)	Conduct comprehensive skills needs analysis; develop a framework of existing qualifications and gaps (technical and vocational education and Training (TVET) colleges, universities, private training providers); facilitate the establishment of centres (centres of excellence, incubation centres); facilitate work placement for learners; facilitate access into CMT studies; facilitate CMT recognition of prior learning (RPL) processes; incorporate CMT in the existing mentorship frameworks.	CMT skills audit finalised in 2019 and recommendations in the process of being implemented including the integration of CMT into existing programmes (incubation, mentorship and RPL); facilitation of work placement with cruise liners (e.g. MSC Cruises), implementation of CMT skills programmes across various provinces. Challenges identified include the lack of CMT specific qualifications (elements of CMT are spread across existing Tourism and Hospitality qualifications), this therefore has limited the implementation of RPL initiatives.
Marine Transport	Increase capacity to develop seafarer skills for ~1,200 ratings and ~720 officers per year through TVETs and universities; coordination of maritime education and training; research and career development; support for maritime schools.	Support provided to universities through subvention programme; lecturer development programmes; qualifications and curriculum developed; support provided to maritime high schools (bursaries; resources, teacher development, online modules). SAIMI maritime awareness programme in partnership with various players in the sector including the development of an online platform known as Divelyn. Seafarer targets not fully met due to capacity constraints as well as limited training berths. 3 universities offering seafarer qualifications are Cape Peninsula University of Technology (CPUT), Durban University of Technology (DUT), and Nelson Mandela University (NMU). TVETs offering maritime related qualifications and training are False Bay College, uMfolozi, and College of Cape Town. Efforts are being made to promote the increased participation by TVETs in the maritime sector through capacity building initiatives. In addition to the berth challenge, these few institutions cannot produce the targeted throughput. Research and innovation programme with universities facilitated – marine robotics units have been established at NMU and University of Cape Town (UCT).

¹⁵ Source: Operation Phakisa Skills 3ft Plans and progress updates by the members of the Operation Phakisa Skills Working Groups managed by SAIMI.

Focus Area	Initiatives	Progress made
Marine Manufacturing	Train 2 550 TVET College graduates on an 18-month workplace-based experiential learner programme; establish trade RPL, competency-based modular training (CBMT) or centres of specialisation; train 18 172 learners as artisans, semi-skilled workers; increase usage of Employment Services of South Africa (ESSA) system and targeted career awareness services as a high-value recruitment tool for Marine Transport and Manufacturing (MTM).	Between 2015 and 2020 apprenticeships & learnerships (1 416 beneficiaries) and skills programmes (2 961 beneficiaries) in various maritime related trades. Mentorship training programmes for artisan development launched by SAIMI and other stakeholders. RPL boatbuilding toolkit approved and trade test centre established at False Bay College in 2021. Continuous advertisement of maritime opportunities on Department of Labour employment services system. Targets not being met due to capacity constraints, impact of economic environment on industry that is project-based, and limited availability of workplaces.
Marine Protection and Ocean Governance (MPG)	Occupations required for Operation Phakisa identified and are registered on the Organising Framework of Occupations (OFO); conduct a skills audit to establish skills needs for the sector, qualifications for each MPG Phakisa Occupation developed; advocacy and research programme for MPG Phakisa occupations implemented and sustained; MPG workplaces identified with plans and processes developed to expand number and capacity of workplaces. Workers with relevant experience identified and placed using the recognition of prior learning processes to enable competency for each MPG Phakisa occupation.	Occupations identified and new ones registered; skills audit conducted in 2018 and implementation in progress. Research chairs in Law of Seas and Marine Spatial Planning established at Nelson Mandela University (NMU). Need identified for research chair in maritime law and a research chair in maritime security. Two qualifications approved (NMU) – LLM Ocean Governance and MA Maritime Studies. Establishment of community of practice in Oceans Account Framework to ensure the inclusivity, safety, security and sustainability of coastal communities. SAIMI partly sponsors the Oceans Governance course, which is offered by the International Oceans Institute – South Africa (IOI) during September each year (20 beneficiaries).
Offshore Oil and Gas Exploration	Develop a skills strategy roadmap; appointment of university and development chairs; facilitate the establishment of a community of practice and centre of excellence; facilitate the establishment of a professional body; facilitate the establishment of vocational training centres for scarce and critical skills.	Skills strategy roadmap completed, implementation in progress focusing on engineer, technician and artisan development. Community of practice in oil and gas, in partnership with National Research Foundation established. Professional body being established through South African Oil and Gas Alliance (SAOGA). Challenges include level of maturity of offshore oil and gas industry in the country, resulting in limited opportunities and availability of skills, however with the new discoveries in Mossel Bay opportunities are envisaged.
Small Harbour Development	Value chain analysis and skills audit; develop and implement skills development interventions, allocate resources and establish partnerships.	Value chain analysis and skills needs analysis in progress.

IV Conclusion

Inroads have been made into advancing skills development and capacity building in the maritime sector since the launch of Operation Phakisa in 2014. There are, however, gaps in the area of building capacity at various institutions, especially TVET colleges, that need to be addressed to enable them to

offer maritime qualifications, as well as in the development of qualifications in other focus areas of the oceans economy. Capacity building should include lecturer, qualification and curriculum development, as well as the development of adequate infrastructure and the provision of equipment. The Operation Phakisa targets that were initially set in 2014 have

not been fully met because of changes in the economic environment, including subdued demand. This has resulted in the revision of the original targets in some focus areas through the introduction of a comprehensive change management process driven by the delivery units (line departments) and the Department of Planning, Monitoring and Evaluation.

The Skills Study and Skills Summit facilitated in 2011 by the South African Maritime Safety Authority (SAMSA) and the work done on maritime sector skills by the Human Resource Development Council (HRDC) in 2014, provided a solid foundation for the development of the Operation Phakisa (Oceans Economy) skills initiatives. Collaboration and partnerships are key to the success of the process, especially with industry, to ensure that the supply of skills meets the required demand to avoid training for unemployment. Industry involvement in qualification and curriculum development is also key. There has been limited participation by industry in the skills initiatives structures and efforts are being made to increase their participation. Collaboration between stakeholders in the maritime skills development arena is also required to pool collective resources to avoid duplication of efforts/initiatives and expand reach.

The continuous search for training berths, globally to facilitate work placement and absorption, and the marketing of South African cadets are also critical. The maritime environment is also evolving due to technological advancements. Maritime training and education policies and frameworks need to adapt to these changes; with the identification of skills and training to meet the needs of the 4IR. Furthermore, the advent of COVID-19 has emphasised the need to fast-track blended learning, as well as making necessary adjustments to policy in order to accommodate such changes. Increased availability of simulation facilities and consideration by regulators to use simulators as part of sea-time training have been proposed. Maritime education and training is costly and funding for maritime skills development initiatives remains a challenge. A Maritime Skills Development Fund has been proposed under Operation Phakisa, resuming engagements in this regard should be considered to devise an approach. Another area that needs to be considered is promoting SMME development in the oceans economy through enabling access as well as skills development. Entrepreneurial skills development for some of the learners within the system as well should be promoted to provide them with an alternative to employment.

