NIHERST

International Labour Organization

Assessment of 21st Century Skills Across Emerging Sectors

Maritime Sector

Volume 1

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Acknowledgements

The successful completion of the "Assessment of 21st Century Skills Across Emerging Sectors: Maritime Sector" report was made possible through the contributions and support of numerous individuals and institutions.

NIHERST extends our deepest gratitude to our project partner and sponsor, the International Labour Organization (ILO), whose collaboration was instrumental to this project. Special recognition is given to Ms. Ilca Webster, Specialist on Skills and Lifelong Learning at the ILO, for her invaluable technical support and guidance to the survey team throughout the duration of the project.

The Institute also expresses its sincere appreciation to the 159 employers from the five emerging industries who participated in the survey, providing essential data and insights that underpin this report.

NIHERST gratefully acknowledges the support and oversight provided by the Ministry of Education and the Ministry of Tertiary Education and Skills Training. Additionally, we appreciate the contributions of various ministries, agencies, universities and associations, whose collaboration and input were crucial to the success of this assessment, notably the:

1. Ministry of Public Administration and Artificial Intelligence;
2. Ministry of Planning, Economic Affairs and Development;
3. Ministry of Labour;
4. Ministry of Sport and Youth Affairs;
5. Central Statistical Office (CSO);
6. The University of the West Indies (UWI);
7. University of Trinidad and Tobago (UTT);
8. College of Science, Technology and Applied Arts of Trinidad and Tobago (COSTAATT);
9. National Training Agency of Trinidad and Tobago (NTA);
10. Youth Training and Employment Partnership Programme (YTEPP);
11. Employers' Consultative Association of Trinidad and Tobago (ECA);
12. Public Services Association (PSA); and
13. Trinidad and Tobago Manufacturers' Association (TTMA).

Finally, we extend our heartfelt thanks to the dedicated staff at NIHERST, particularly those in the Science and Technology Statistics Department, for their tireless efforts and commitment in producing this report.

Foreword

In today's world, technology is evolving at a rapid pace, reshaping industries, jobs, and the skills required for success. For a country such as Trinidad and Tobago (T&T), where human capital is one of our greatest assets, we must ask ourselves some critical questions. Are we preparing our workforce for what's coming next? Are our young people equipped not just with qualifications, but with the skills needed to remain relevant, adaptable, and employable?

To examine these critical questions, NIHERST, in collaboration with the International Labour Organization (ILO), conducted an in-depth assessment of 21st Century Skills across emerging sectors in Trinidad &Tobago.

This inaugural report focuses on the maritime sector, an industry long embedded in T&T's national economic fabric, yet facing increasing pressure to modernise and grow. The maritime sector holds significant promise for sustainable development and competitiveness, but realising this potential requires more than investments in infrastructure. It calls for a new generation of Science, Technology, Engineering, and Mathematics (STEM) oriented professionals capable of navigating an increasingly digital, innovation-driven landscape, especially as important global trends such as climate change and digitalisation, continue to reshape the world of work and the maritime industry.

The report outlines the employers' challenges in finding the right people with the right skills and the difficulty in recruiting in engineering, environmental science, and IT-related talent, thus underscoring the importance of targeted education and training strategies to address the mismatch between labour market needs and available skills.

Since its establishment, NIHERST has remained committed to advancing science, technology, and higher education in Trinidad and Tobago and is proud to have contributed to this important body of research that supports workforce development.

On behalf of the Institute, I extend sincere thanks to the ILO for its valued partnership, to the employers within the maritime sector, professionals who shared their insights, and to the NIHERST team, whose dedication made this report possible.

Ms. Julie David
President (Ag.)
NIHERST

Partner Message

The International Labour Organization (ILO) Decent Work Team and Office for the Caribbean is proud to be part of this publication to support Trinidad and Tobago's efforts to transition towards a more diversified workforce.

This report focuses on the Maritime Sector, it forms part of an impressive wider strategy by the National Institute of Higher Education, Research, Science and Technology (NIHERST) to identify needs and actions for effective skills development in emerging sectors. It offers a timely and insightful assessment of the 21st century skills and STEM competencies shaping the future of this industry.

It would be remiss of me not to highlight that the results presented in this report are based on a NIHERST survey launched with guidance from the ILO Global framework on core skills for life and work in the 21st century and technical advice from Ms. Ilca Webster, Lifelong Learning Specialist at the ILO Caribbean Office.

The ILO commends NIHERST for its targeted approach to enhancing skills anticipation and closing skills gaps for this sector. The maritime sector stands as a cornerstone of innovation and economic growth. Recruiting talent equipped not only with technical expertise but also with the soft and cognitive skills that are often underdeveloped in recent graduates is key to unlocking the full potential of this sector.

This report is more than a snapshot of current challenges; it is a call to action. By embracing its insights and recommendations, stakeholders across government, academia, and industry can work collaboratively to ensure that Trinidad and Tobago not only keeps pace with global trends but leads in shaping a digitally empowered future.

Dr. Joni Musabayana
Director
ILO Caribbean Decent Work Team and Office for the Caribbean

Executive Summary

Trinidad and Tobago's maritime sector is not just a vital engine of economic growth, it is a strategic frontier for innovation and national development. The country's maritime domain holds immense potential. However, the sustainability and expansion of this sector hinges on one critical factor, a future-ready workforce equipped with 21st century and STEM (Science, Technology, Engineering and Mathematics) skills. International organisations such as the World Bank and the OECD (Organisation for Economic Co-operation and Development) have underscored the importance of STEM education in preparing individuals to meet these evolving demands.

STEM education not only builds foundational knowledge on critical disciplines but also cultivates 21st Century Skills - such as problem-solving, critical thinking, collaboration and digital literacy - that are essential for navigating today's innovation-driven economy. These competencies, underpinned by STEM education and training, are relevant in the maritime sector and are vital for navigating the transition to a knowledge-based economy and ensuring workforce resilience.

To support evidence-based planning and targeted skills development, NIHERST, in partnership with the International Labour Organization (ILO), undertook the Assessment of 21st Century Skills Across Emerging Sectors. The study was designed to provide insights into the current and future skills demands in five (5) key industries: Maritime, Tourism, Software Design and Applications, Agro-processing and Aviation. This report presents the first in a series of sectoral analyses, focusing on the maritime industry, offering evidence-based findings to guide policy development and workforce planning aimed at strengthening national capacity and competitiveness in this vital industry.

The Trinidad and Tobago economy relies heavily on maritime resources such as oil and gas extraction, tourism and fisheries for economic growth and prosperity. The country's ocean-based economy within its Exclusive Economic Zone (EEZ) is estimated to be worth US$22.5, or 81% of national GDP (2015).[1] Furthermore, maritime plays a pivotal role in supporting various emerging sectors targeted for development. The essential role of the maritime industry, as a primary source of

[1] Ministry of Planning and Development. Integrated Coastal Zone Management Policy Framework. Revised by Integrated Coastal Zone Management Inter-Ministerial Committee. 2020. (Original reference: CH2M Hill Halcrow. 2016).

natural resources and in supporting other industries, underscores the importance of developing targeted programmes that focus on strategic expansion of this sector. The growth of the maritime sector will depend heavily on several critical factors, including the strength of its labour force. As the maritime industry evolves in response to growing technological and environmental trends, a highly skilled workforce will be necessary to drive innovation, competitiveness and sustainable growth in the sector.

The Assessment of 21st Century Skills Across Emerging Sectors is an essential initiative that aims to gather relevant data to inform policies designed to develop the workforce of five key industries. This publication represents the findings from 23 companies involved in maritime activities. The key findings of the report are summarised below.

The analysis in this report begins by outlining the key characteristics of employers in the maritime sector, which served to contextualise the research findings and provide a clearer understanding of the local industry landscape. Data collected revealed that the majority of businesses surveyed (69%) had been in operation for over 20 years, indicating a well-established sector with longstanding players. Additionally, approximately three-quarters (74%) of the establishments were classified as micro and small enterprises (MSEs), employing fewer than 25 persons, underscoring the sector's composition of predominantly smaller firms. The main economic activities represented among these businesses were Ship Repair and Dry Docking (52%) and Maritime Services (44%), reflecting the sector's core operational focus areas.

Another important aspect explored in this publication is the composition and characteristics of the workforce in the maritime sector. Collecting data on workforce characteristics, particularly in relation to STEM, is crucial for understanding the current composition of the labour force and for identifying both present and future workforce needs. The findings reveal that the maritime sector employed more males than females, with a higher percentage of businesses employing 10 or more male employees (43%) compared to only 30% for female employees. Regarding occupational groups, the majority of establishments employed Managers (95%) and Clerical Support Workers (61%)[2], with males outnumbering females in all groups except Clerical Support. When it comes to

[2] The occupational groups presented in this report are based on the International Labour Organization's International Standard Classification of Occupations (2012) and are further detailed in Appendix I.

STEM qualifications, 48% of the establishments surveyed reported having employees with STEM degrees, while 52% did not. The presence of employees in STEM occupations was generally low across the board[3]; however, the highest concentration was found in Engineering roles, followed by positions in Computer Science/IT and Natural Sciences. A breakdown by sex showed that males were more prevalent in Engineering and Computer Science/IT roles, whereas females were more represented in Natural and Environmental Sciences occupations.

Job Vacancies and Recruitment Challenges

Workforce data from 23 maritime establishments highlights a subdued recruitment environment, with only 30% of firms reporting current vacancies, and a similarly low percentage (30%) indicating recently filled positions. Notably, 35% of employers reported vacancies in non-STEM fields, while only 15% reported vacancies in STEM-related areas, primarily Engineering and Computer Science/IT, with the vast majority in Engineering. Most employers did not encounter challenges when filling either STEM or Non-STEM positions; however, among those who did face difficulties, a greater number reported that STEM vacancies were more challenging to fill. When examining the types of roles, the highest levels of difficulty were noted for Technicians and Associate Professionals, followed by Managers and Professionals. Within the STEM fields, employers reported the greatest difficulty in filling vacancies in Natural Sciences, followed by Engineering and Computer Science/IT occupations. Notably, Marine Engineers and IT Professionals were identified as the most difficult STEM positions to fill. The primary factor contributing to these challenges was a low number of applicants possessing the required skills. To address these issues, employers recommended several strategies, including the creation of more training opportunities aligned with industry needs, greater promotion of maritime studies at career fairs, the development of effective policies to support employee training and development, and the introduction of additional maritime programmes at both university and TVET levels. At present, the University of Trinidad and Tobago (UTT) remains the only tertiary institution offering maritime studies in the country.

[3] STEM occupations are based on the Bureau of Labour Statistics, Department of Labour, United States of America, Occupational Employment and Wage Statistics Survey, 2021 and are listed in Appendix II.

Core Skills and Skills Mismatches

An integral component of this research involved gathering data on the skills of the workforce to identify skills mismatches in the maritime sector. Skills mismatch represents a discrepancy between the skills demanded by employers and the skills individuals possess. This can affect economic growth by limiting workers' employment and salaries and firms' profitability and productivity.[4] The skills examined in this study are based on nineteen (19) core skills that are described in Appendix III. These skills were identified by the ILO as core skills that were important building blocks to lifelong learning and adapting to changes in the labour market. This is particularly relevant to the maritime sector, where identifying the core skills required to achieve business goals and matching them to the skills of recent applicants and existing employees can facilitate a better understanding of the magnitude and nature of the skills gap. Ensuring that maritime workers possess these core skills is crucial for maintaining the sector's efficiency and competitiveness in a rapidly evolving global economy.

The study revealed several key findings: most employers indicated that all 19 core skills were important, excluding basic green job skills. Communication, collaboration and teamwork, emotional intelligence, and foundational literacies were ranked highest. Regarding drivers of change, the main internal factors were profit (74%), people (35%), and technology (26%), with marketing (21%), leadership (12%), organisational (11%), and communication skills (9%) identified as critical to address these changes. External drivers included competitors (86%), technology (43%), and climate change (21%), requiring skills such as problem solving (21%) and adaptability (18%).

Regarding employers' perception on the skill levels of recent university graduates employed in their establishments, 50% or more of the employers experienced some level of difficulty in finding social and emotional, and cognitive and metacognitive skills among university graduates applying for job vacancies in their companies. The highest level of difficulty was recorded for foundational literacies followed by conflict resolution and negotiation; emotional intelligence; analytical and critical thinking; creative and innovative thinking; self-reflection and learning to learn; and

[4] Productivity is defined as a ratio between the volume of output and the volume of inputs. It measures how efficiently production inputs, such as labour and capital, are being used in an economy to produce a given level of output (OECD 2024)

planning and organising. The least difficulty was observed for basic digital skills. Over a half (55%) of the establishments reported that recent graduates were somewhat prepared for work while 36% stated well prepared.

In terms of existing employees, a half (50%) or more of the employers assigned a high rating to the 19 core skills among their existing employees except Waste reduction and waste management and Energy and water efficiency. The highest ratings were assigned to communication, collaboration and teamwork, conflict resolution and negotiation, analytical and critical thinking, and planning and organising. There is evidence of a skills gap among employees in the maritime industry based on the variation between the skills employers identified as key for employees to possess in order to achieve business goals and the current skills among existing employees. While over 90% of the employers indicated that 13 of the 19 core skills were important for employees to possess to successfully achieve business targets, only 78% or lower assigned high ratings to each skill among existing employees. Approximately three-quarters (74%) of the employers reported that the lack of skills among workers did not affect their operations while 13% disagreed and a similar percentage did not reply.

Demand for STEM Labour

The study also examined the demand for STEM labour across the sector, acknowledging that as industries continue to evolve and adopt more innovative practices, the need for STEM-related skills and personnel is becoming increasingly critical. Understanding current and future demand for STEM labour is essential to identifying gaps in the labour market and determining the types of jobs that will be needed to sustain growth and competitiveness. Findings from the survey revealed that the current demand for STEM-related occupations was generally low among the establishments interviewed. However, where demand did exist, it was highest for Engineering occupations, followed by Computer Science/IT roles. Conversely, the field of Food and Agriculture recorded the lowest demand for STEM-related skills. Among the top jobs currently sought by employers were Marine Engineers (23%) and IT Technicians (23%). Looking ahead, employers identified Electrical Engineers (21%), Marine Surveyors (14%), and Marine Engineers (14%) as the most important STEM occupations for their organisations over the next five years, based on their strategic direction.

TVET Labour Needs

As part of the assessment, technical and vocational education and training (TVET) labour needs were also identified. Generally, the response registered for the TVET

section was low. It is recommended that assessments focusing mainly on TVET be undertaken to encourage better understanding and cooperation from businesses.

Technological Advancements in the Maritime Industry

This report includes an assessment of technological advancements in maritime operations, focusing on both challenges and opportunities. Emerging technologies such as autonomous vessels, artificial intelligence (AI), blockchain, and green energy are driving increased efficiency and enabling zero emissions. To remain competitive, maritime establishments must adapt by integrating these innovations into their operations. Global technological advancements offer the potential to strengthen local operations and support the expansion of STEM careers. The report also highlights the transformation of Trinidad and Tobago's maritime sector, mapping its shift from traditional methods to technology-driven practices, supporting the ongoing modernisation of the industry.

Policy Relevance and Recommendations

The findings of this study provide critical input for policy and programme design in workforce development. It offers recommendations from employers in the maritime sector on actions Government, industry and tertiary institutions should take in order to strengthen STEM education and STEM labour. Employers provided recommendations on how tertiary education programmes could be improved to meet the needs of industry and the role of Government and private sector in developing STEM labour. Some of the key recommendations include: increase practical training in tertiary programmes; ensure education programmes are aligned to the needs of industry; increase training opportunities to meet the needs of the industry; improve alignment of scholarships to the needs of the sector; introduce more incentives for businesses in STEM industries; increase more training programmes for employees; and increase internship and apprenticeship programmes. General recommendations based on the findings of the study are also included in this report. These recommendations focused on improving STEM education, increasing training opportunities, integrating STEM in the classroom, training STEM educators, promoting STEM education and careers, increasing data collection on the labour market statistics, and strengthening linkages between stakeholders among other recommendations. Building a resilient, future-ready maritime workforce will require concerted action across government, academia, and industry to close existing skills gaps and unlock the sector’s full growth potential.

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Abbreviations and Acronyms

AI	Artificial Intelligence
CBTT	Central Bank of Trinidad and Tobago
CSO	Central Statistical Office
GHG	Greenhouse Gas
GORTT	Government of the Republic of Trinidad and Tobago
ISCO	International Standard Classification of Occupations
ILO	International Labour Organization
ICT	Information and Communication Technologies
IMO	International Maritime Organization
IoT	Internet of Things
IT	Information Technology
MoE	Ministry of Education
MSEs	Micro and Small Enterprises
MSMEs	Micro, Small and Medium Enterprises
NIHERST	National Institute of Higher Education, Research, Science and Technology
OECD	Organisation for Economic Co-operation and Development
SMEs	Small and Medium Sized Enterprises
STEM	Science, Technology, Engineering and Mathematics
S&T	Science and Technology
SDG	Sustainable Development Goal
T&T	Trinidad and Tobago
TVET	Technical and Vocational Education and Training
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme

UNESCO	United Nations Educational, Scientific and Cultural Organization
UTT	University of Trinidad and Tobago
UWI	The University of the West Indies
WEF	World Economic Forum

Introduction

With over 80% of Trinidad and Tobago's GDP estimated to be derived from its ocean-based economy, the maritime sector is not only a lifeline of national economic activity but also a critical enabler of future growth. From oil and gas exports and fisheries to ship repair and underwater heritage tourism, the sector touches every corner of the economy, yet it faces mounting challenges driven by rapid technological change, skills shortages, and evolving global demands. How well this sector adapts and thrives will depend significantly on the quality and readiness of its workforce.

The Assessment of 21st Century Skills Across Emerging Sectors project is both timely and strategically significant, aligning closely with the Government's 2025 policy priorities. It serves as a critical mechanism for building a future-ready, STEM-empowered workforce, catalysing economic transformation, and advancing inclusive national development in accordance with the Government's vision for a prosperous and modern Trinidad and Tobago. A core pillar of the Government's Youth Development Policy is its commitment to equipping the next generation with the skills, purpose, and opportunities needed to thrive in an increasingly dynamic and technology-driven global landscape. In keeping with this commitment, the Government has also signaled its intention to embrace artificial intelligence (AI), digital technology, and new media as enablers of meaningful employment opportunities.

NIHERST, in collaboration with the International Labour Organization (ILO), undertook the Assessment of 21st Century Skills Across Emerging Sectors study from February 2023 to July 2025. The overarching objective of this study is to provide accurate data on STEM labour requirements in key industries to assist policymakers in developing effective education, training, and workforce strategies in response to rapid technological advancements. This report presents the research findings from the maritime sector.

The maritime sector of Trinidad and Tobago comprises of various sub-sectors that can be grouped around five economic ecosystems. These include: maritime and port (including bunkering, maritime transport and transhipment, port operations and development, cold stacking, ship repair, dry docking, breaking and recycling); food (fisheries); defence; tourism (tourism, yachting and underwater cultural heritage); and the rest of the economy (enabling sectors such as spatial planning, special zones, energy sector, etc.).[5] Trinidad and Tobago has two main ports that

[5] Ministry of Trade and Industry. *Final Draft National Maritime Policy and Strategy*. 2021.

provide a container trade, the Port of Port of Spain and the Port of Point Lisas. These two ports handle a wide range of cargo, including crude oil, petrochemicals, and containerised goods. The oil and natural gas sector, which is the main economic activity of the country, benefits significantly from the maritime industry, as shipping plays a critical role in the transportation of these resources.

The maritime industry is undergoing a global transformation, driven by technological advancements. This shift has underscored the need for modernisation, environmental sustainability and workforce development. Rapid technological advancements have significantly increased the demand for highly skilled workers with STEM competences. STEM competences refer to an individual's ability to apply STEM knowledge, skills and attitude appropriately in his or her everyday life, workplace or educational context.[6] It is widely agreed that building STEM competencies within the workforce is essential for increasing innovation, growth and competitiveness. Therefore, it is imperative that employees are equipped with the requisite skills, competencies and qualifications needed for the future of work so that can they truly realised their full potential and maximise their contribution to economic development.

STEM skills are essential for workers to adapt to the evolving work environment due to fast-paced technological advancements. This research was conducted to gather data on the demand for STEM-related skills and labour in the maritime industry of Trinidad and Tobago. This study sought to provide data on the characteristics of both employers and employees of the industry. It investigated existing vacancies within the industry and the challenges employers encountered when attempting to fill these positions. The study also included a thorough analysis of the skills demanded by businesses to meet its strategic goals, comparing these needs with the current skill sets of both recent job applicants and existing employees. Moreover, the research identified key factors driving change in businesses and the skills needed to address them. Additionally, the enquiry focused on the current and future demand for STEM labour. It also investigated the types of innovations adopted in the global maritime industry market along with the associated careers and benefits. Drawing from the research findings, a series of evidence-based recommendations were developed.

This report is organised into the following sections:

Section 1 describes key aspects of the survey methodology employed for the study. The following aspects are discussed in this chapter: the objectives of the study;

[6] UNESCO International Bureau of Education. *Exploring STEM Competences for the 21st Century.* 2019.

research methods used; designing the survey questionnaire; sample design; data collection; and data processing and presentation.

Section 2 focuses on the characteristics of establishments that participated in this study, including length of time in operation, employment size by sex and occupational group and main economic activity performed by businesses.

Section 3 presents data on the characteristics of the workforce. This section provides data on employees by sex, occupational group, STEM qualifications and STEM occupations.

Section 4 introduces the recruitment issues reported by employers in the maritime sector. This section offers data on the number of establishments with current vacancies, the difficulty employers experienced during recruitment, and vacancies filled in the last twelve (12) months. In addition, the section provides a comparison of vacancies and recruitment issues by STEM and non-STEM fields and also features recommendations to overcome these challenges.

Section 5 presents an assessment of the skills mismatches in the maritime sector. This section examines the skills employers identified as important for employees to possess in order to meet organisational goals and objectives. Additionally, an assessment of the skills among recent job applicants, university graduates and existing employees is depicted in this section. Section 5 also provides data on the success of universities in preparing graduates for the workplace.

Section 6 examines the demand for STEM workers, including current and future demands. The top STEM occupations demanded by the industry based on their strategic plan are also identified.

Section 7 identifies the TVET needs in the maritime sector.

Section 8 offers recommendations provided by employers on how the tertiary education, government and business sectors can help improve STEM competencies.

Section 9 highlights significant technological advancements in the maritime sector, along with key STEM careers linked to these innovations. It also explores the ease and advantages of integrating these technologies into maritime operations. Furthermore, the section provides an analysis of the technological developments within the Port of Trinidad and Tobago.

Section 10 offers general recommendations based on the research undertaken, stakeholder consultations and the results of the industry survey.

Section 11 is the conclusion that reiterates salient points made throughout this publication.

1. Research Design

This section describes key aspects of the survey methodology employed for the Assessment of 21st Century Skills Across Emerging Sectors. The methodology for this study was guided by the European Training Foundation/European Centre for the Development of Vocational Training/ILO guide to developing and running an establishment skills survey.[7] This section begins by identifying the objectives of the study. The next aspect discussed is the research method employed for the study. The section also includes a description of the design of the survey questionnaire, presenting several key documents that guided the development of the questionnaire. Additionally, the section summarises the sample design and response rate for the survey. The final aspects discussed under this section are data collection and limitations, data processing and presentation.

1.1 Objectives of the Study

The objectives of the study are to:

- Provide data on the skills mismatches in emerging sectors
- Provide data on the demand of STEM graduates in emerging sectors
- Provide information to improve the alignment between education and labour market demand
- Provide data to inform policymakers, education specialists, industry and all stakeholders in creating policies to develop the STEM workforce of the country
- Provide data on key areas where scholarships/incentives are needed to encourage students to pursue degrees in these fields
- Collaborate with the public universities to align their programmes to the key STEM areas and to introduce new programmes where necessary
- Provide information to introduce students to relevant STEM careers necessary for growth and development of critical sectors of the economy

[7] European Training Foundation/European Centre for the Development of Vocational Training/ILO. *Developing and Running an Establishment Skills Survey: Guide to Anticipating and Matching Skills and Jobs Volume 5.* 2017

1.2 Research Method

The survey employed a mixed methods approach. A questionnaire was designed to collect both quantitative and qualitative data.

1.3 Questionnaire Design

The questionnaire was developed based on the objectives of the study and was designed to generate the key information necessary to achieve the objectives. The questionnaire design was guided by existing labour force studies and guides, mainly the ILO's Global Framework on Core Skills for Life and Work in the 21st Century and STEM in TVET Curriculum Guide.

1. The ILO's Global Framework on Core Skills for Life and Work in the 21st Century was utilised to capture data on the skills characteristics of the workforce. Recognising the importance of core skills for enabling workers to attain decent work and improving living standards, the ILO developed the Global Framework on Core Skills for Life and Work in the 21st Century. The framework was developed after a comprehensive literature review of international and national core skills frameworks and an analysis of the impact of the global drivers of transformative changes on the world of work was undertaken to extract the most important skills necessary to adapt to the future of work. Additionally, several consultations were undertaken to revise these skills into 19 core skills considered essential both for work and life. The Framework identified 19 core skills that were grouped into the four categories shown in Table 1. These skills are further defined in Appendix III.

Table 1: Core skills for life and work in the 21st century

Core skills for life and work in the 21st century			
Social and emotional skills: • Communication • Collaboration and teamwork • Conflict resolution and negotiation • Emotional intelligence	**Cognitive and metacognitive skills:** • Foundational literacies • Analytical and critical thinking • Creative and innovative thinking • Strategic thinking • Problem-solving and decision-making • Self-reflection and learning to learn • Collect, organise and analyse information • Planning and organising • Career management	**Basic digital skills**: • Use basic hardware • Use basic software • Operate safely in an online environment	**Basic skills for green jobs:** • Environmental awareness • Waste reduction and waste management • Energy and water efficiency

2. The survey utilised the STEM in TVET Curriculum Guide, ILO Women in STEM for Workforce Readiness and Development Programme to gather data on STEM skills in TVET workers. The STEM in TVET Curriculum Guide identified four major domains of STEM competencies that support TVET including STEM knowledge, thinking skills, multiliteracies, and socio-emotional intelligence. These skills are described further in Appendix IV.

1.4 Sample Design

A representative sample of 61 businesses from the maritime sector was contacted to participate in the survey. A survey frame was created using several data sources including the CSO business register. The sector was stratified by sub-sector and size as well as a sample was generated from each stratum using systematic random sampling. Of the 61 businesses contacted, 23 responded, representing a response rate of 38% .

1.5 Data Collection

1.5.1 Interviewers
Field interviewers were recruited to conduct interviews with employers. These interviewers already had considerable training and experience in conducting labour surveys. They were further trained on the survey objectives and questionnaire. Data collection was undertaken during the period of October to November 2023.

1.5.2 Pilot Study
A pilot study was undertaken using a sample of twenty-four (24) businesses to pre-test the survey instrument to ensure that respondents understood the questions correctly and were able to provide accurate answers. The feedback from the pilot study was used to improve the questionnaire for greater accuracy in responses.

1.6 Limitations of the study

There were several challenges encountered whilst undertaking this study. These include:

i. Business listing was outdated - The CSO listing was outdated and had to be updated by the project team. It is important that an updated businesses listing is available for future studies. This would save time and ensure greater accuracy of the sampling frame.
ii. Lack of disaggregated data for emerging sectors – There was no business listing available for some sectors categorised as emerging. Some emerging sectors, such as software design and applications, are part of a broader sector, as a result these companies had to be extracted from the overall list. In certain cases, alternative sources were used to compile a list of businesses within these specific sectors. There is a need for up-to-date listings of sectors identified for expansion. This would not only support future research but also enable the accurate measurement of growth within these industries.
iii. Low response from industry – A substantial percentage of employers declined to complete the survey, citing several reasons, mainly time constraints. This lack of participation highlights the need to increase the promotion of STEM skills and the importance of STEM workers in driving competitiveness, growth, and sustainability within businesses. It also emphasises the importance of data collection to guide policies that support

workforce development, ensuring businesses can meet both their current and future workforce needs.

iv. Most maritime companies were Micro, Small and Medium Enterprises (MSMEs) and generally recorded low employment and recruitment. This underscores the importance of ensuring employers recognise the value of STEM skills and professions for future growth, while also ensuring that the STEM workforce is aligned with industry needs and accessible to MSMEs.

1.7 Data processing analysis and presentation

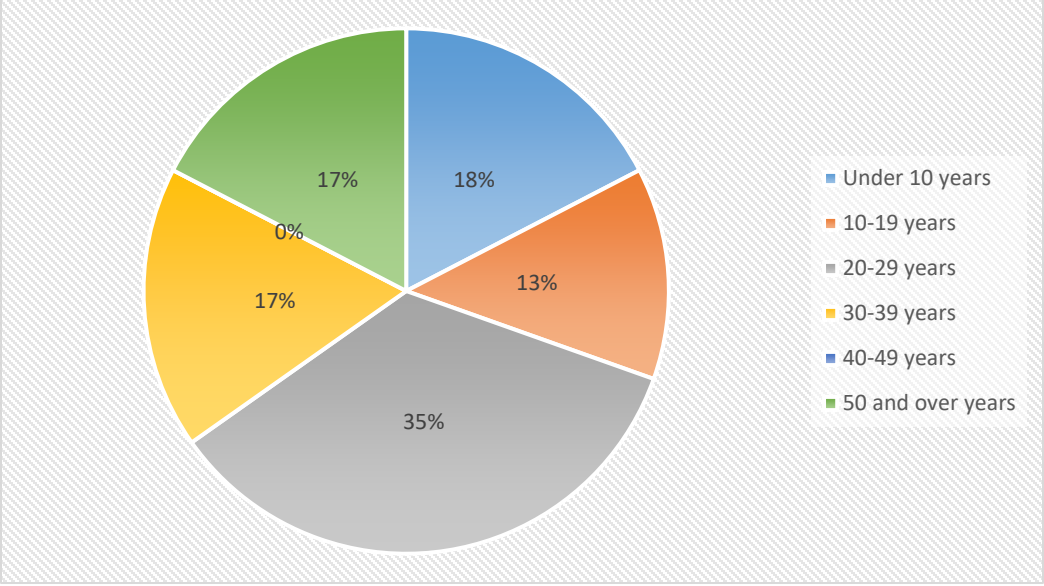
The quality of the data was checked for accuracy. Where there were discrepancies the field interviewer or office staff contacted the respondents for verification. Quantitative and qualitative data was coded and processed on SPSS and Excel. The results of the study are presented in the chapters that follow.

2. Characteristics of Employers

This section describes some of the key characteristics of employers in the maritime sector of Trinidad and Tobago. The purpose of collecting data on the characteristics of employers is to contextualise the findings presented in this report and to facilitate a better understanding of the survey population. The key characteristics of employers examined in this study were length of time in operation, employment size and main economic activity.

The first characteristics of employers presented in this section is the length of time in operation. Figure 1 presents the percentage of establishments in the maritime sector by the length of time in operation. Overall, the data shows that businesses are at various stages of maturity, with the highest percentage (35%) having been in operation for 20 to 29 years, followed by those operating for less than 10 years (18%), 30 to 39 years (17%), and 50 years or more (17%). The large number of businesses operating for 20 years and over reflects a strong level of resilience among establishments within the industry, as well as the potential for continued innovation.

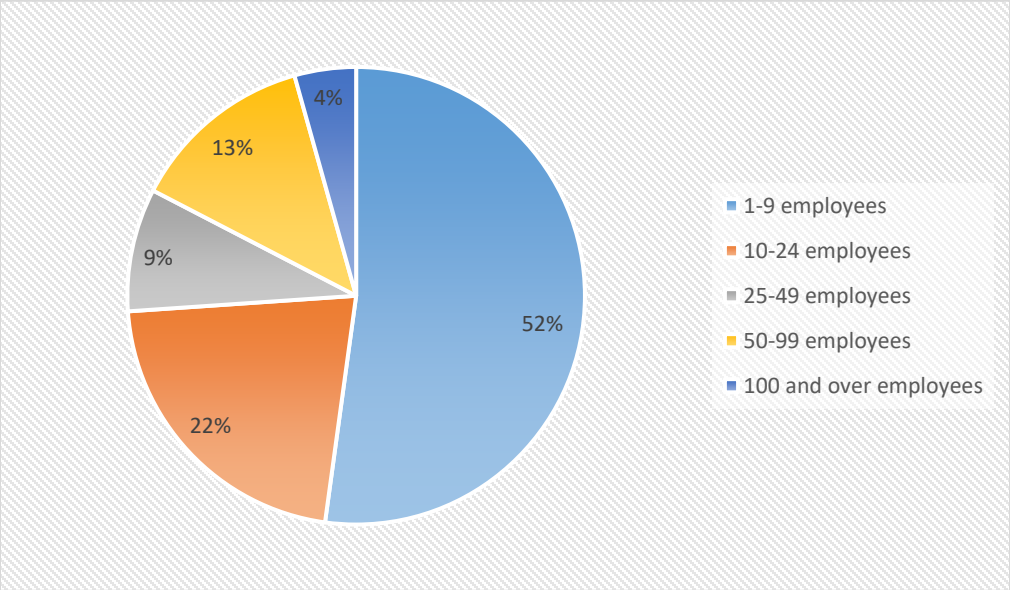
Figure 1: Percentage of establishments by length of time in operation



With regard to employment size, the results show that the maritime sector was predominantly made up of Micro and Small Enterprises (MSEs). Figure 2 shows that over a half (52%) of the establishments that participated in the survey had less

than 10 employees and 22% had between 10 to 24 employees. At the national level, it is estimated that 95% of the businesses in Trinidad and Tobago were micro, small and medium-sized enterprises (MSMEs), with the vast majority being micro and small.[8] The dominance of MSEs within the maritime sector presents both challenges and opportunities for employment, innovation and competitiveness. While these businesses are well-positioned to benefit from technological advancements, they may face challenges in attracting STEM talent. Competition from larger companies, which offer more attractive compensation and training packages, can hinder smaller businesses in the maritime sector from accessing the key STEM talent necessary for their growth and success. The large proportion of MSEs in the maritime sector underscores the need for policies that support smaller businesses by improving access to STEM talent and resources that would help unlock their innovation potential.