Lastly, continuous awareness creation about the sector is required to provide information about maritime careers.

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Nwabisa Matoti

South African Maritime Skills Supply and Demand Forward Thinking for Maritime Education and Training Excellence

*Derek Zimmerman**

The South African International Maritime Institute (SAIMI) is engaged in answering the questions that centre around whether the country's maritime skills supply matches the industry's demand. The SAIMI commissioned a study¹ to evaluate the maritime skills situation in South Africa, culminating in a final report in 2019. The purpose of this study was to determine the overall demand for maritime and ocean economy skills in order to grow the sector, and to determine whether there is adequate capacity within the skill supply framework to meet this demand. This exercise required an assessment of the anticipated demand and the current supply of skills capacity in South Africa, with any surplus or deficit being clearly highlighted. The author investigated a number of credible studies and international best practice examples within a framework supported by the latest skills data about the supply and demand dynamics in the maritime economy arena. It was found that South Africa is producing graduates with maritime-related qualifications in sufficient numbers, but not with the relevant types of skills required by the industry, which are mainly technical and professional maritime skills. A shift in emphasis is required to prioritise scarce, critical and future-proof skills for the growth of the maritime economy, with a particular emphasis on the maritime skills that will be needed in the context of the fourth industrial revolution (4IR).

This work was presented to a representative platform of stakeholders in industry, academia and government at the SAIMI Forward Thinking Conference for Maritime Education and Training Excellence² to review current maritime skills capacity against future demand and to consider collaborative and collective ways to

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¹ DG Zimmerman 'Oceans economy skills requirement. Employment and skills development assessment for South Africa' (2019) A report prepared for the South African International Maritime Institute (SAIMI).

² South African International Maritime Institute (SAIMI) 'Forward Thinking for Maritime Education and Training Excellence' (2019) A report on a conference to discuss this topic held in Durban, South Africa 13–15 October 2019, Durban.



close the skills gap. The outcome of the conference confirmed this report's findings and recommendations to address these shortcomings.

A focused and driven programme is required within the South African maritime environment to align and accelerate all maritime education, research and skills enhancement to the market needs of the maritime sector, with the private sector directly involved throughout.

Keywords: *maritime education, skills and training, supply and demand, skills gap, skills development and capacity, fourth industrial revolution, equitable skills balance*

I Maritime skills to support the development of the maritime industry in South Africa

South Africa recognises the maritime sector and the emerging ocean economy as one of the important sectors; a new frontier that can make a significant contribution to stimulating economic growth and employment. This sector needs to be supported with appropriate initiatives, policies and private-public sector collaboration in a global context.

One of the key drivers of the creation of employment opportunities in the South African ocean economy and maritime sector is the supply of appropriately skilled people to match the demand for skills that the maritime sector requires, mainly by the private sector. This is a global trend, which is exacerbated by increasing automation and digitisation; increasingly stringent safety and environmental requirements; and fuel efficiency and carbon abatement pressures; together with geopolitical changes that could affect the future of the industry and its economic dynamics. The maritime industry input and data indicates that current labour skills, specifically in the marine manufacturing and engineering domains, are not reflective of the requirements of the workplace.

In order to activate this maritime potential, the country needs a labour force and needs to provide the skills to more precisely match the demand that would support growth in the maritime sector.

II Background to maritime skills training in South Africa

A number of maritime education and training (MET) challenges have been highlighted by the maritime training industry, including the difficulty faced by tertiary institutions to attract and retain lecturers with the appropriate levels of experience and knowledge, together with students who enter the technical and vocational education and training (TVET) colleges and universities having difficulty with the level of learning that is required of them in the maritime sector, particularly in science, technology, engineering and mathematics (STEM) subjects.^{3,4} These skill deficiencies need to be addressed at school level, nationwide. These issues exacerbate the disconnect between the fast-paced, and increasingly technical, global maritime sector and the courses being offered in South Africa.

Seafarer training is an element of the maritime training milieu that continues to present its own set of challenges, with cadets being trained for a certain market and then not being able to secure employment in the private sector; consequently, they are not able to record the requisite sea-time to conclude the practical elements of their courses. This is a clear indication of the mismatch between skills provision and industry requirements or demand. The private sector needs to be more closely engaged with in order to tailor skills and, additionally, the numbers of cadets should be matched to anticipated demand.

³ Zimmerman op cit note 1.

⁴ SAIMI op cit note 2.

With maritime technology advances and the increasing influence of the fourth industrial revolution (4IR), there is an even greater need to ensure that the requisite skill sets are offered to students, in order to meet the requirements of employers in increasingly competitive global markets. This would be in the interests of both the students and the South African maritime sector.

III The maritime skills forecasting model adopted for this study

Over the past decade, a global realisation of the importance of the maritime sector and ocean economy has taken place, with an increasing emphasis on the role the maritime sector can play in environmental issues; food and energy security; trade and transport; and general economic progress. Defining the oceans economy and how it is measured is fundamental to being able to predict the market dynamics of maritime skills supply and demand. A global literature review was undertaken to establish best practices.

Within the South African economic context, the national accounts as per the internationally accepted Standard Industrial Classification (SIC) framework were used as a baseline against which an oceans economy framework was distilled, using a gross domestic product (GDP) decomposition approach, according to a methodology proposed by Stephen Hosking in 2015⁵ and 2017.⁶ This Ocean Economy GDP framework was then transposed into an ocean economy employment profile, with both GDP and employment extrapolated within the Operation Phakisa framework and timescales. This maritime industry overview, together with an industry analysis, allowed a demand framework to be formulated, against which maritime skills supply could be measured and contextualised, highlighting any positive or negative divergence for consideration.

(a) Demand for Maritime Skills in South Africa.

The Operation Phakisa Ocean Economy laboratory workgroups estimated approximately 1 million jobs or full-time employment (FTE) opportunities by the year 2033. This report's 20 year modelling forecast indicates an employment baseline of 389 000 FTE in 2015, growing to 895 000 FTE by 2035. When applying the employment framework established by the ADRS⁷ expansion and replacement demand profiles, anticipated maritime skills demand is equivalent to an expansion demand of approximately 25 000 FTE per annum, which, when the fisheries, marine tourism and construction activities are excluded, leaves an annual demand of 10 000 FTE for the maritime sectors evaluated in this study. These skills were then profiled according to the marine skill sets and industry ratios, as determined by a 2015 Irish study,⁸ to determine the general categories of skills in demand for generic maritime sectors in the global domain.