Figure 2: Percentage of establishments by employment size



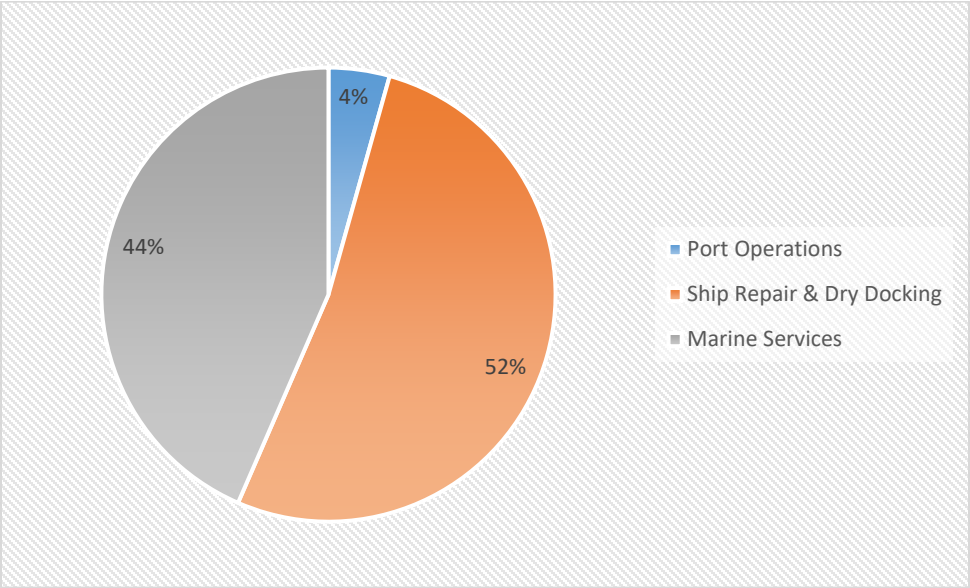
Another characteristic of employers featured in this section is the main economic activity they performed. The activities in the local maritime industry were diverse, however, for the purpose of this study the activities were grouped under the following three categories: Port Operations; Ship Repair & Dry Docking; and Marine

[8] Central Bank of Trinidad and Tobago. *Research Papers Vol. 3 No. 2.* September 2023.

Services including Offshore Bulk Transhipment, Bunkering, Cold Stacking, Maritime Logistics and Open Ship Registry.

Figure 3 presents the main economic activity of establishments that replied to the survey. The largest proportion (52%) of establishments was observed in Ship Repair and Dry Docking while 44% were recorded in Maritime Services and 4% in Port Operations.

Figure 3: Percentage of establishments by main economic activity

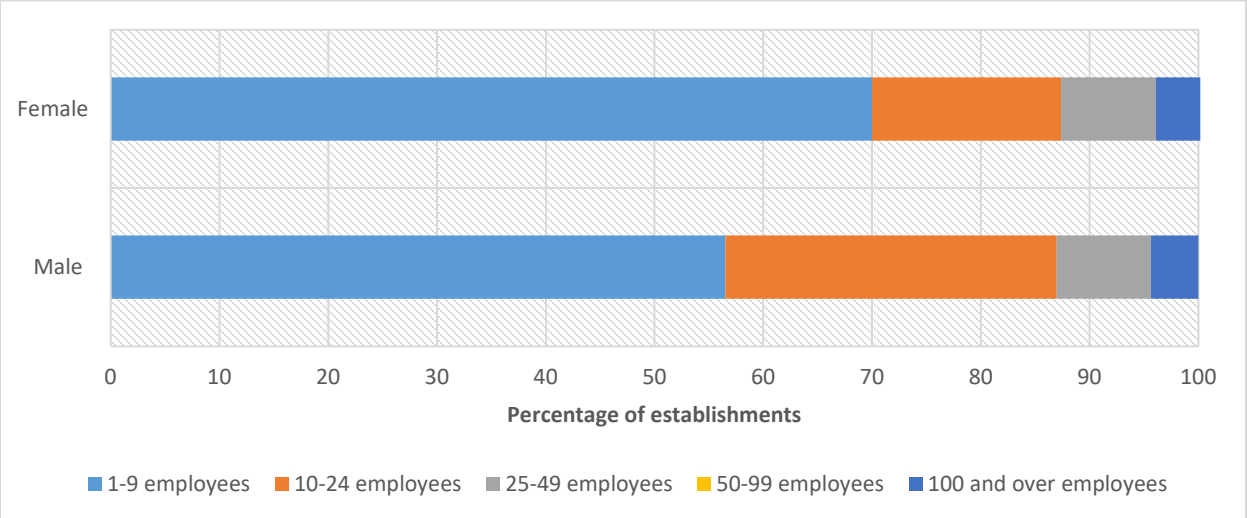


3. Characteristics of the Workforce

Collecting data on the characteristics of the workforce is important in order to understand the current composition of the workforce, identify skills mismatches and provide information to enable proper workforce planning. This section provides data on employees by sex, occupational group, STEM qualifications and STEM occupations.

In terms of sex, Figure 4 shows that the maritime industry employed more males than females. A higher percentage (43%) of businesses employed 10 or more male employees compared to 30% in the case of the females. The lower number of female employees, particularly in higher-level positions such as Professionals and Technicians and associate professionals (Figures 5–7), highlights the need to encourage greater female participation in the maritime industry. This will help ensure that women are not excluded from crucial roles in key sectors. Encouraging greater female participation not only promotes gender equality but also ensures that the maritime industry workforce is more diverse, robust and sustainable, ultimately contributing to the overall development of the industry.

Figure 4: Employment size by sex



The ILO's International Standard Classification of Occupations (ISCO) was used to describe the workforce by occupational groups. Figures 5 – 7 present the workforce of the maritime businesses by occupational group and sex. The main findings within occupational groups are summarised below.

- Managers:
  - All the establishments (95%) that responded to the question employed Managers with the majority employing 1-9. Five percent (5%) did not provide a response.
  - Males outnumbered their female counterparts in managerial positions; 43% of the establishments reported no female manager compared to 9% in the case of male managers.

- Professionals:
  - Overall, 31% of the establishments employed staff in this category.
  - The number of males (30%) employed in the Professional category was marginally higher than females (26%).

- Technicians and associate professionals:
  - Over one-third (35%) of the establishments that responded to the survey had workers under this occupational group.
  - Similar to the two previous occupational groups, the percentage of males (34%) was higher than females (22%) in this category.

- Clerical support workers:
  - Approximately three-fifths (61%) of the establishments employed clerical support workers.
  - By sex, a larger proportion of females (52%) was employed in this category compared to males (30%).

- Service and sales workers:
  - Approximately two-fifths (39%) of the respondents employed service and sales workers.
  - The percentage of males (35%) employed in this occupational group was doubled that of the females (17%).

- Skilled agricultural, forestry and fishery workers:
  - There were no skilled agricultural, forestry and fishery workers in the businesses who participated in the study.

- Craft and related trades workers:
  - Only 9% of the establishments reported workers in this category and they were all males.

- Plant and machine operators, and assemblers:
    - Thirteen percent (13%) of the establishments employed workers in this category, and all were male employees.

- Elementary Occupations:
    - One-quarter (25%) of the employers had workers in elementary occupations in their establishments.
    - Males (26%) out-numbered females (17%) in this category as well.

The data reveals that the largest proportion of establishments employed Managers (95%) followed by Clerical support workers (61%). A smaller proportion of establishments employed workers in Professionals (31%) and Technicians, and Associate Professionals (35%) categories. This suggests that many establishments may lack a workforce with the necessary skills to drive productivity, innovation, and competitiveness in a technology-led environment. As a result, this could lead to gaps in the skills and expertise required to support future growth of the sector and ensure long-term sustainability.

Figure 5: Employment by occupational group and sex – Both sexes

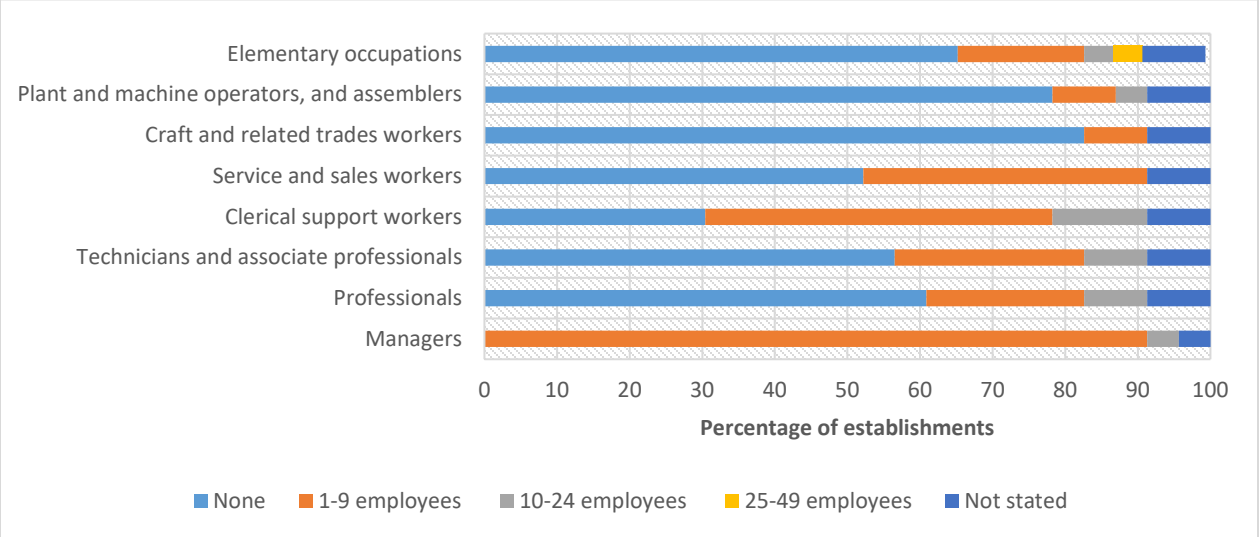


Figure 6: Employment by occupational group and sex – Males

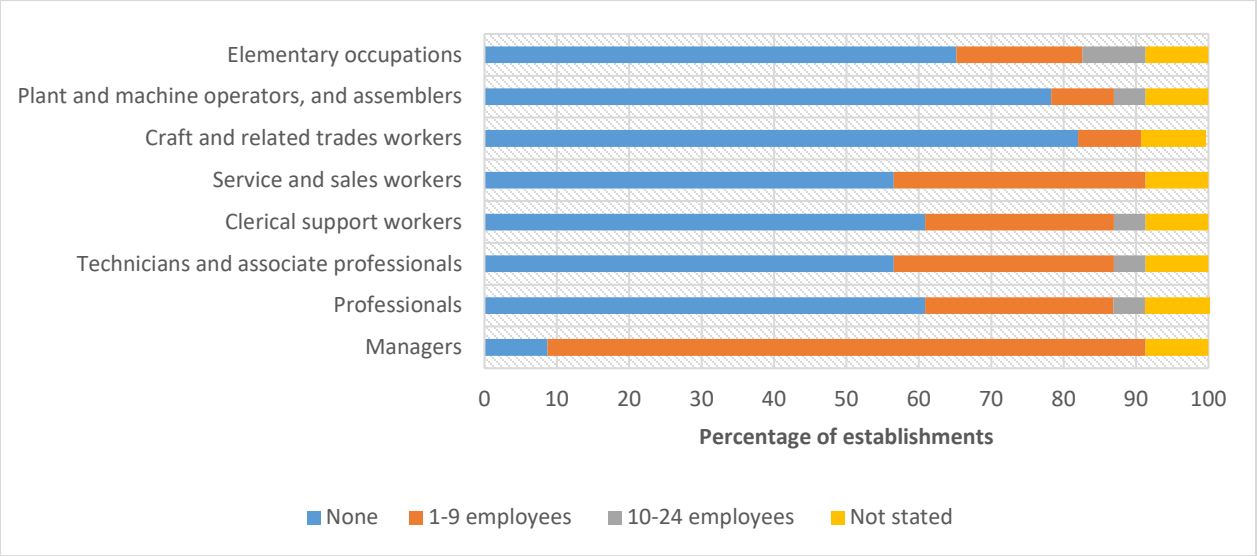


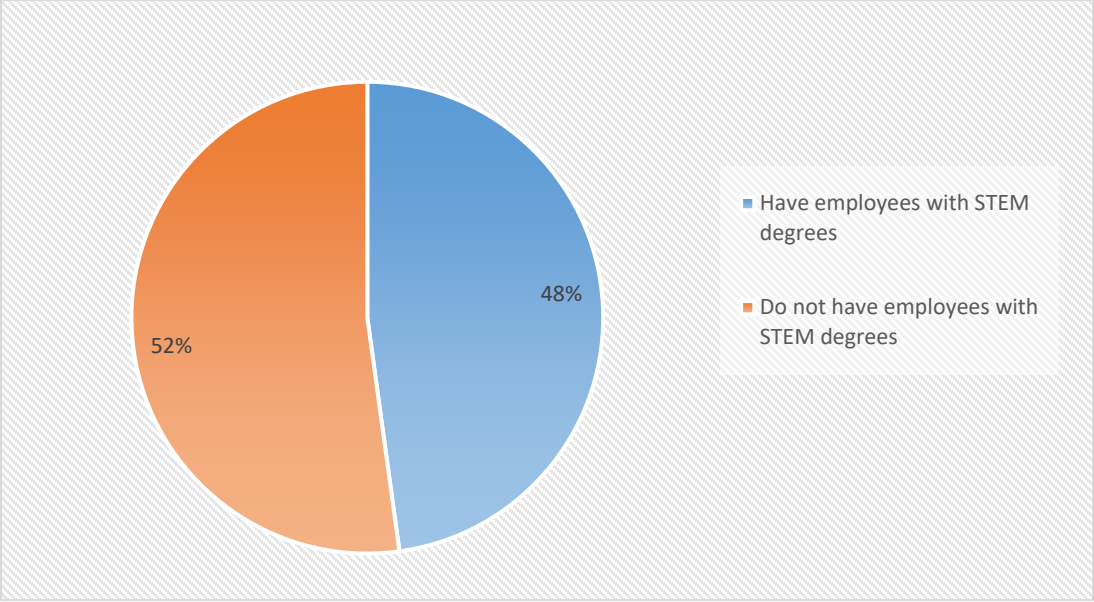
Figure 7: Employment by occupational group and sex – Females

To effectively assess the STEM labour needs within the maritime sector, it is necessary to first gather data on the current STEM workforce in the industry. This involves determining the overall size of the STEM workforce, as well as analysing key characteristics, such as STEM fields represented, gender distribution, and occupational groups. By understanding the composition of the existing STEM workforce, the gaps or shortages in STEM roles can be identified to help guide strategies to develop a workforce that can meet the evolving needs of the sector.

For the purpose of this study, STEM fields included Natural Sciences; Engineering; Computer Science/IT; Mathematics and Statistics; Food and Agriculture; Medical and Health; and Environmental Sciences.

Figures 8 – 11 summarises key data on employees with STEM qualifications by occupational group and sex. Overall, 48% of the establishments surveyed had employees with STEM degrees while 52% did not (Figure 8). The large proportion of establishments without STEM talent is concerning, given the importance of STEM employees for innovation and sustainable growth. The absence of a skilled STEM workforce could hamper establishments from leveraging new technologies that are crucial for staying competitive in an increasingly technology-driven market. This shortage can lead to broader challenges, including slow economic development and reduced job creation within the sector.

Figure 8: Percentage of establishments with employees with STEM degrees



A review of STEM qualifications within occupational groups shows that, in general, there was a low number of employees with STEM qualifications within each occupational group (Figure 9). The occupational group that recorded the highest percentage of employees with STEM degrees was Managers (39%), followed by Professionals (22%); Technicians and Associate Professionals (18%); Clerical support workers (13%); and Service and sales workers (4%). The following job categories did not have any employees with STEM qualifications and are therefore not included in Figures 9 – 11, Craft and related trades workers; Plant and machine operators, and assemblers; and Elementary occupations.

A further examination of STEM qualifications by gender shows that a higher percentage (35%) of establishments reported female managers with STEM degrees compared to 30% in the case of male managers (Figures 10 & 11). The reverse was observed for the Clerical support workers and Service and sales workers occupational groups, which registered more male employees with STEM degrees than female employees. A similar percentage of male and female in the Professionals (17%) and Technicians and Associate Professionals (13%) categories possessed STEM degrees.