(b) Supply of Maritime Skills in South Africa

An in-depth analysis of the general skill supply situation in South Africa was undertaken, which consisted of an evaluation of the Department of Higher Education and Training (DHET) data,⁹ together with Statistics South Africa (StatsSA)¹⁰ data, amongst other data sources, as well as a more direct approach with primary research undertaken for the maritime sector or for Ocean Economy curricula or skills.

This research was undertaken at a high level, with primary data collected. The analysis allowed the four major maritime skill sets of operations, skilled trades, technical skills and professional skills, as well as the top nine types of skills or courses in each category to be formulated for the maritime skills supply situation in 2017 (Table 1).

⁵ S Hosking et al. 'The Economic Contribution of the Ocean Sector in South Africa' (2014) 38(2) *Studies in Economics and Econometrics* 65–82.

⁶ S Hosking *Progress Overview on the Contribution of the South African Ocean Sector* (Cape Town, Cape Peninsula University of Technology 2017).

⁷ Applied Development Research Solutions (ADRS) 'Skills supply and demand in South Africa: A 10 year forecast (2016 – 2025)', (2016) The Bridge. An ADRS simulation policy brief.

⁸ Expert Group on Future Skills Needs *A study of the Current and Future Skills Requirements of the Irish Marine/Maritime Economy to 2020* (Dublin, Department of Enterprise, Trade and Employment 2015).

⁹ Human Sciences Research Council HSRC *Skills Supply and Demand in South Africa* (Labour Market Intelligence Partnership 2016). LMIP is a research consortium led by the Human Sciences Research Council (HSRC), and funded by the Department of Higher Education and Training (DHET).

¹⁰ Statistics South Africa StatsSA 'National Accounts. Input-Output tables for South Africa, 2012' (2015) Report Number 04-04-02.

Table 1: Supply of Maritime Skills by Category in 2017¹¹

Supply of Maritime Skills in South Africa by Broad Category – 2017			
Operational Skills (Maritime) • Sailing and Skippers • Able Seafarer • Cadet Training • Safety & Fire Fighting • Basic Oil & Tanker • Navigation • First Aid at Sea • Stevedoring • Rigging and Lashing • Others	5 370 (60%)	Technical Skills (Maritime) • Mechanical Engineer – Diploma • Maritime Studies – Diploma • Marine Science – Diploma • Oceanography • Nature Conservation • Nautical Studies – Diploma • Maritime Studies – Diploma • Marine Engineering – Diploma • Maritime Law • Others	437 (5%)
Skilled Trades (Maritime) • Yacht & Boat Building • Freight Handling • Trade & Transport • Commercial Diving • Customs & Excise • Maritime Safety Training • Electronic Navigation • Radio & Communications • Welders, Boilermakers & Fitters • Others	2 603 (29%)	Professional Skills (Maritime) • Marine Engineering – Degree • Maritime Studies – Degree • Law of the sea • Oceanography • Marine & Environmental Law • Marine Research • Geological Sciences • Zoology and Botany • Ichthyology • Others	504 (6%)
Totals – Maritime Skills – 2017			8 914

These are the relevant skills in the four major occupation categories identified above that are able to be supplied by the various maritime-orientated training institutions. More research of a primary nature is required in order to provide missing detail.

IV The disconnect between demand and supply of maritime skills in South Africa

When the demand is matched to supply, the 'administration' and 'managerial' positions were excluded from both categories because they are not deemed to be maritime-specific. The data totals led to an average

annual demand of 7 013 positions and a supply of 8 914 positions, indicating a gross surplus in supply of 1 902 maritime-related positions. What is significant in this skill supply *surplus*, and highlighted by the detail, is that there is a surplus of maritime operational and skilled trades in the market of 3 924, which would include the sea cadet programmes. The data also indicates a *deficit* or shortage of technical and professional maritime skills of approximately 2 022; leaving an implied overall skills surplus in the market of 1 902, with a glaring shortage of technical and professional skills. This clearly indicates the *disconnect* or *mismatched* supply of skills in the South African maritime sector (Table 2).

¹¹ Source: Zimmerman op cit note 1.

Table 2: Supply and Demand of Maritime Skills by Category in 2017¹²

#	Skills Profile – SA Maritime	Demand: 20 Years	Demand: Annual	Supply: Annual	Surplus / (Deficit)	% of Demand
1	Operations (Maritime)	38 250	1 913	5 370	3 458	180.8
2	Administration (Non-maritime)	36 750	–	–	–	–
3	Skilled Trades (Maritime)	42 750	2 138	2 603	466	21.8
4	Technical Skills (Maritime)	47 000	2 350	437	(1 913)	(81.4)
5	Professional Skills (Maritime)	12 250	613	504	(109)	(17.8)
6	Management (Non-maritime)	23 000	–	–	–	–
7	Totals	200 000	7 013	8 914	1 902	27.1

A high-level interpretation of this data, which needs to be engaged with and expanded upon, would seem to suggest that there is a lack of understanding of maritime industry needs, which manifests itself in mismatched or inappropriate training facilities, curricula and trainers or teachers, with inadequate and under-funded training facilities. However, it was also noted that there are instances of adequate facilities, which are currently underutilised, and with training capacity, which could be put to more effective use if stock were taken of all facilities and they were deployed in a more collaborative manner by the training community, both public and private.

V What the conference delegate respondents proposed

The SAIMI's 2019 conference, titled 'Forward Thinking for Maritime Education and Training Excellence', emphasised the engagement of conference participants to engage with the outcomes. The responses of the conference respondents to the presentation of the report and its data were generally in agreement with the findings and tended to highlight the following issues: a lack of focus

on medium to highly skilled maritime occupations; the pervasive and disproportionate upskilling of previously disadvantaged persons; inadequate deployment of existing infrastructure and facilities; a lack of engagement with the private sector on their specific requirements; and the need for proactive and collaborative engagement founded upon credible data, as the key issues to be addressed. The large divergence in skill sets between the TVET institutions and the universities was also highlighted, together with the low output and the poor standard of Grade 12 certificates, and many of these students lack of adequate readiness for tertiary education.

The requirement to address 'new economies' was emphasised, with the need to respond to changing technologies and the skills required by the relevant sectors to produce the appropriate candidates. The changing needs due to 4IR were highlighted as important considerations, with this view strongly supported by the private sector shipbuilding respondent, who stated that 'there is a need to engage industry when forecasting skill's demand and to ask the right questions'.¹³ The impending skills gap was further highlighted by the skill profile of

¹² Source: Zimmerman op cit note 1. Operation Phakisa Working Groups (Laboratories) data sheets, expanded over 20 years in the Zimmerman and Hosking Ocean Economy satellite account structure and matched to SAIMI derived demand and supply data collected through primary data collection, based to 2017.

¹³ Prasheen Maharaj, Chief Executive Officer, Southern African Shipyards. Opinion expressed on 14 October 2019 at the 'Forward Thinking for Maritime Education and Training Excellence' Conference 13–15 October 2019, Durban.

this private sector ship-building entity, with the average age of their artisans being 37 years old and, therefore, satisfactory. The average age of this entity's technicians is 58 years old, with a looming skills deficit in a few years' time. The expertise required in this shipbuilding industry is all Industry 4.0 aligned, being marine systems, marine electrical, commissioning and propulsion orientated.

The conference report concluded this section by stating the challenges as follows:

*General supply side constraints include the funding and construction of facilities, a shortage of skilled educators and industry relevant training curricula. Specific maritime supply side constraints include a general lack of understanding of the industry, a credible database and specialist training. There is a need to look at the capacity we have and to become more collaborative in engagement to match supply and demand.*¹⁴

This sentiment holds true today and is supported by a range of current views.

VI Technology and 4IR as a nascent opportunity

One of the recurring themes of the conference, besides the mismatch between supply and demand, was the need to address the skills deficit in the various technical domains, both current and emerging. Nascent maritime opportunities are to be found in the oil and gas sectors. With important gas reserves being discovered and opened up along our coastline, as well as the coastlines of our neighbours, the possibilities for offshore renewable energy, particularly offshore wind, and the emerging hydrogen economy are myriad. The hydrogen economy requires accessible, well priced renewable energy, together with the shipping and transportation infrastructure to convey the hydrogen produced to mainly developed country markets. This requires planning and implementation in a manner that will allow South Africa and its people to take advantage of these economic opportunities, supported

by our abundant resources, commanding geographic situation and market-leading position in the African maritime economy. South Africa is able to address this market and has already made a sound start in the policy environment to support these initiatives.

The first three industrial revolutions led to many of the world's current environmental problems, with Industry 4.0 providing an opportunity to right these wrongs, as we run up against the ocean's natural limits, by introducing policies and practices that embrace current technologies and provide economic opportunities and natural solutions, at the same time. Various entities and authors have described the 4IR or Industry 4.0 as the use of digital and robotic technologies to significantly improve traditional commercial and industrial practices. Inherent in the preparation for Industry 4.0 is the need to provide the institutions and the skilled people to implement these policies and practices, whilst, at the same time, altering or transferring the skills and employment opportunities that Industry 4.0 will, by definition, disrupt and destroy.

In a presentation by the World Maritime University at the SAIMI conference,¹⁵ Dr Kitada provided an overview of how Industry 4.0 and automation will impact maritime labour in the year 2040, highlighting the long-term nature of the policy and planning environment that is required for these skills initiatives. The presentation clearly acknowledged the challenge that Industry 4.0 could pose to existing labour structures, stating that technology could reduce the staff required per unit, but the expanding trend of international trade would counterbalance this reduction. The inherent threats to the current labour situation are addressed in a quote from the United Nations:

*Technological advances may disrupt labour markets as traditional jobs change or disappear, even as the number of young job-seekers continues to grow. Re-training will be needed at previously unimaginable scales. Education must adapt, from the earliest grades. And the very nature of work will change.*¹⁶

¹⁴ SAIMI op cit note 2.

¹⁵ M Kitada 'Education and Training in the Fourth Industrial Revolution: What we are missing and what are we pioneering?' Paper presented at the 2019 conference of the South African International Maritime Institute Conference 13–15 October 2019, Durban.

¹⁶ United Nations Secretary-General, António Guterres in an address to the General Assembly, 25 September 2018 in World Maritime University Transport 2040: Automation, Technology, Employment – The Future of Work Reports 58 (Malmö, World Maritime University 2019) (available at <https://commons.wmu.se/lib_reports/58>).

What is clear from this overview is that the seafarer's tasks will become more digitalised, especially in operations monitoring and systems management, and that education and training will need to adapt to equip seafarers, and the many other industries that will be affected, with new skills required, many of them not even considered or understood at this early stage.

VII A proposed way forward to an equitable skills balance

The various presentations and discussions at the Forward Thinking conference all tended to reach the same conclusions and, together with the findings of this report, a combined set of recommendations for proceeding firmly and purposefully from here could be as follows:

- a. The South African schooling system and curricula need to support STEM and maritime skill sets to better prepare potential maritime students;
- b. Career awareness in the maritime sector could be enhanced at school level with subjects such as Nautical Science or Maritime Economics being offered by schools;
- c. More stringent selection criteria need to be applied to students enrolling in courses to ensure that they have the requisite foundational skills, particularly in STEM;
- d. The need to attract suitably qualified lecturers and keep them abreast of maritime industry developments should be addressed;
- e. Use of the National Skills Fund (NSF) should be made to enable collaboration between South African maritime training institutions and to coordinate their activities;
- f. Future workshops need to move beyond discussions and become more focused and proactive in seeking and implementing practical industry-accepted skilling programs;
- g. Closer collaboration between the private and public sector needs to be fostered to provide a holistic view of enterprise development that acknowledges the continuous technological changes in the industry; and
- h. One comprehensive strategy needs to be formulated with an implementation programme that is subscribed to by all industry stakeholders, both public and private, that is currently relevant and that is updated constantly, according to changing industry needs.

VIII Concluding thoughts

The maritime sector remains a nascent and strategic economic sector, which can be leveraged to exploit South Africa's geographical advantage and achieve the economic objectives enunciated in the 2030 National Development Plan (NDP), supported by the Operation Phakisa Ocean Economy initiative, which was launched in 2014.

A proposed approach for the South African Maritime Sector skills and training sector is encapsulated in a statement by Guy Ryder of the International Labour Organization as follows:

How can we manage transformative change at work, caused by multiple factors – technology, demographics, climate change, globalization – to ensure decent work, stability and social justice? It means anticipating technological changes and assuring that education and skills in the labour market keep pace, but fundamentally it calls for a clear focus on the human objectives of policy development.¹⁷

The time for meaningful and purposeful collaboration for the development of the requisite policy to provide the appropriate skills and capacity within this important maritime economic domain is now upon us and requires appropriate planning and action.

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¹⁷ Guy Ryder, Director-General, International Labour Organization in *World Maritime University Transport 2040: Automation, Technology, Employment – The Future of Work Reports* 58 (Malmö, World Maritime University 2019) (available at <https://commons.wmu.se/lib_reports/58>).

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Derek Zimmerman



Forward Thinking for Leading Excellence in Maritime Education and Training

Momoko Kitada*

In the wake of the fourth industrial revolution (4IR), maritime labour and skills needed for the future maritime industry are in question. The role of maritime education and training (MET) has become even more important to equip young people with necessary skills and support the growth of maritime industries. Based on a review of the literature on the impact of 4IR on maritime jobs, this paper proposes a human-centred approach to design the future maritime industry with various stakeholders. While appreciating scenario-based planning to prepare for the future, the paper discusses how South African readiness to technology would potentially provide an opportunity for forward thinking for leading excellence in maritime education and training.