Figure 9: Percentage of establishments with employees with STEM degrees by sex and occupational group – Both sexes

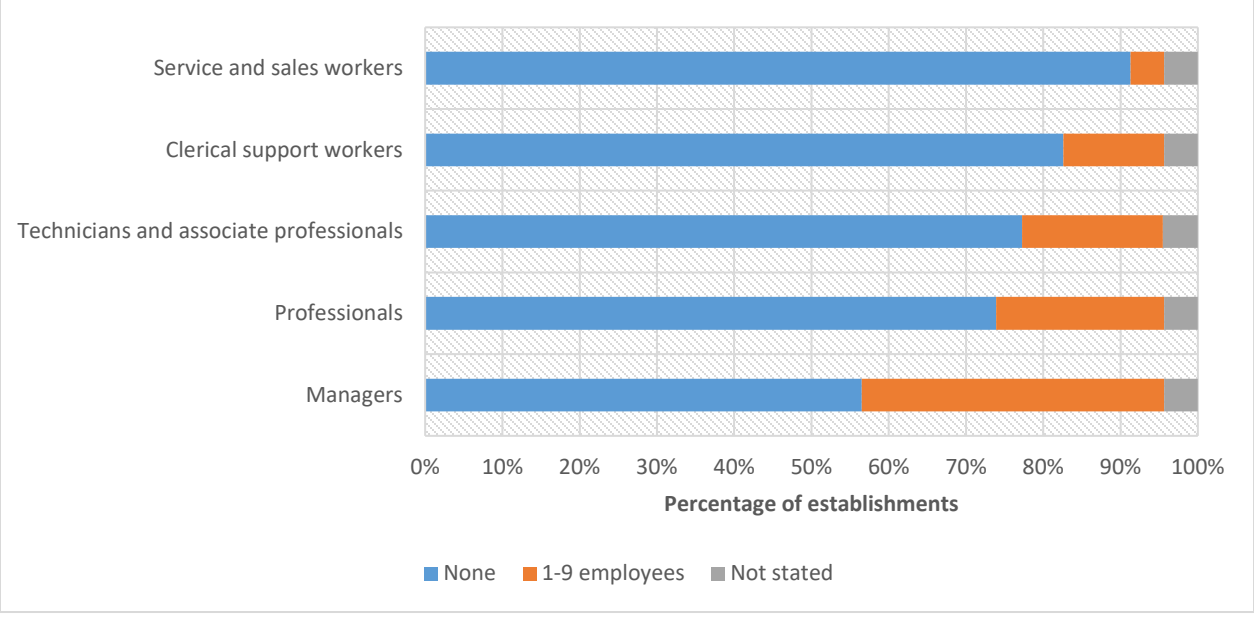


Figure 10: Percentage of establishments with employees with STEM degrees by sex and occupational group - Males

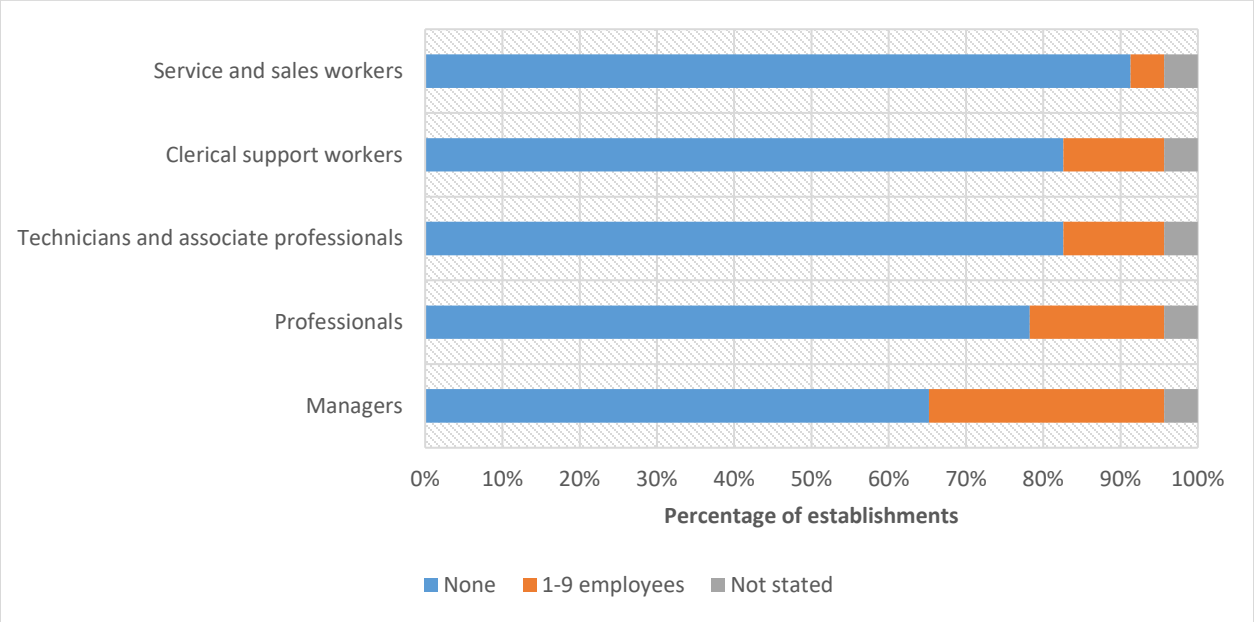
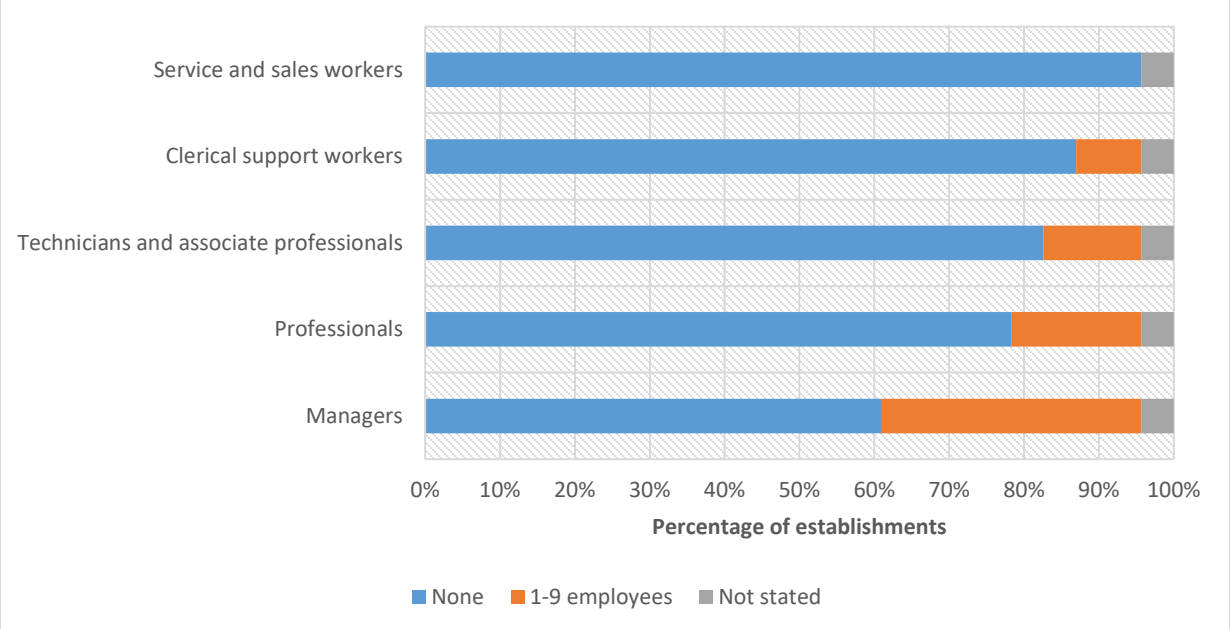


Figure 11: Percentage of establishments with employees with STEM degrees by sex and occupational group - Females



In addition to STEM qualification, the report also explored the labour force participation in STEM occupations. For the purpose of this study, STEM occupations consisted of Natural Sciences; Engineering; Computer Science/IT; Mathematics and Statistics; Food and Agriculture; Medical and Health; and Environmental Sciences occupations. In addition, a list of STEM occupations is included in Appendix II. Although educational requirements vary, the survey focused on STEM occupations that required a bachelor's degree or higher.

Figure 12 shows the number of employees in STEM occupation groups within the establishments that participated in the survey. The data shows that the number of employees in each of the STEM occupation groups was very low. The highest percentage of employees was observed in Engineering occupations followed by Computer Science/IT and Natural Sciences occupations. There were no employees in Mathematics and Statistics, and Food and Agriculture occupations.

A review of the number of employees in STEM occupations by gender, shows that there were more males in Engineering and Computer Science/IT occupations than females (Figures 13 and 14). Females out-numbered males in Natural Sciences and Environmental Sciences occupations while a similar proportion of male and female employees was observed in Medical and Health occupations. While STEM careers in all disciplines are essential, current trends suggest that technological advancements will significantly drive future job opportunities, with particular emphasis on ICT and Engineering. Therefore, increasing participation in these professions, particularly among women, is crucial for meeting the future labour demands and driving overall economic growth.

Figure 12: Employees in STEM occupation group by sex – Both sexes

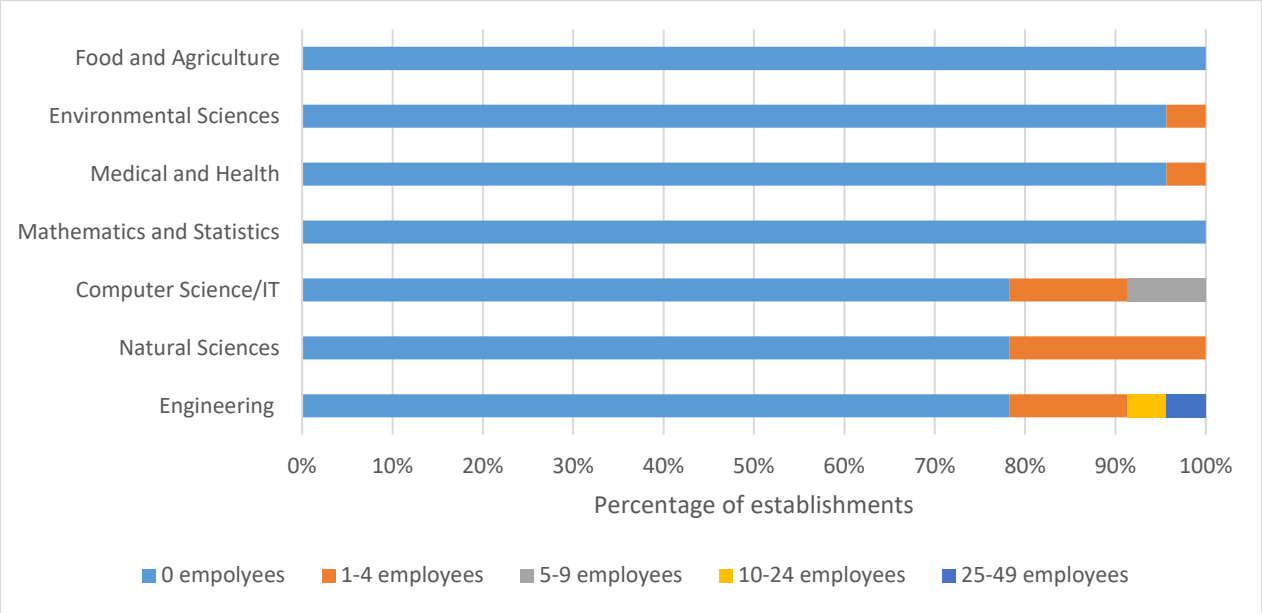


Figure 13: Employees in STEM occupation group by sex – Males

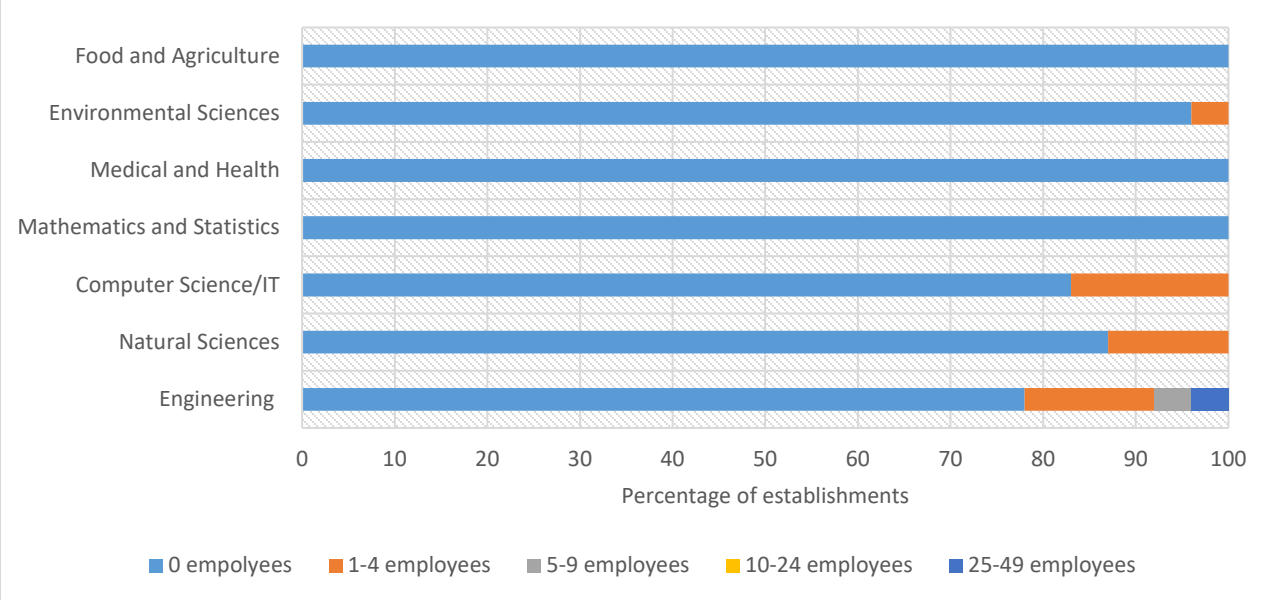
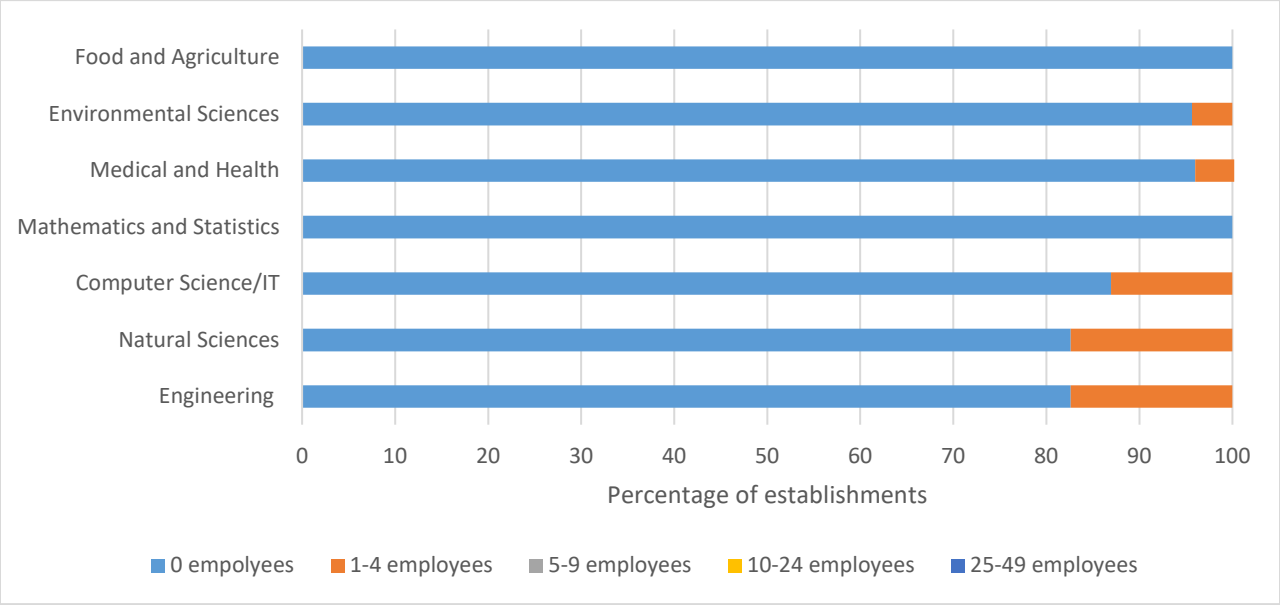


Figure 14: Employees in STEM occupation group by sex – Females



4. Recruitment and Vacancies

Data on vacancies and recruitment provides valuable insights into employment trends within the maritime industry and identifies the fields that have the most opportunities. This data is particularly important for policymakers, workforce planners, educational institutions, job seekers and students. This section begins by identifying the proportion of employers with vacancies, particularly in STEM occupations, at the time of the survey. The study considered vacancies across various STEM fields, including Natural Sciences; Engineering; Computer Science/IT; Mathematics and Statistics; Food and Agriculture; Medical and Health; and Environmental Sciences. In addition, a comparison of STEM and non-STEM vacancies was undertaken to compare the employment opportunities available to STEM graduates and non-STEM graduates in the maritime sector. The section also features the number of vacancies employers filled over the last twelve (12) months and whether they had difficulties filling these vacancies. Additionally, this section offers recommendations from employers on actions needed to overcome these difficulties.

In terms of vacancies, Figure 15 reveals that overall, there was a low number of vacancies in establishments that responded to the survey. A substantially lower percentage (30%) of the establishments reported vacancies during the survey period compared to 70% with no vacancy.

Figure 15: Percentage of establishments with current vacancies

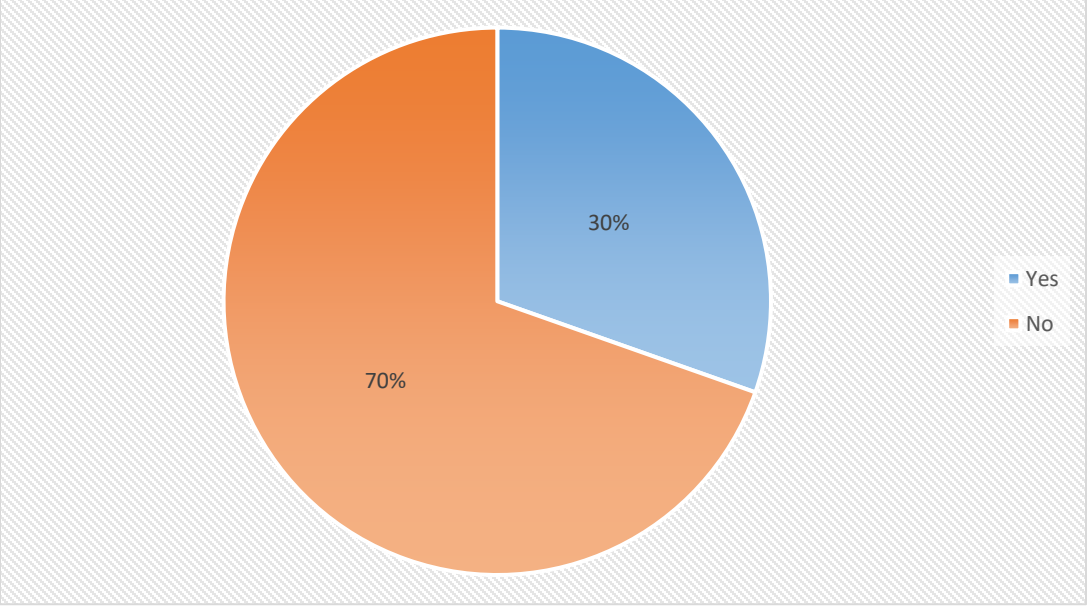


Figure 16 shows the percentage of establishments with current vacancies by STEM and non-STEM fields. The survey results reveal that a larger proportion (35%) of employers reported vacancies in non-STEM fields compared to vacancies STEM fields (15%). In addition, of the total number of non-STEM vacancies (27) was higher than the total number of STEM vacancies (16) (Figure 17). This meant that there were more job opportunities in the maritime sector for graduates in non-STEM fields compared to graduates in STEM fields. This implies that the maritime sector was currently recruiting more non-STEM talent while the vast majority of key jobs projected for the future were in STEM fields. The low rate of STEM employment in maritime establishments is concerning and may suggests a need for greater awareness and understanding among employers about the critical role STEM professionals will play in future development.