Keywords: *maritime education and training (MET), seafarers, fourth industrial revolution (4IR), South African maritime sector, human-centred approach*

1 Introduction

For years, the term ‘maritime education and training’ (MET) has been understood in both the narrow and broad sense of educating maritime professionals with relevant competencies for specific jobs. In a narrow scope, MET is regarded as seafarer education and training under the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) 1978, as amended. A broader scope of MET would, arguably, address the need for education and training for maritime professionals in various technical domains that support maritime operations and services, including port management/operations; port state control (PSC);

search and rescue (SAR); and maritime administrations, among others. Such an understanding of MET would become more complex as maritime jobs become more diverse.

In the last decade, the fourth industrial revolution (4IR) has been recognised as a game-changer in various industries, including the maritime sector. A range of maritime operations and services is expected to be provided remotely through increasing connectivity between ship and shore.¹ The trends of the 4IR are described as ‘disruptive’ and it is difficult to predict what future skills will be needed and how MET can proactively adapt to these new changes. Further, the COVID-19 pandemic has accelerated the use of digital technology

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¹ M Baldauf et al. *E-Navigation, Digitalization and Unmanned Ships: Challenges for Future Maritime Education and Training* Paper presented at the 2018 12th Annual International Technology, Education and Development Conference (INTED) (2018) Barcelona, Spain.

in MET to increase resilience in organisations.² In this paper, the role of MET will be revisited with a particular emphasis on a human-centred approach to designing a future maritime industry and increasing resilience in the face of uncertainties.

The paper is organised as follows: the impact of the 4IR on maritime labour is discussed. Based on the trends of these discussions, which tend to focus on technology, this paper argues that a more human-centred approach is required to design a future maritime industry. The paper concludes with the important contribution that MET can make to building capacity and resilience in the industry through education.

II Fourth industrial revolution and maritime labour

A series of industrial revolutions were experienced by humans with technological development (Figure 1) and have brought various opportunities for maritime labour. The first industrial revolution (Industry 1.0) was characterised by water- and steam-powered mechanisms, beginning in the late eighteenth century. Around this time, the first commercially successful steamboat was in operation in the United States

of America (USA). Later in 1926, the first Mickey Mouse cartoon, *Steamboat Willie*, was released and symbolised industrialisation and maritime labour. Maritime trades increased across oceans and ship design technology was also improved, which brought huge profit to the maritime industry. The second industrial revolution (Industry 2.0) highlighted efficiency in production systems to meet demand and supply in the nineteenth century – a time of mass production, supported by consumerism. Subsequently, this increased the volume of cargo. The third industrial revolution (Industry 3.0) made the first computers and automation available during the twentieth century. Large volumes of cargo were handled with computation and automated technologies and this increased career opportunities for maritime professionals, including sea- and shore-based jobs.³ The fourth industrial revolution (Industry 4.0) in the twenty-first century put a new trend forward where human activities and job tasks are segmented and converted to data. Various digital systems have become seamlessly interconnected under cyber-physical systems, leading to innovative solutions and opportunities in industries.⁴ The maritime industry also sees a new horizon of technological development, such as smart, green and connected shipping.

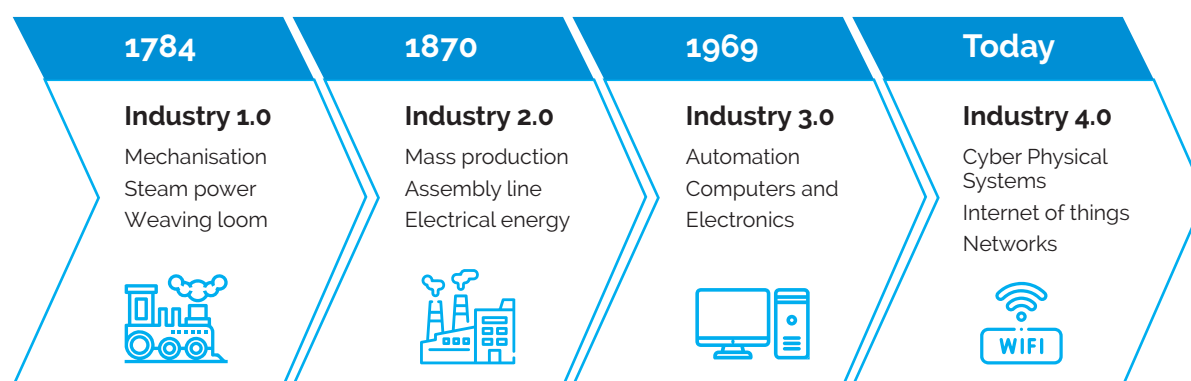


Figure 1: A Glance of Industrial Revolutions

In the history of industrial revolutions, humans have faced employment and skill development issues. Indeed, some jobs have been created, while others have been lost. For example, during the past industrial revolutions, jobs

in machinery operations and maintenance in factories became in demand; however, individual jobs in textile and agriculture industries were no longer cost effective.⁵ This trend can be applied to the maritime industry as well.

² I Bartusevičienė, A Pazaver & M Kitada 'Building a resilient university: ensuring academic continuity—transition from face-to-face to online in the COVID-19 pandemic' (2021) *WMU Journal of Maritime Affairs* <https://doi.org/10.1007/s13437-021-00239-x>.

³ UNCTAD *Technology and Innovation Report 2018: Harnessing Frontier Technologies for Sustainable Development* (2018) UNCTAD.

⁴ J Lee, B Bagheri & H-A Kao 'A cyber-physical systems architecture for Industry 4.0-based manufacturing systems' (2015) 3 *Manufacturing Letters* 18–23.

⁵ BE Kaufman 'Employee voice before Hirschman: its early history, conceptualization and practice' in A Wilkinson et al. *Handbook of Research on Employee Voice* (Camberley, Edward Elgar Publishing 2020).