Figure 16: Percentage of establishments with STEM and Non-STEM vacancies

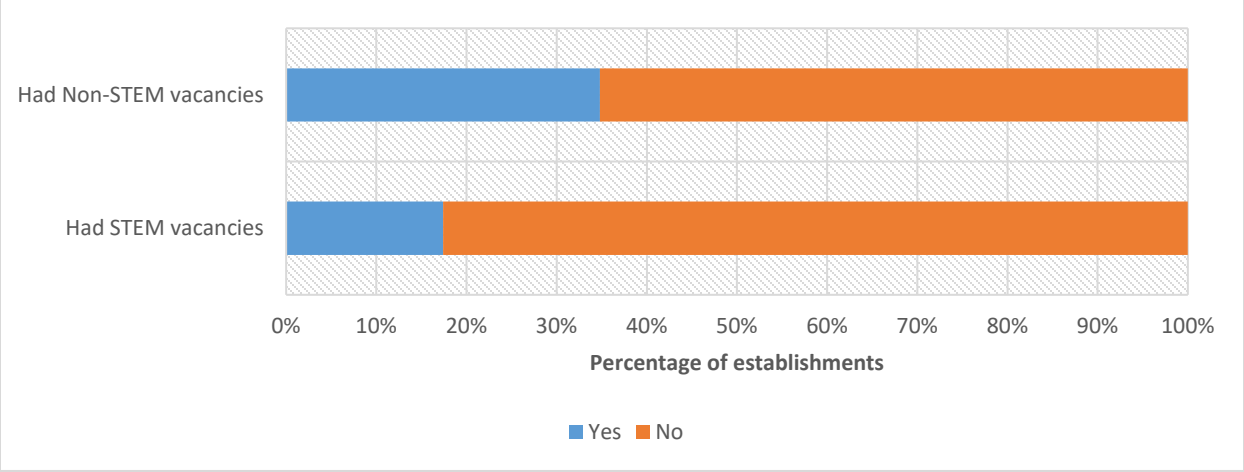
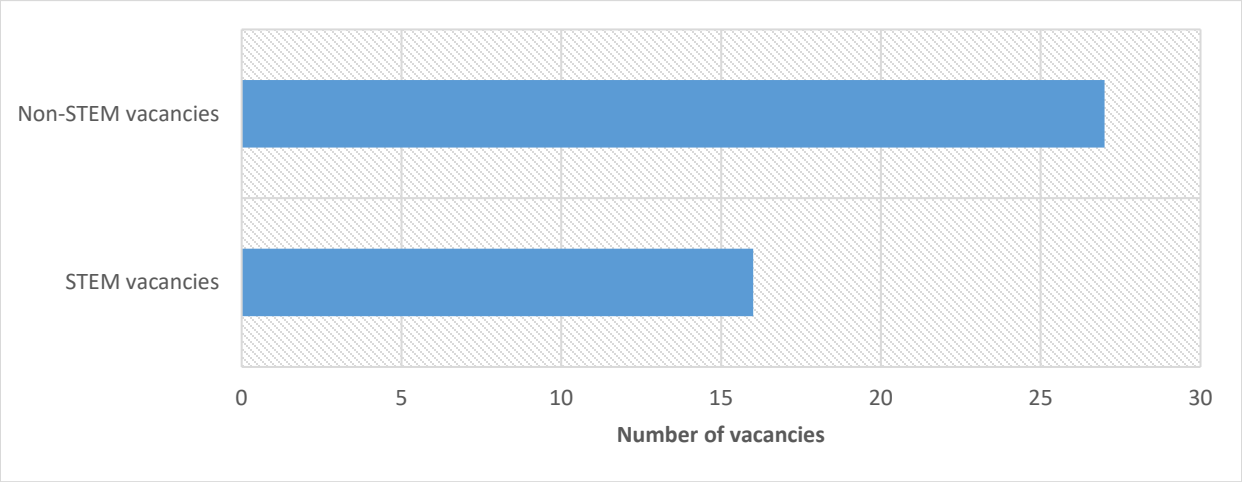
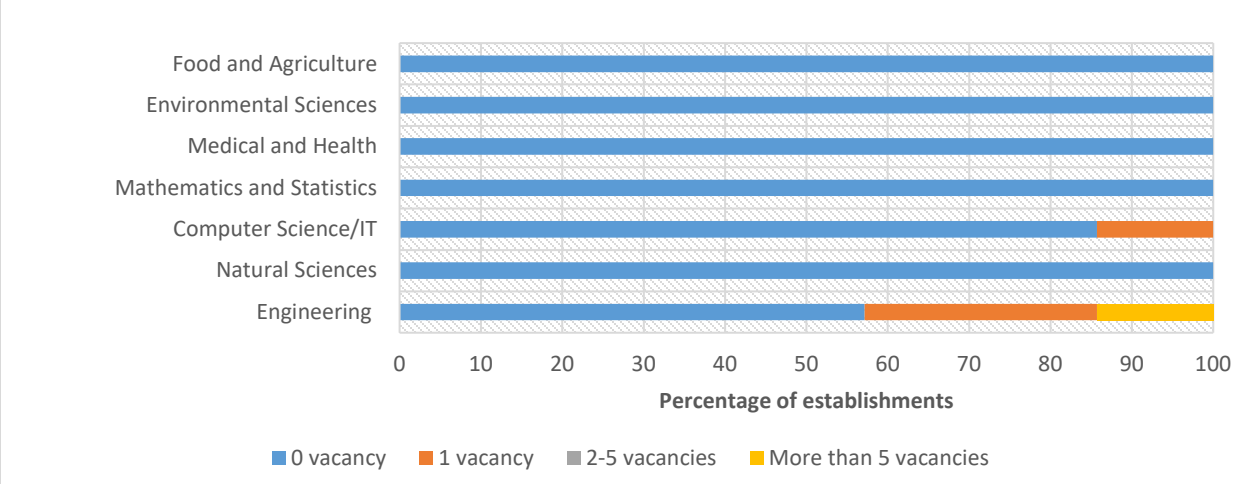


Figure 17: Number of STEM and Non-STEM vacancies



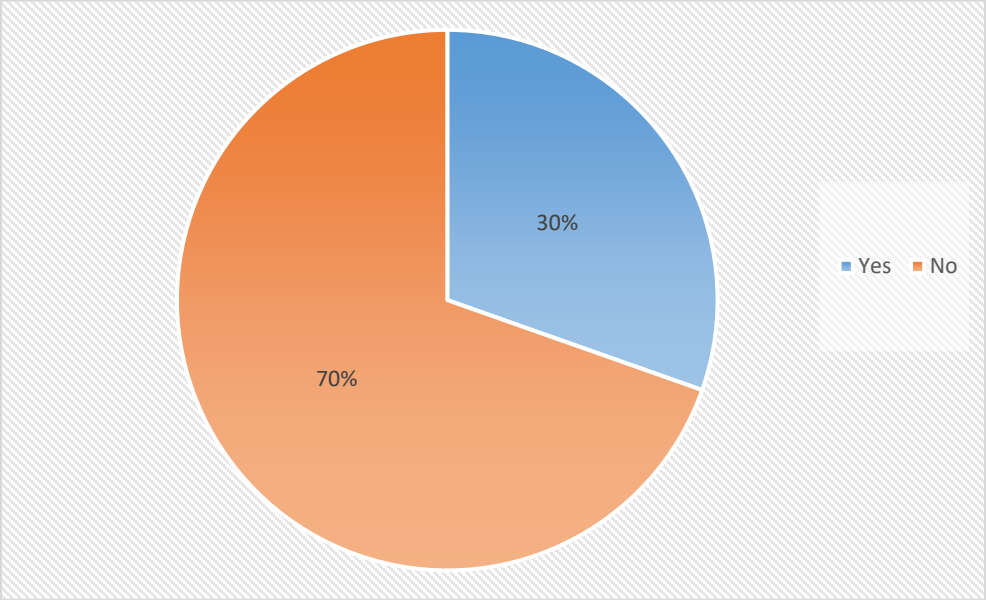
With regard to STEM vacancies, the survey captured data on the number of vacancies within each STEM fields. The data shows that all vacancies reported by employers who participated in the study were in the fields of Engineering and Computer Science/IT, with the vast majority in Engineering (Figure 18). This trend is in line with global trends where emerging technologies are driving the demand for increasing talent in ICT and Engineering.

Figure 18: Percentage of establishments by STEM vacancies



In assessing recruitment in emerging sectors, the survey captured data on the number of vacancies filled over the last 12 months of the survey period. Figure 19 shows that 30% of the employers filled vacancies over the last 12 months while the majority (70%) did not. The data suggests that job opportunities in the sector were very limited for recent graduates. Given that the sector was chosen for expansion, it is important to map the current workforce and align it with the skills needed for the future workforce in a technology-driven environment.

Figure 19: Percentage of establishments that filled vacancies over the last 12 months



The employers who filled vacancies over the last 12 months were asked if they experienced any difficulty when filling both STEM and non-STEM vacancies. Table 2 presents a comparison of the level of difficulty employers experienced when filling STEM and non-STEM vacancies within the various occupational groups. The majority of employers, generally, did not experience any difficulty in filling both STEM and non-STEM vacancies. However, employers reported more difficulty filling STEM occupations compared to non-STEM occupations.

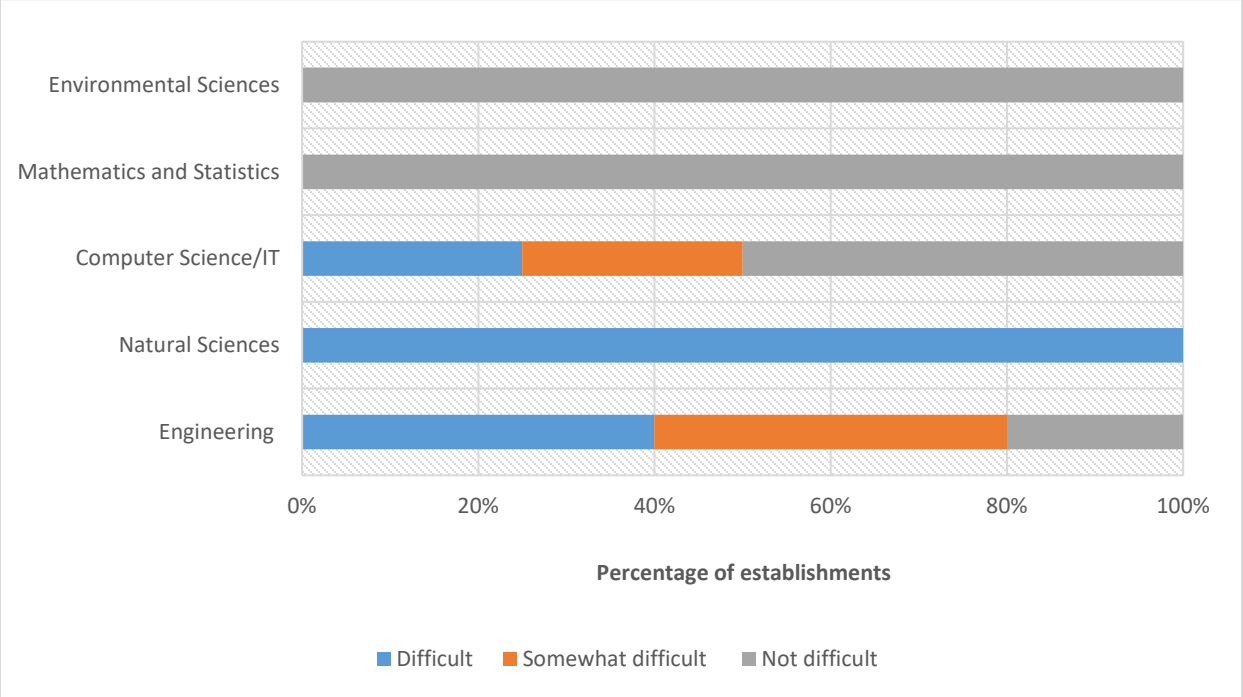
By occupational group, the data shows that a half (50%) or more of the respondents within each occupational group experienced no difficulty in filling vacancies over the last 12 months. The highest level of difficulty was recorded for Technicians and associate professionals followed by Managers and Professionals.

Table 2: Comparison of difficulty experienced when filling STEM and Non-STEM vacancies by occupational groups

Occupational groups	STEM vacancies			Non-STEM vacancies		
	Difficult to fill	Not difficult to fill	Total	Difficult to fill	Not difficult to fill	Total
1. Managers	43	57	100	33	67	100
2. Professionals	43	57	100	33	67	100
3. Technicians and associate professionals	50	50	100	40	60	100
4. Clerical support workers	17	83	100	10	90	100
5. Service and sales workers	0	100	100	0	100	100
6. Skilled agricultural, forestry and fishery workers	0	100	100	0	100	100
7. Craft and related trades workers	33	67	100	0	100	100
8. Plant and machine operators, and assemblers	33	67	100	25	75	100
9. Elementary occupations	0	100	100	29	71	100

A further breakdown of the level of difficulty employers experienced when trying to fill the STEM vacancies in their companies over the last 12 months by STEM fields is shown in Figure 20. The highest level of difficulty was observed for Natural Sciences (100%) occupations followed by Engineering and Computer Science/IT occupations. None of the employers filled any vacancy in Food and Agriculture therefore that field is not represented in Figure 20.

Figure 20: Level of difficulty experienced when filling STEM vacancies



Of the employers who experienced difficulty in filling STEM vacancies, the significant contributing factors were also examined. Figure 21 presents the factors affecting recruitment and their level of significance. The most significant factor contributing to the difficulty employers experienced while trying to fill STEM vacancies was a low number of applicants with the required skills which 43% and 29% of the employers rated 5 and 4 respectively. This implies that there is a shortage of qualified candidates with the necessary skills for STEM jobs, highlighting a skills gap in the workforce. Three-quarters (75%) of the employers assigned a rating of 4 to poor terms and conditions (e.g. salary) offered for the post. This indicates that the compensation offered by some employers are not competitive enough and fails to meet international standards for STEM labour. As a result, some employers would have difficulty attracting STEM talent. Employers may need to reassess their compensation packages to ensure they are competitive enough to attract skilled STEM professionals. Additionally, over a half (57%) of the employers assigned ratings of 4 and 5 to not enough people were interested in doing this type of job. The least significant factor was too much competition from other employers.

Figure 21: Significant factors why STEM occupations are difficult to fill

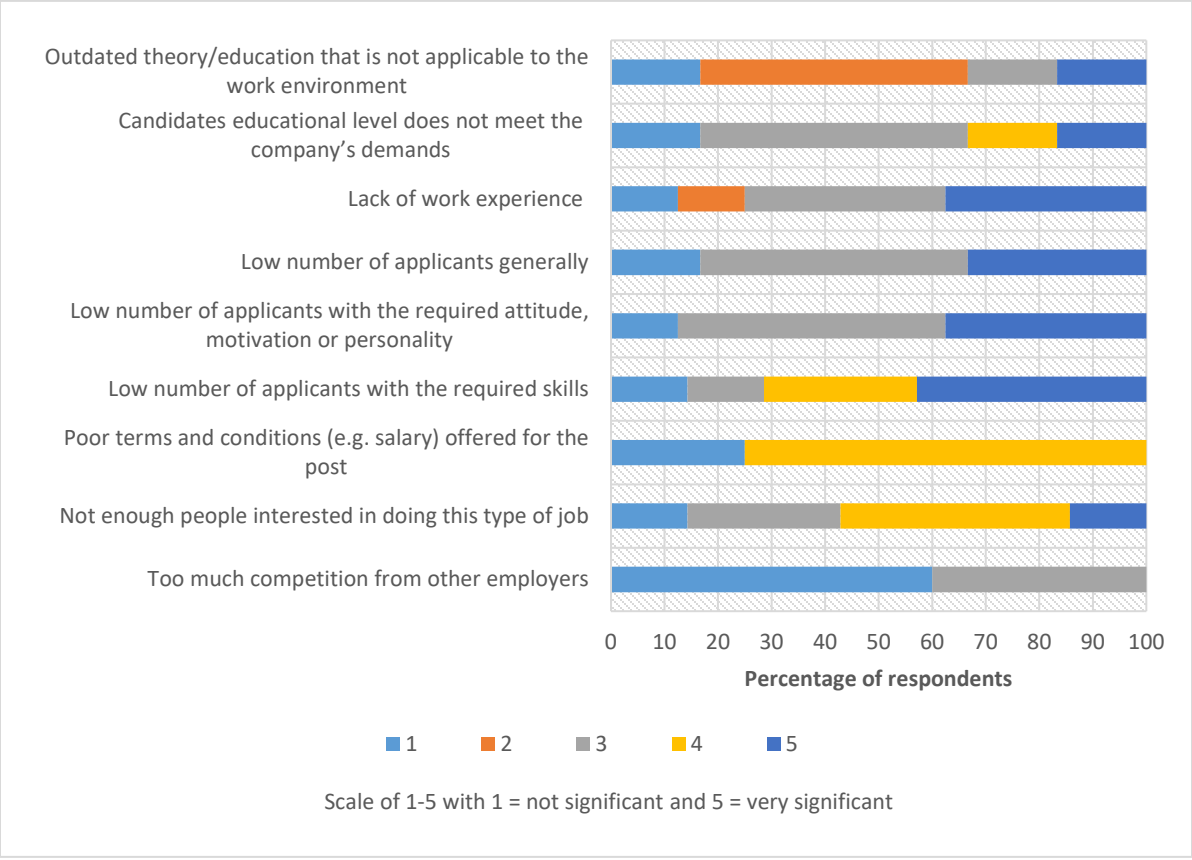


Figure 22 summarises the recommendations employers suggested to overcome problems experienced while filling STEM vacancies. A larger proportion (46%) of employers did not provide a recommendation while 18% in each case stated create more training opportunities aligned to the industry and increase promotion of maritime studies at career fairs. Additionally, 9% of the employers suggested creating effective policies to support training and development of employees and a similar percentage suggested introducing more maritime programmes at universities and TVET education providers.