The number of seafarers deployed on a vessel has significantly decreased in the last century to cut down on labour costs and carry more cargo by removing a large majority of the crew. Recent discussions on autonomous ships highlight the advantage of having few or no crew on board in relation to increasing safety operation while decreasing (labour) costs.^{6,7}

According to Kaufman,⁸ the first, second and third industrial revolutions largely impacted on labour in one specific industry, such as the textile and agricultural industries, by introducing technologies of mechanisation. However, the 4IR is not limited to one industry but creates a larger scale of change in work and life for everyone. Massive data traffic goes back and forth to facilitate digital communications in commerce, business, education, transportation, security and other domains. In *Societies of Control*,⁹ our information and activities are constantly being collected,

analysed and recorded. This is a game-changer for how things are done and, subsequently, influences employment and skills needed for the future. Under the 4IR, it is clear that employment has been polarised between low- and high-skilled non-routine jobs, while jobs at medium skill levels have declined.¹⁰

What automation and jobs are forecasted in the maritime sector? The Transport 2040 report¹¹ (WMU, 2019) summarised the automation trends in the maritime industry as automation and maintenance of vehicles and infrastructure, user interface and new services (Figure 2). While a ship itself may be fully or partially automated, land-based vehicles, cranes and inspection drones may also be remotely operated. Furthermore, user interface changes imply skill requirements to operate the maritime business because prior knowledge of shipping and engineering may not be necessary. New services initiated through digital technology can change how the job is

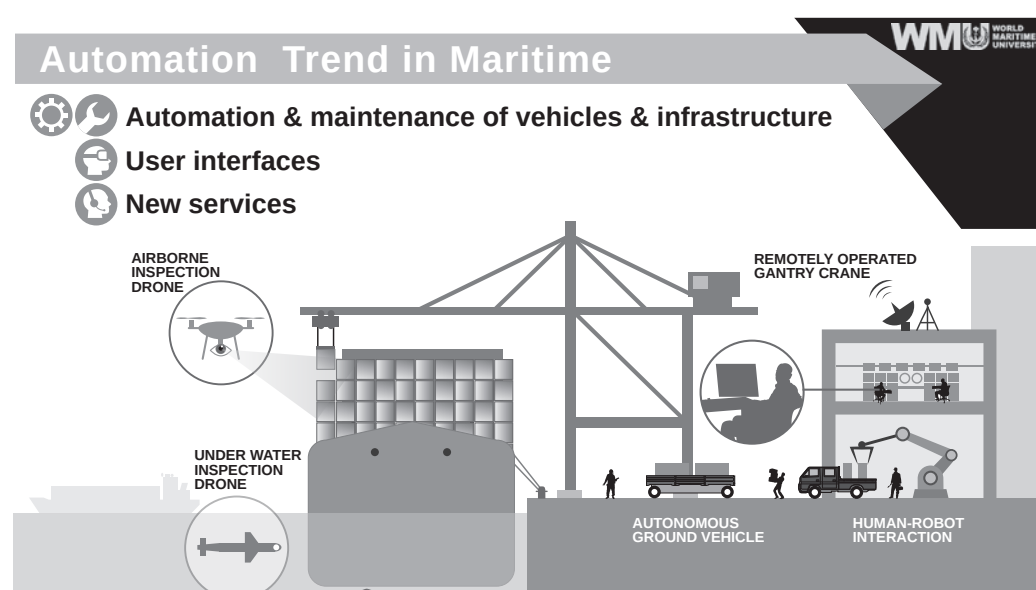


Figure 2: Automation Trends in the Maritime Industry¹²

⁶ T Noma *Existing Conventions and Unmanned Ships – Need for Changes?* (MSc dissertation World Maritime University 2016).

⁷ C Kooij *Towards Unmanned Cargo Ships – A Task Based Design Process to Identify Economically Viable Low and Unmanned Ship Concepts* (PhD thesis Delft University of Technology 2021).

⁸ Kaufman op cit note 5.

⁹ G Deleuze 'Postscript on the Societies of Control' (1992) 59, October 3–7.

¹⁰ UNCTAD op cit note 3.

¹¹ World Maritime University (WMU) *Transport 2040: Automation, Technology, Employment – The Future of Work* (Malmö, World Maritime University 2019) (available <<http://dx.doi.org/10.21677/itf.20190104>>).

¹² Source: Ibid.

done. Drones may deliver necessary parts within 24 hours from online orders or maritime services and software may be offered by subscription rather than one-time purchase.

One of the main challenges to this forecasting of maritime digitalisation is the lack of future scope.

The International Maritime Organization (IMO) has categorised maritime autonomous surface ships (MASS) into four levels of autonomy (Table 1). Without understanding what future we envision, it is very difficult to discuss skills and education for future maritime professionals.

Table 1: IMO's Definitions of MASS's Level of Automation

Degree	Level of autonomy	South Africa by Broad Category – 2017
Degree one	Ship with automated processes and decision support	Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times unsupervised but with seafarers on board ready to take control.
Degree two	Remotely controlled ship with seafarers on board	The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.
Degree three	Remotely controlled ship without seafarers on board	The ship is controlled and operated from another location. There are no seafarers on board.
Degree four	Fully autonomous ship	The operating system of the ship is able to make decisions and determine actions by itself.

III Scenario-based planning

To overcome the challenge of forecasting future maritime automation, scenario planning is one useful methodology to set a direction for preparing education and training for future maritime professionals. Scenario planning offers an opportunity to consider changing factors in social, technological, economic and political domains and to communicate various ideas about the future.¹³

De Klerk¹⁴ conducted a systematic literature review on the 4IR, using the keywords such as autonomous, shipping, maritime, automation and jobs and autonomous ships based on the online EBSCO Library Database archived

since 2015. Based on this review, De Klerk built four potential scenarios: Yankee (business as usual in 2000); Quebec (autonomous shipping strategies implemented by leading countries by 2025); Delta (unmanned vessels approved under certain conditions by 2035); and Oscar (unmanned vessels under operation worldwide by 2040) (see Figure 3). De Klerk's scenario planning is helpful and complementary to the efforts made by the International Maritime Organization (IMO) (i.e., MASS scoping exercises¹⁵) and WMU (i.e., Transport 2040 report¹⁶). Among the four scenarios, the scenario – Delta was concluded as the most plausible in terms of the timeframe and target to discuss future maritime industries.

¹³ Y Kishita et al. 'Research needs and challenges faced in supporting scenario design in sustainability science: a literature review' (2016) 11 *Sustainability Science* 331–347.

¹⁴ Y de Klerk *Scenario Planning for an Autonomous Future: A Comparative Analysis of National Preparedness Relating to Maritime Policy/Legislative Frameworks, Societal Readiness and HR Development for Autonomous Vessel Operations* (MSc dissertation World Maritime University 2019).

¹⁵ International Maritime Organization (IMO) *Outcome of the Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS)* (2021) International Maritime Organization, MSC.1/Circ.1638.

¹⁶ WMU op cit note 11.

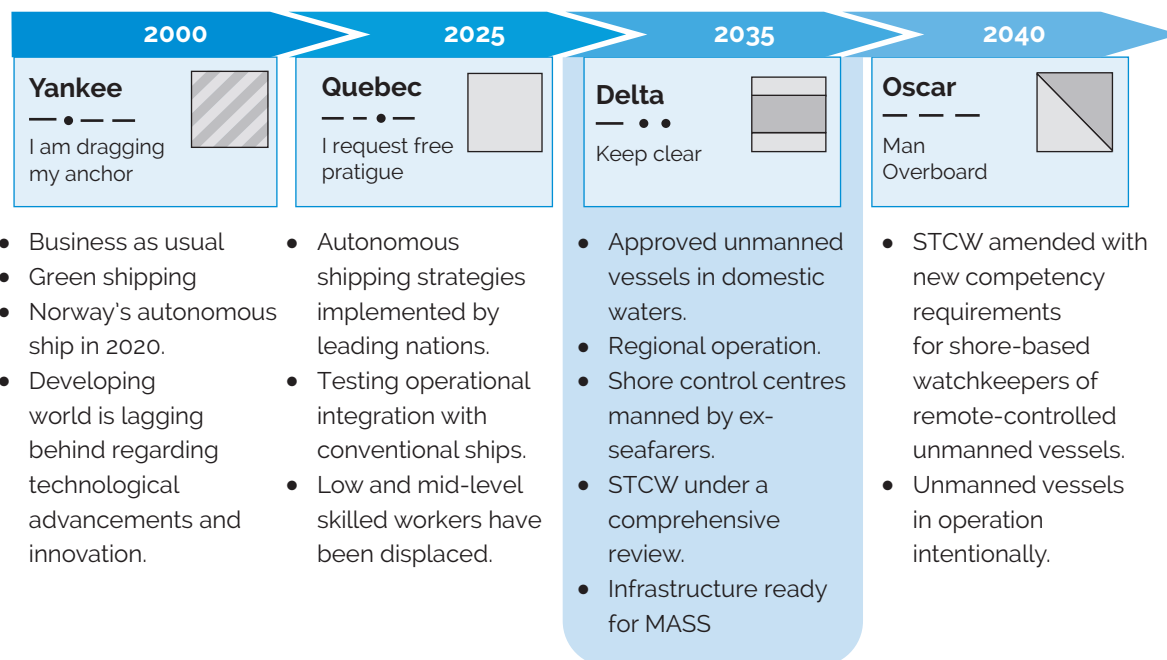


Figure 3: Four Scenario Forecasting in Maritime Digitalisation¹⁷

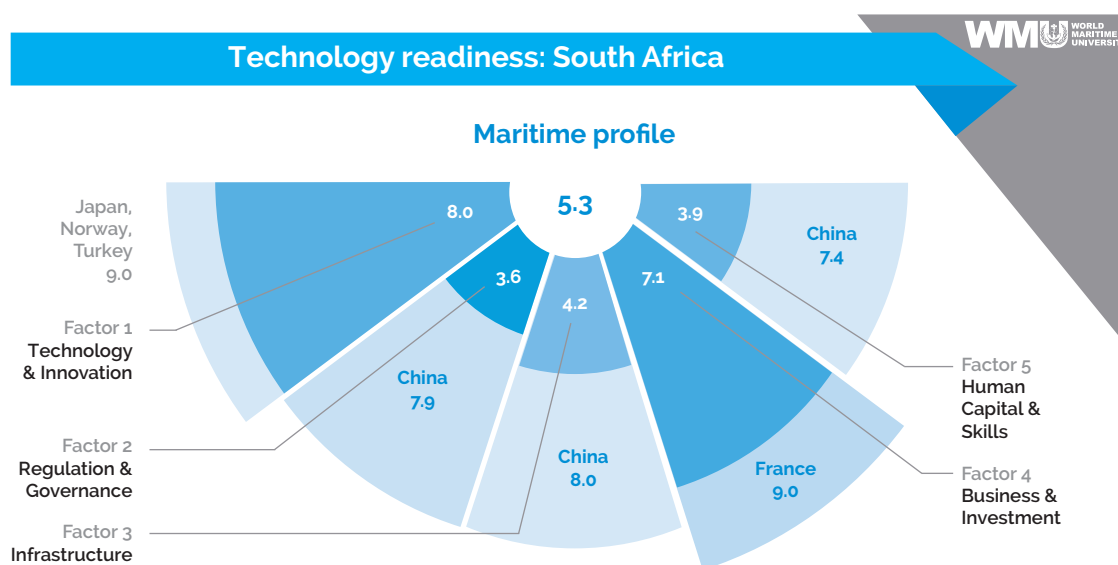
Admittedly, the scenario – Delta provides an opportunity for forward thinking for leading excellence in maritime education and training. Increasing human-machine and machine-machine interactions for future maritime operators emphasises the prominence of communication and leadership skills in the context of ship operations in the era of the 4IR¹⁸. However, it also means that human capital and skills (F5) for the country must be supported by other factors, such as technology and innovation (F1); regulation and governance (F2); infrastructure (F3); and business and investment (F4). Figure 4 shows a summary of South Africa's technology readiness. In the case of South Africa, its maritime profile looks rather unbalanced with respect to the five factors above. While two factors, technology and innovation (F1) and business and investment (F4), are scored high, the other three factors

– regulation and governance (F2), infrastructure (F3) and human capital and skills (F5) – are dragging down the potential of the country for leading excellence.¹⁹ How can South Africa cope with these challenges? It is reasonable to consider education as a key to solving the problems identified in Figure 4. Education does not only relate to human capital and skills (F5), but also to other factors. In order to write laws and regulations and to establish maritime governance (F2), South Africa needs talented maritime professionals. Sustainable and innovative design of infrastructure (F3), supported by technology and innovation (F1) and business and investment (F4), also requires talent and people who have the right skills. Therefore, it is fair and logical to approach the challenges associated with the 4IR from a maritime education and training perspective.

¹⁷ Source: De Klerk op cit note 14.

¹⁸ M Kitada et al. 'Command of vessels in the Era of digitalization' in JI Kantola et al. (eds.) *Advances in Human Factors, Business Management and Leadership, Advances in Intelligent Systems and Computing* (2019) AHFE 2018, AISC 783, 339–350, DOI: 10.1007/978-3-319-94709-9_32.

¹⁹ WMU op cit note 11.

Figure 4: Technology Readiness of South Africa²⁰

IV The role of maritime education and training

Preparing for future industry needs is a common concern for maritime stakeholders, including MET institutions. Education is a long-term investment in the future. Human capital theorists advocate the ways in which education increases the productivity and efficiency of workers as economic outputs of the country.²¹ From a human rights perspective, human dignity is the basis for education and 'Everyone has the right to education' as highlighted in Article 26.1 of the United Nations' Universal Declaration of Human Rights.²² A rapid pace of technological development tends to focus on techno-economic approaches to defend the view that humans should learn new skills and anticipate future demands. While this view sounds reasonable, there is one thing missing from this approach, which is human dignity; humans have the right to education. In other words, it is not because of new technology that humans should learn skills. This is a

very important point that is often forgotten in the current debate of education for the future. Humans are the ones who should decide what subjects to learn, what jobs to choose, and what careers they want. This human-centred approach will make the maritime industry more attractive and exciting for young generations. Techno-economic approaches have other pitfalls. As De Klerk²³ presented four future scenarios of automation in the maritime industry, we can only assume that certain conditions may happen by some point in time, to the best of our knowledge. Such assumptions may not come true at a moderate probability. If MET providers design a new training course based on an assumption, it is possible that the provided training will turn out to be of little value because of the wrong assumption. I, therefore, argue that MET, as well as previous education before choosing MET, should emphasise rather generic and technical skills that allow people the flexibility to decide what they need to learn to adapt to their changing jobs and careers. Figure 5 shows a study by De Klerk et al.²⁴ that identified the skills required in South Africa for the future maritime

²⁰ Source: WMU op cit note 11.