Figure 22: Recommendations to overcome problems experienced when filling STEM occupations

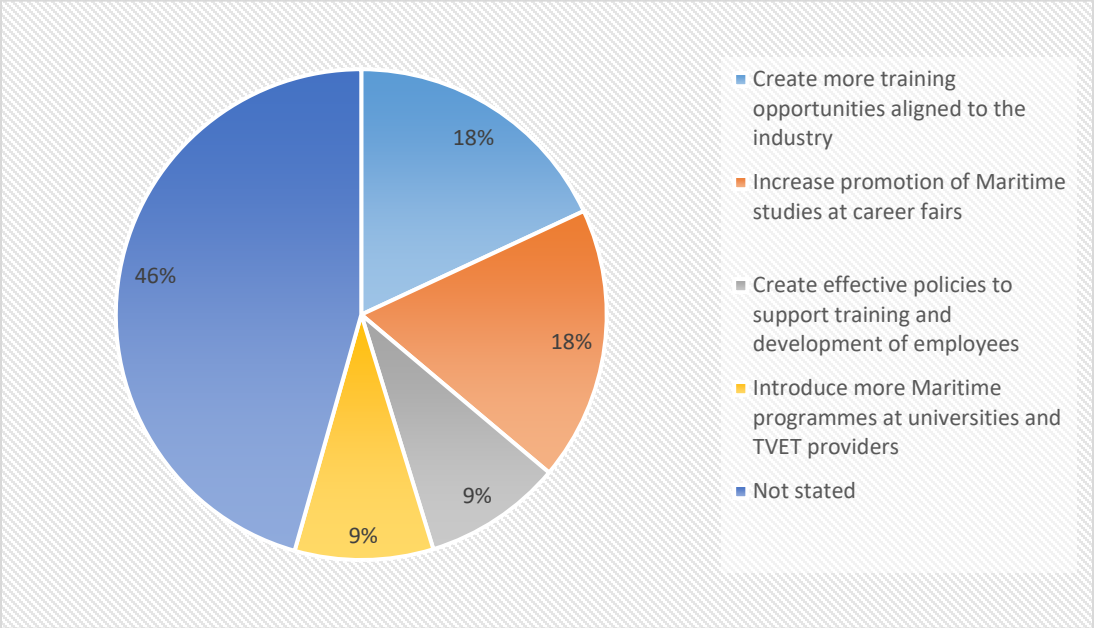
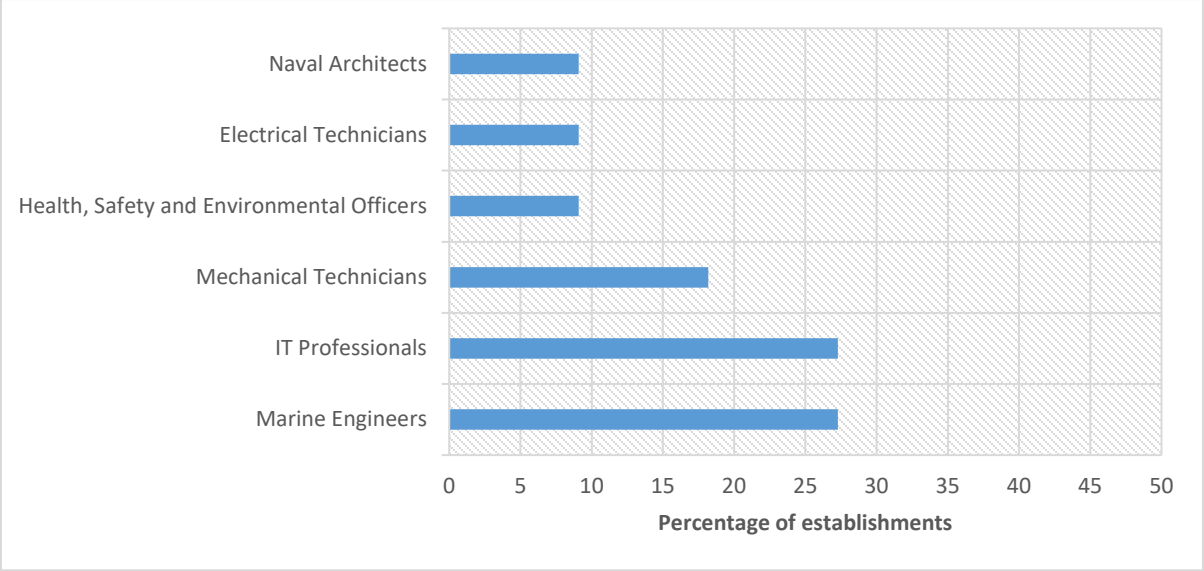


Figure 23 presents the STEM occupations that respondents in the maritime industry identified as the most difficult to fill. The most difficult occupations to fill were Marine Engineers (27%) and IT Professionals (27%). Eighteen percent (18%) of the establishments that responded to the study cited Mechanical Technicians (18%) as the most difficult STEM occupation to fill. A similar percentage of employers (9%) identified Naval Architects, Electrical Technicians and Health, Safety and Environmental Officers as the most difficult to fill.

Figure 23: Most difficult STEM occupations to fill



5. Skills of the Workforce

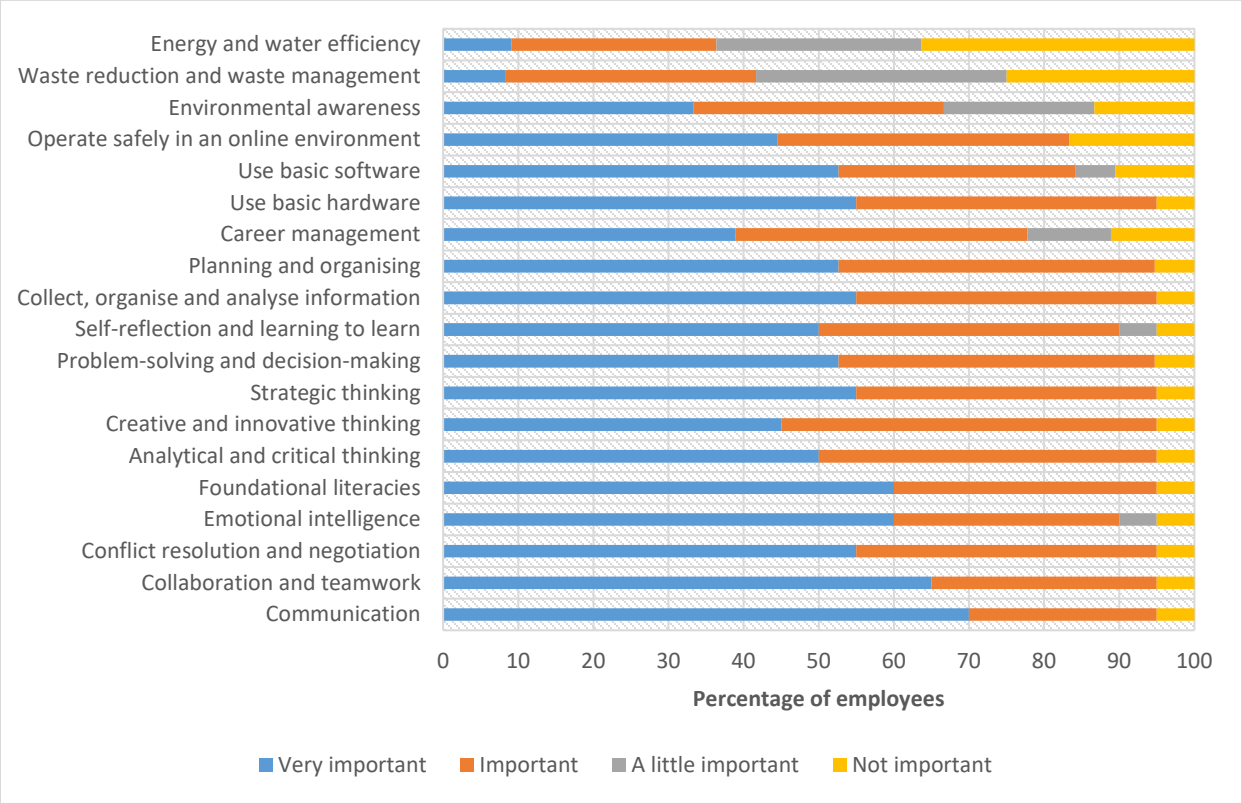
Development of skills can benefit both businesses and employees. Skills development can transform businesses by increasing productivity and competitiveness. In terms of employee development, core skills are essential to increase employability of workers, increase opportunities to obtain decent work and improve their standard of living. The ILO Global framework on core skills for life and work in the 21st Century was utilised to identify and define the core skills assessed in this study. These skills are listed in Table 1 and further defined in Appendix III.

The purpose of this section is to assess the existing skills mismatches in the maritime sector. This section provides data on the skills that employers consider essential for employees to achieve organisational goals and objectives. It also summarises information on the internal and external factors driving change and the necessary skills required to respond to these factors. Following the identification of core skills required by employers for achieving business goals and objectives, the skills of recent job applicants, university graduates and existing employees were examined mainly to determine the skill mismatches in the workforce. The section concludes with an evaluation of how well university graduates were prepared for the workplace.

5.1 Demand for Skills by Employers

Figure 24 lists the 19 core skills and employers rating on the level of importance for employees to have these skills in order to achieve the goals and objectives of the businesses. The majority of employers indicated that it was important (very important + important) for employees to possess all of the skills listed in Figure 24 except Waste reduction and waste management and Energy and water efficiency. The most important skill was Communication which was rated ‘very important’ by the highest percentage (70%) of employers followed by Collaboration and teamwork (65%), Emotional intelligence (60%) and Foundational literacies (60%). The skills that received the lowest ratings in terms of importance were Basic skills for green jobs (Environmental awareness, Waste reduction and waste management and Energy and water efficiency). The lack of importance placed on basic skills for green jobs is concerning given the call for urgent action to combat climate change at both the global and national levels.

Figure 24: Employers' rating of skills employees should have to meet business goals



5.2 Drivers of Change and Skills Required

In order to establish what skills were important in the maritime industry for current and future development the internal and external drivers of change were identified along with the main skills required to address each driver.

The internal drivers of change reported by businesses are depicted in Figure 25. The main internal driver of change was profit (74%) followed by people (35%), Technology (26%) and HSE (4%). Overall, Marketing/Customer Service (21%) was viewed as the most important skill to address internal drivers of change followed by leadership (12%) organisation (11%) and communication (9%) (Figure 26). The following were the main skills identified to address each internal driver:

1. Profit – Marketing (32%)
2. People – Leadership (20%) and Marketing (20%)
3. Technology – IT (22%)
4. Health and Safety – Risk analysis (100%)

Figure 25: Top internal drivers of change in establishments

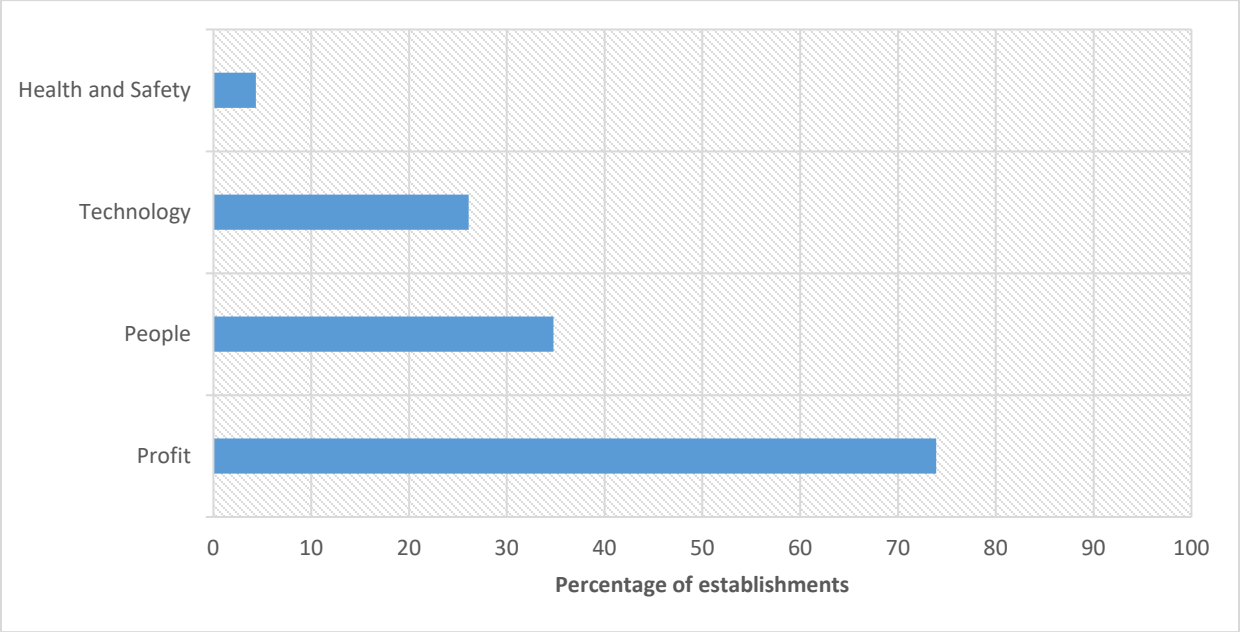
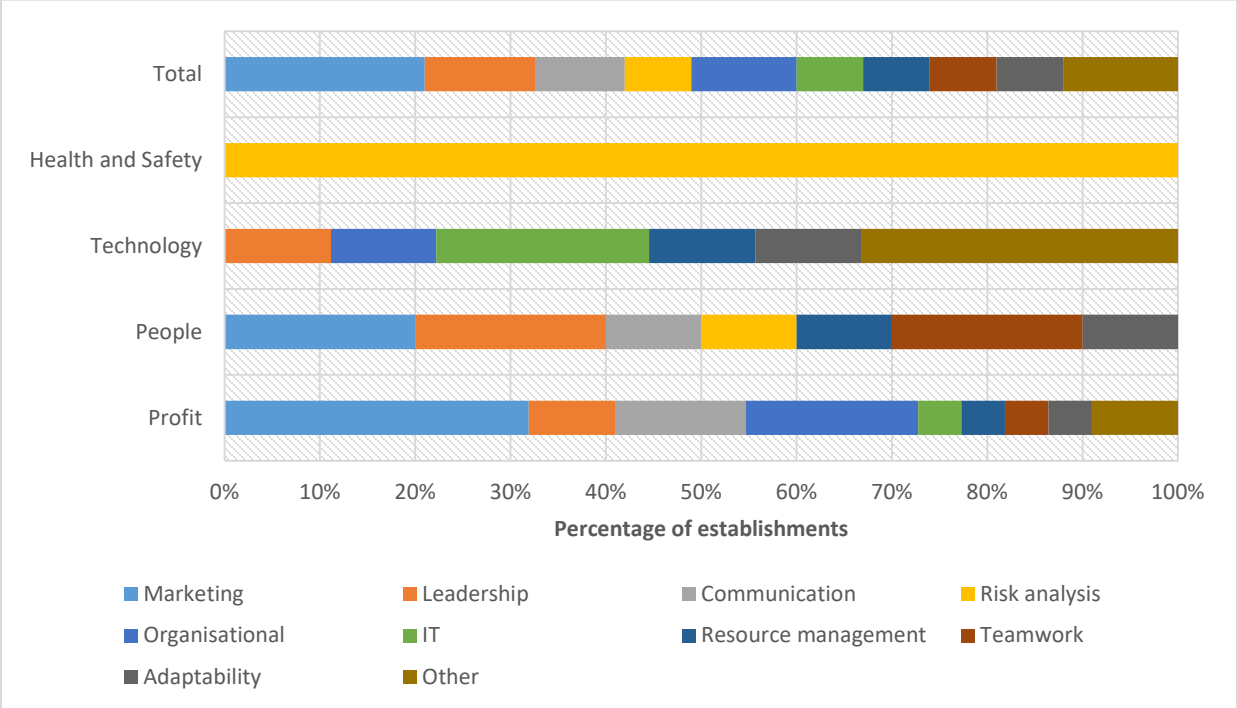


Figure 26: Main skills required to address internal drivers of change



In terms of external drivers of change in maritime establishments, employers were asked to list the top two (2) drivers of change and the skills required to address these drivers. The survey results revealed that the top external driver of change was competitors (86%) followed by technology (43%), climate change (21%) and regulations (14%) (Figure 27). Figure 28 depicts the skills employers identified as necessary to address external drivers of change. Overall, the top two (2) skills recorded were problem solving (21%) and adaptability (18%). The following were the main skills identified to address each internal driver:

1. Competitors – Adaptability (21%), Communication (21%), Marketing (21%)
2. Climate change - Problem solving (50%)
3. Technology - IT (43%)
4. Regulations - Problem solving (67%)

Figure 27: Top external drivers of change in establishments

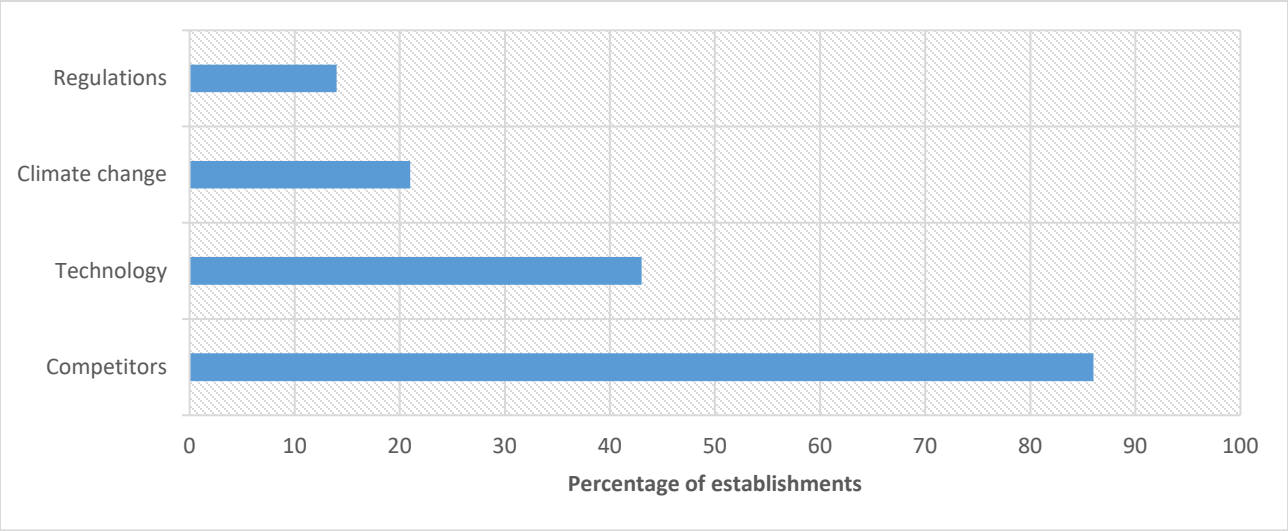
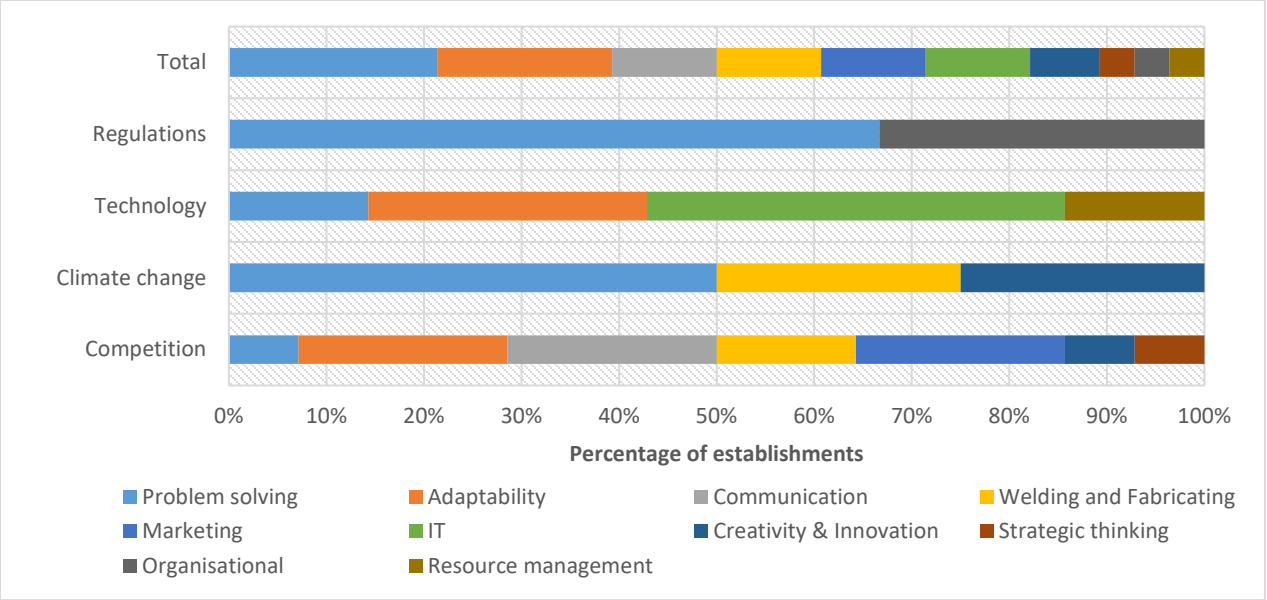


Figure 28: Main skills required to address external drivers of change

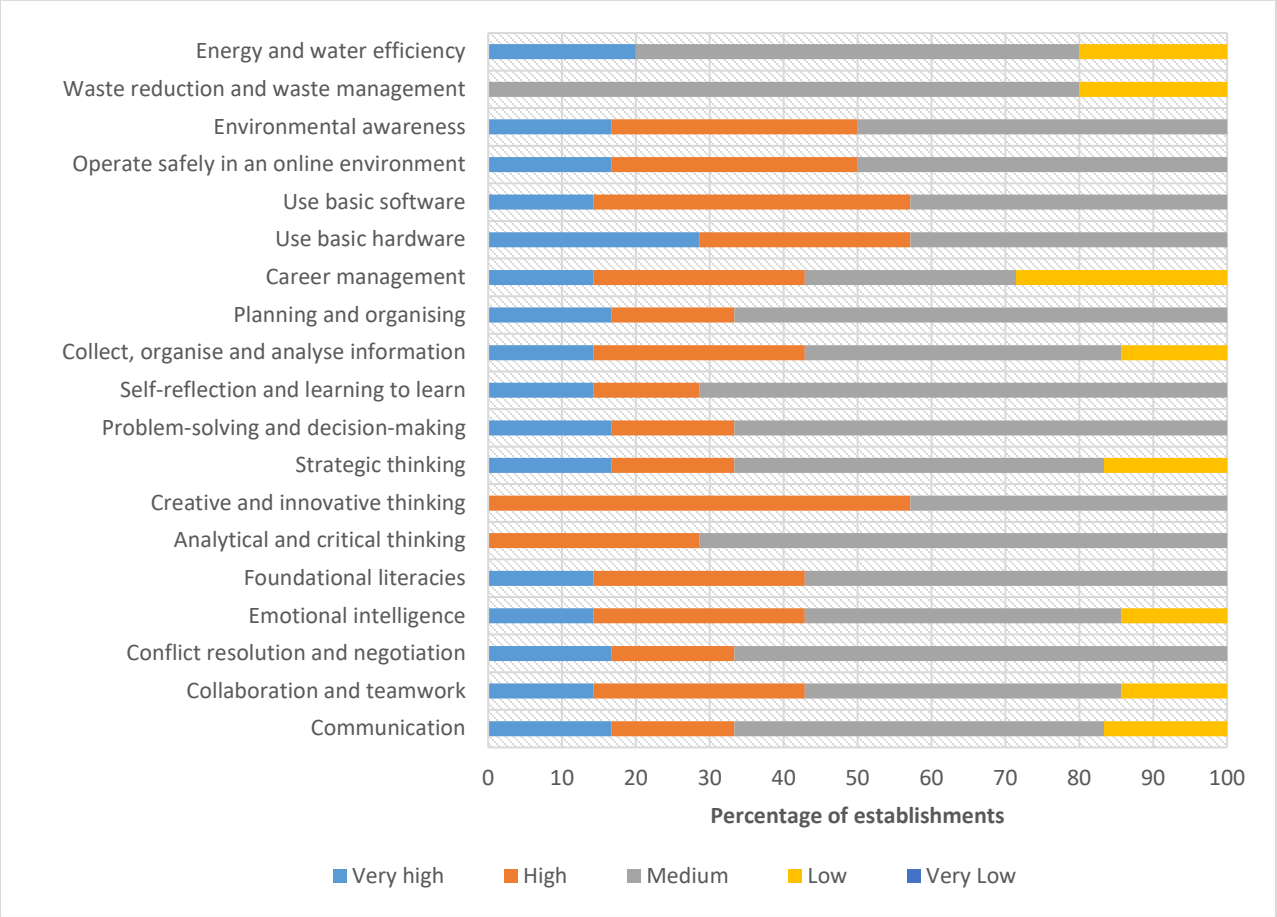


5.3 Employers' Perception on the Skill Levels of Employees

To gain a comprehensive understanding of the level of skills among employees in emerging sectors, employers were asked to assess their employees' proficiency across the 19 core skills identified as crucial building blocks to lifelong learning and adapting to changes in the labour market. This included new entrants into the workforce and existing employees. The new entrants assessed were employees who graduated from university between the years 2021 and 2023.

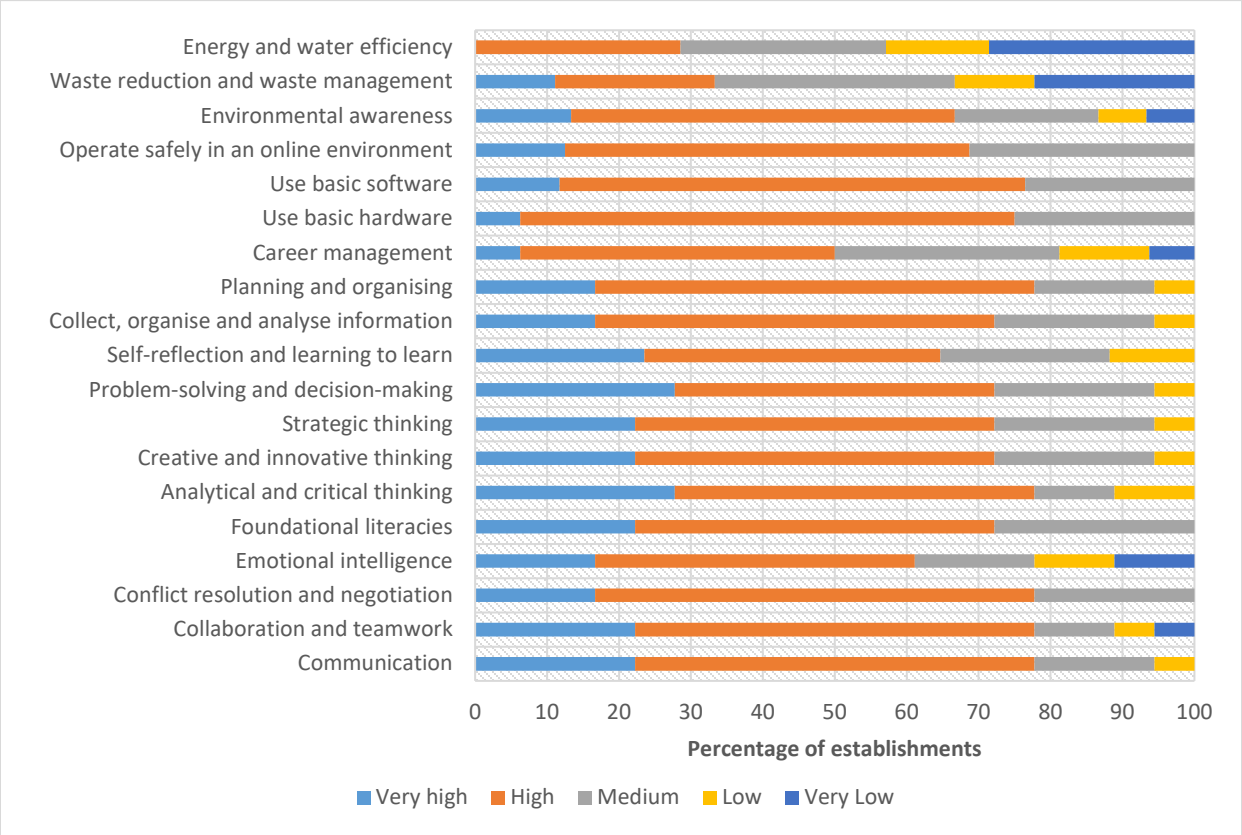
Figure 29 presents employers' perception on the skill levels among recent university graduates, focusing on the 19 core skills. These skills were evaluated on a 5-level scale, ranging from very low to very high. The data indicates that most employers rated recent university graduates' skill levels as either high (very high + high) or medium across all 19 core skills. Notably, a larger proportion of employers rated these graduates' skill level as medium across 10 core skills. The prevalence of medium ratings reveals potential gaps in the skill set of the workforce, which could impact overall productivity and innovation. Recent university graduates received the highest rating for using basic hardware (57%), operating basic software (57%), and creative and innovative thinking (57%). This suggests that the future workforce is becoming more proficient using technology, which is essential as businesses continue to rely more heavily on technology. The lowest rating (very low + low) was assigned to Career management (29%).

Figure 29: Employers' rating of the level of skills among recent university graduates



A review of the skill sets of existing employees was also undertaken in order to fully understand how their skills aligned with business goals. Employers rated the level of skills among their employees for the 19 core skills. Figure 30 shows that a half (50%) or more of the employers assigned higher ratings (very high and high) to the level of each core skill among their employees except Waste reduction and waste management and Energy and water efficiency. The highest rating (78%) was assigned to Communication; Collaboration and teamwork; Conflict resolution and negotiation; Analytical and critical thinking; and Planning and organising.

Figure 30: Employers' rating of level of the skills of existing employees



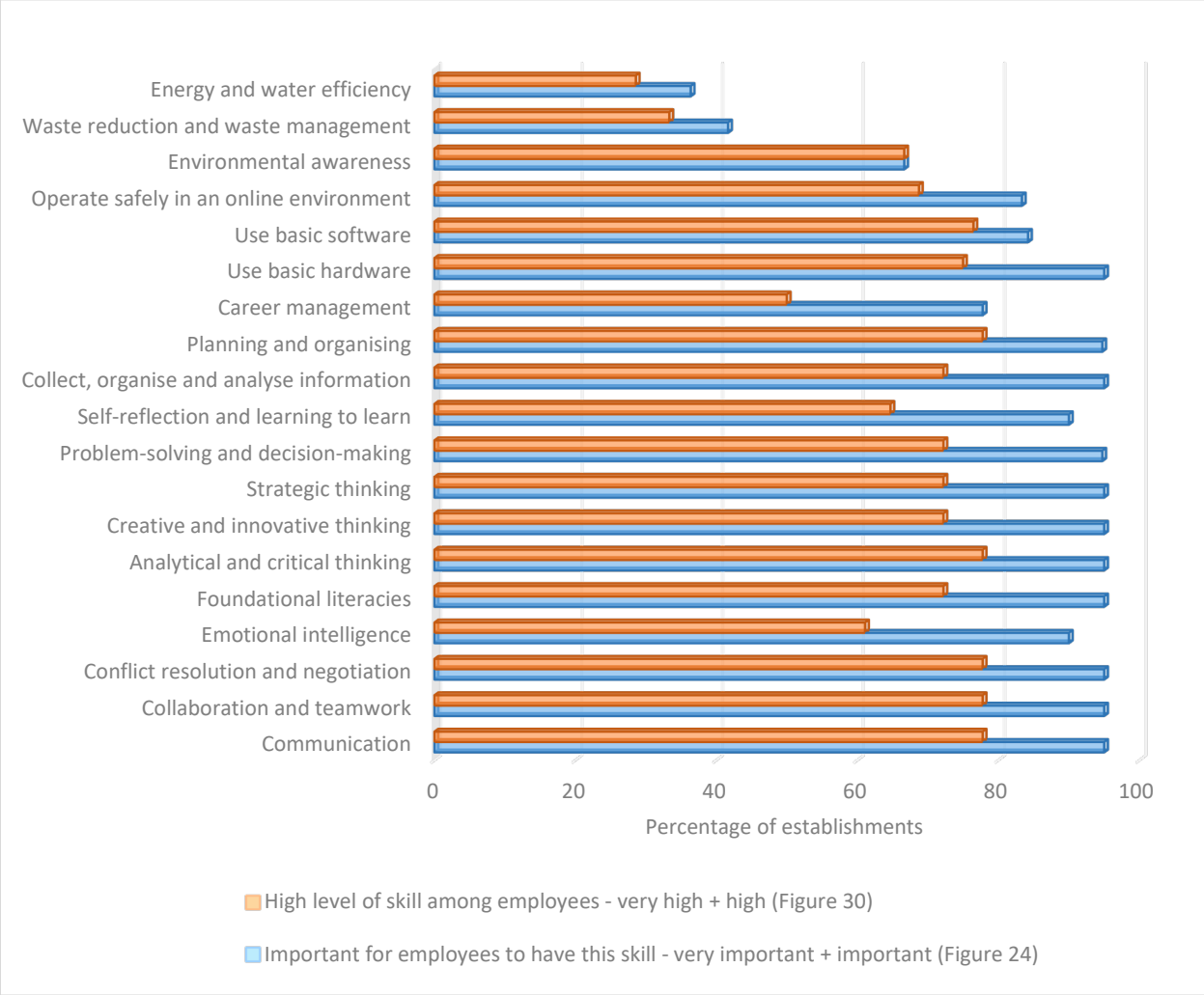
5.4 Skills Mismatch

An analysis of the skill mismatches was undertaken by comparing the data provided by employers on the skills that were important for employees to possess with the actual skill levels of those employees. This comparison revealed the areas where there was a mismatch between the required skills and the current skill levels of employees.

Figure 31 presents a comparison between the percentage of employers who reported skills that were important (very important + important) (Figure 24) for employees to have and the percentage of the workforce possessing a high (very high + high) (Figure 30) level of these skills. This comparison highlights a gap in the level of skills employers required from employees and the actual level of skills employers reported among employees in their establishments. The percentage of employers who indicated that the skill was important for the success of the business was greater than the percentage of employees with a high level of skill in 18 of the 19 core skills. The largest gaps were recorded for Emotional intelligence

(29%), Career management (28%) and Self-reflection and learning to learn (25%). The gap between the skills considered important by employers and what they perceived as the actual proficiency levels within their workforce is a significant issue. This mismatch can lead to several problems, including lower productivity, innovation, and economic growth.