²¹ GS Becker *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education* 3 ed (Chicago, The University of Chicago Press 1993).

²² F Schweitzer 'Human dignity and education – a protestant view' (2016) 72(4) *HTS Teologiese Studies/Theological Studies* 1–8.

²³ De Klerk op cit note 14.

²⁴ Y de Klerk, ME Manuel & M Kitada 'Scenario planning for an autonomous future: a comparative analysis of national preparedness of selected countries' (2021) *Marine Policy* 128 <https://doi.org/10.1016/j.marpol.2021.104428>.

industry. Future MET must be lifelong learning. If people are willing to continuously learn new skills and have dignity in their maritime careers, such human-centred

approaches are far more resilient and sustainable than techno-economic approaches.

Skills required: South Africa

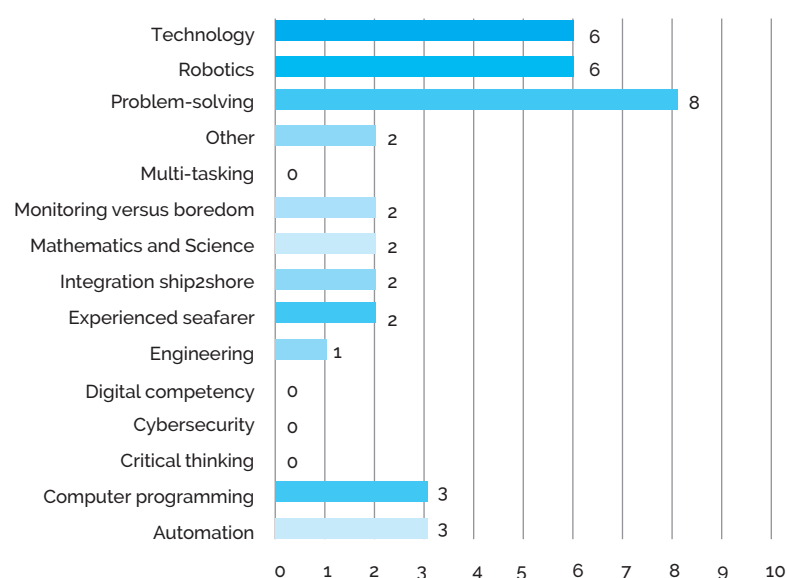


Figure 5: Skills Required in South Africa for the Future Maritime Industry²⁵

In this scope of lifelong learning, MET institutions and other training providers are responsible for offering learning opportunities for skills on demand and ensuring equal access to men and women, boys and girls. The more attractive the maritime industry becomes, the more open and equal MET needs to be. Increasing collaboration between the industry and MET providers is expected to equip young people with the necessary skills and support the growth of maritime industries. Such industry-academia collaborations are successful when governments support and encourage the initiatives by establishing an enabling environment for innovation through education.

V Conclusion

This paper addressed the role of MET in providing talented young people to source the industry in the era

of the 4IR. It began with contrasting the characteristics of past industrial revolutions with the new trends of the 4IR and their implications on maritime jobs. The IMO's scoping exercises on MASS provides common understandings of anticipated autonomy levels in the industry. Those autonomy levels are considered by future scenario planning by De Klerk.²⁶ Several findings on South African readiness and skills required for the future maritime industry by WMU²⁷ and De Klerk et al.²⁸ provided helpful information about the role of MET as a lifelong learning provider. The paper argued the limitation of techno-economic approaches to MET and proposed human-centred approaches instead to empower the maritime industry and young people who can flexibly design their maritime careers through lifelong learning. Increasing collaboration between industry and academia must be supported by the government to ensure lifelong

²⁵ Source: Ibid.

²⁶ De Klerk op cit note 14.

²⁷ WMU op cit note 11.

²⁸ De Klerk et al. op cit note 24.

learning opportunities and equal access to education for men and women. The discussions established in this paper were based on available studies and literature, which did not have space to include other emerging MET aspects, including academic continuity and resilience during the pandemic.²⁹ Further studies are necessary, focusing not only on disruptive technologies but also on other emerging topics around MET to address the role of MET.

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²⁹ Bartusevičienė op cit note 2.

Conclusion

It is the vision of the South African International Maritime Institute (SAIMI) to eliminate the mismatch between skills supply and demand in the oceans economy on the continent, and in South Africa. While a perfect match may never be fully achieved, SAIMI is actively working towards reducing an oversupply of skills that are not in demand. *The Forward Thinking for Maritime Education and Training Excellence Conference* was a first-of-its-kind conference involving all role-players – from government, industry, training institutions and academia – with a specific focus on bridging the gap between skills supply and demand in the maritime industry.

This holistic view of skills development in the maritime industry also recognised the pivotal role entrepreneurship needs to play in pursuing and broadening opportunities in the blue economy. Entrepreneurship remains key to the transformation of the maritime industry in promoting the entrance of new enterprises which have not participated in these sectors before.

In addition to the publication of some of the most critical topics that emerged from the conference, another outcome of the event was the concerted efforts by key stakeholders in heightening the interest of TVET colleges in the blue economy and encouraging their greater participation in the maritime industry. As a result, a task team of key stakeholders that are pursuing these efforts has been established, which is chaired by the South African College Principals' Organisation (SACPO), and further consists of SAIMI representatives, industry representatives, representatives from key SETAs – including the Manufacturing, Engineering and Related Services Sector Education and Training Authority (MerSETA) and the Transport Education and Training Authority (TETA), as well as representatives from the National Skills Fund

(NSF) and the Department of Higher Education and Training (DHET).

A third outcome of the conference was establishing an industry council, where invited key industry organisations work alongside SAIMI to provide training partners with an agenda, set by industry, for skills demand. This will ensure that changes within the maritime industry are timeously provided for in the skills output on the continent and in South Africa, including adapting to the effects of the Covid-19 pandemic. While the pandemic has had a varied impact on the maritime industry itself, it has forced all role-players to look at new ways of skills development – including blended learning and faster adaption to the 4IR.

We look forward to completing all SAIMI-commissioned skills audits for the various subsectors of the oceans economy in 2022. In addition, we are proud to have published this first issue of the *South African Journal of Maritime Education and Training*. Look out for more issues to come with critical research contributions from our esteemed scholars and experts. Our vision is to make a significant contribution to the knowledge economy of the maritime sector.



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