Figure 31: Comparison of employers' rating of skills required to meet business goals and current level of skills of employees



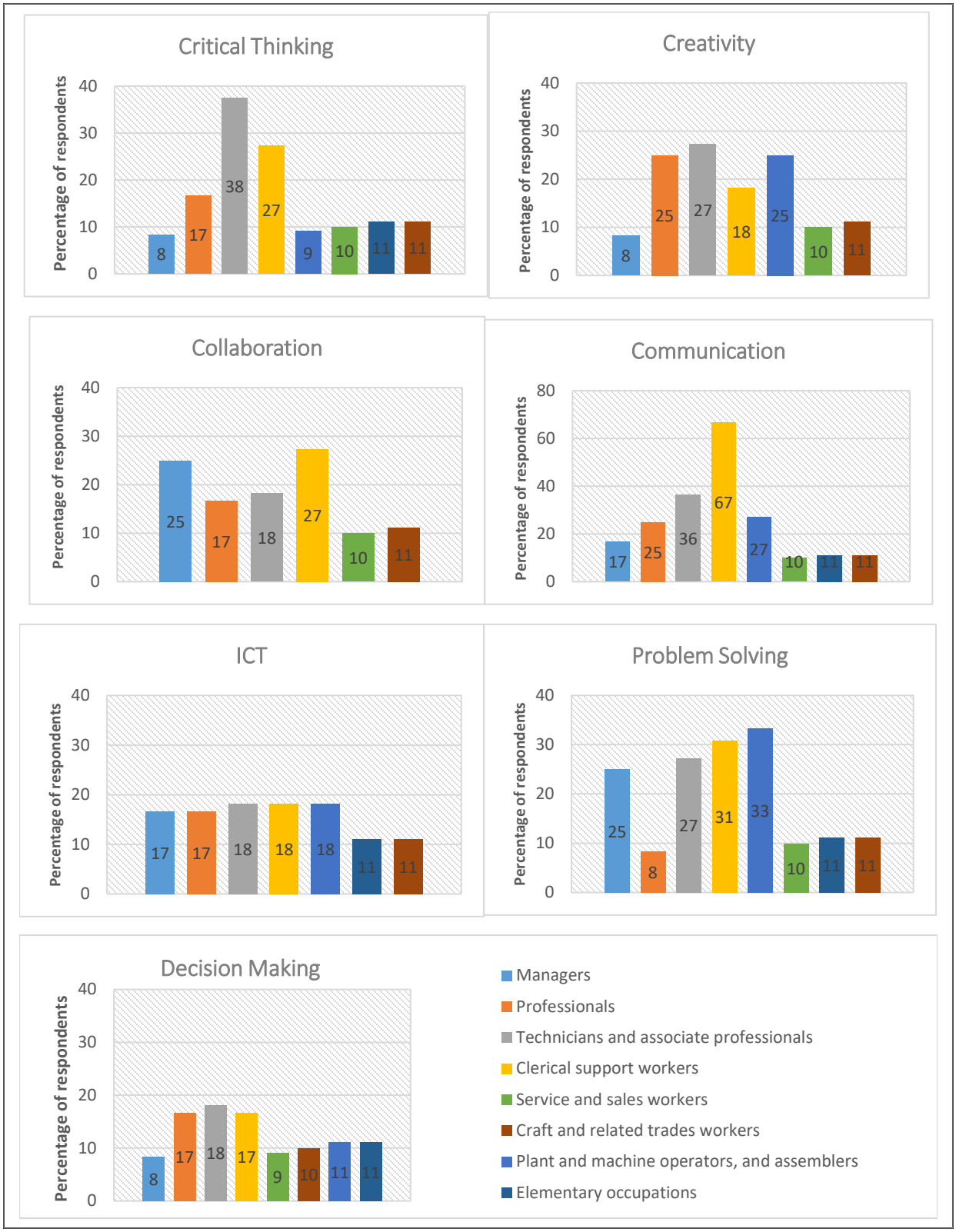
5.5 Level of Difficulty Employers Experienced in Finding Core Skills among Employees

The study also captured data on the challenges employers face in acquiring core skills from new entrants into the workplace. This data is crucial in identifying specific skills that are lacking in new employees. Understanding these difficulties is essential for addressing the root causes of the skills mismatch and implementing effective solutions that can better align the skills of the workforce with the needs of employers.

Figure 32 shows the percentage of employers who found it difficult to find seven (7) key skills – creativity, critical thinking, collaboration, communication, ICT, Decision-making and problem solving - among recent job applicants within each occupational group. Generally, the majority of respondents did not find it difficult to find the seven selected skills among recent applicants within each occupational group except for communication among the clerical support workers which recorded the highest level of difficulty (67%). Clerical support workers, Technicians and associate professionals and Sales and Service Workers were the occupational groups employers found most difficult to find the selected skills. The main skills employers found difficult to find in the different occupational groups are outlined below:

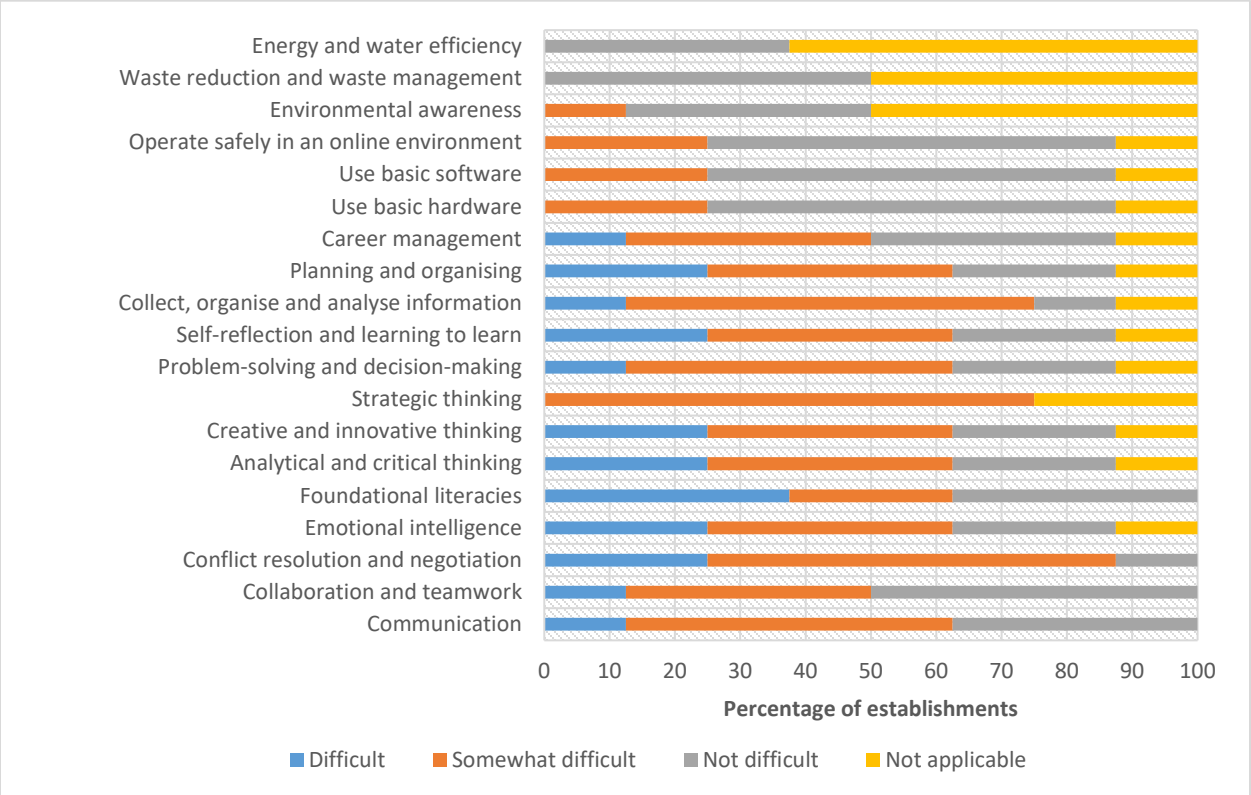
- Managers - Collaboration (25%) and Creativity (25%)
- Professionals - Creativity (25%) and Communication (25%)
- Technicians and associate professionals – Critical thinking (38%), Communication (36%), Creativity (27%) and Problem solving (27%)
- Clerical support workers - Communication (67%), Problem solving (31%), Critical thinking (27%) and collaboration (27%)
- Service and sales workers – Problem Solving (33%), Communication (27%) and Creativity (25%)
- Skilled agricultural, forestry and fishery workers - not applicable
- All other occupational groups - minimum difficulty in obtaining the seven identified core skills.

Figure 32: Employers' rating on the difficulty experienced to obtain skills from recent applicants by occupational groups



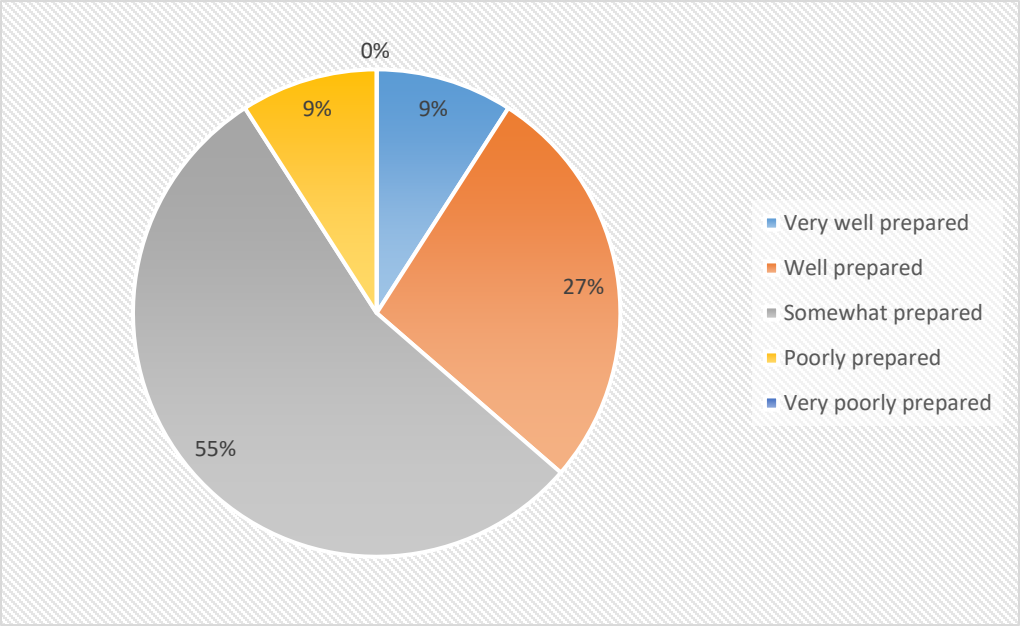
In terms of recent university graduates, the data shows that a half (50%) or more of the employers experienced some level of difficulty in finding Social and emotional skills and Cognitive and metacognitive skills among this group of job applicants (Figure 33). Employers experienced less difficulty in finding Basic digital skills and Basic skills for green jobs among recent university graduates. A substantial percentage of respondents indicated that Basic green skills were not applicable to the jobs of these graduates. The highest percentage (38%) of difficulty was observed for foundational literacies followed by Conflict resolution and negotiation (25%), Emotional intelligence (25%), Analytical and critical thinking (25%), Creative and innovative thinking (25%), Self-reflection and learning to learn (25%) and Planning and organising (25%). A half (50%) or more of the employers assigned a rating of somewhat difficult to the following skills: Strategic thinking (75%), Conflict resolution and negotiation (63%), Communication (50%) and Problem-solving and decision-making (50%). The least difficulty was recorded for the Use basic hardware (63%), Use basic software (63%), Operate safely in an online environment (63%), Waste reduction and waste management (50%) and Collaboration and teamwork (50%).

Figure 33: Level of difficulty employers experienced in obtaining core skills from recent university graduates



Further to the skills mismatches identified above the survey also gathered information on employers' views on the level of preparedness for work among university graduates employed over the last 2 years. Over a half (55%) of the respondents reported that recent university graduates were somewhat prepared for work while 36% indicated that graduates were well prepared (very well prepared + well prepared) and 9% stated poorly prepared (Figure 31).

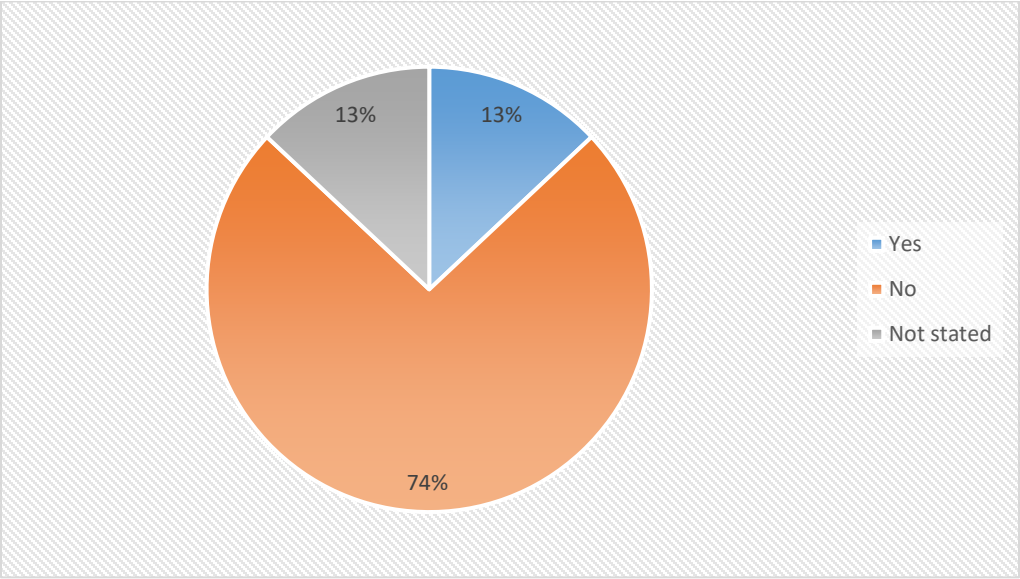
Figure 34: Level of preparedness of for work among university graduates employed over the last 2 years



5.6 Impact of skill-shortage on establishments

The effects of the lack of requisite skills within the workforce can hinder business operations. However, in the case of the establishments that completed the survey, approximately three-quarters (74%) reported that the lack of skills among workers did not affect their operations while 13% disagreed and a similar percentage did not reply (Figure 35).

Figure 35: Lack of skills among workers affected company's operation



6. Demand for STEM Labour

A critical component of the assessment of STEM labour needs in the maritime sector was identification of the current and future demand for STEM workers within maritime establishments. Identifying and understanding the current composition of the labour force is important for employers and policymakers to develop effective policies and programmes to build capacity and capabilities in the workforce. In terms of future demand, forecasting the jobs of the future will help businesses adapt to global changes that are transforming economies, businesses, workforce structures and society as a whole.

Figure 36 shows the current demand for STEM occupations reported by the companies in the maritime industry. The demand for STEM occupations was generally low within each STEM area. The highest demand was recorded for Engineering occupations followed by Computer Science/IT occupations. The lowest demand was observed in the field of Food and Agriculture.

In terms of STEM jobs, the top jobs currently demanded were Marine Engineers (23%) and IT Technicians (23%) followed by Electrical Engineers (15%) (Figure 37).

Figure 36: Current demand for STEM occupations

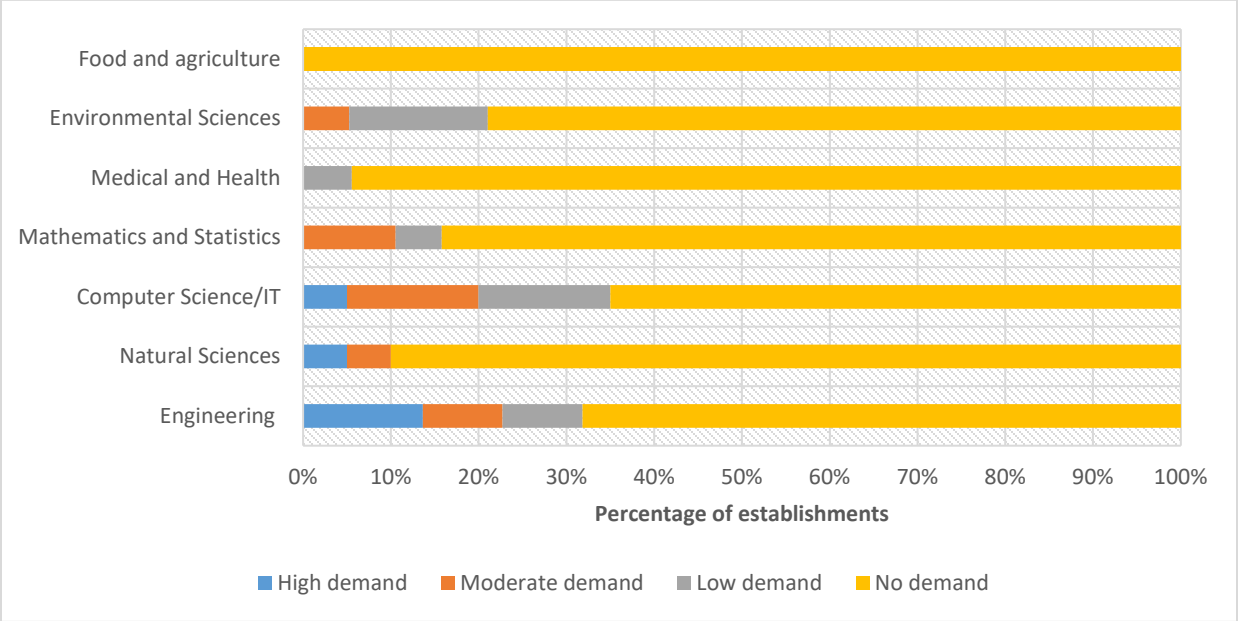
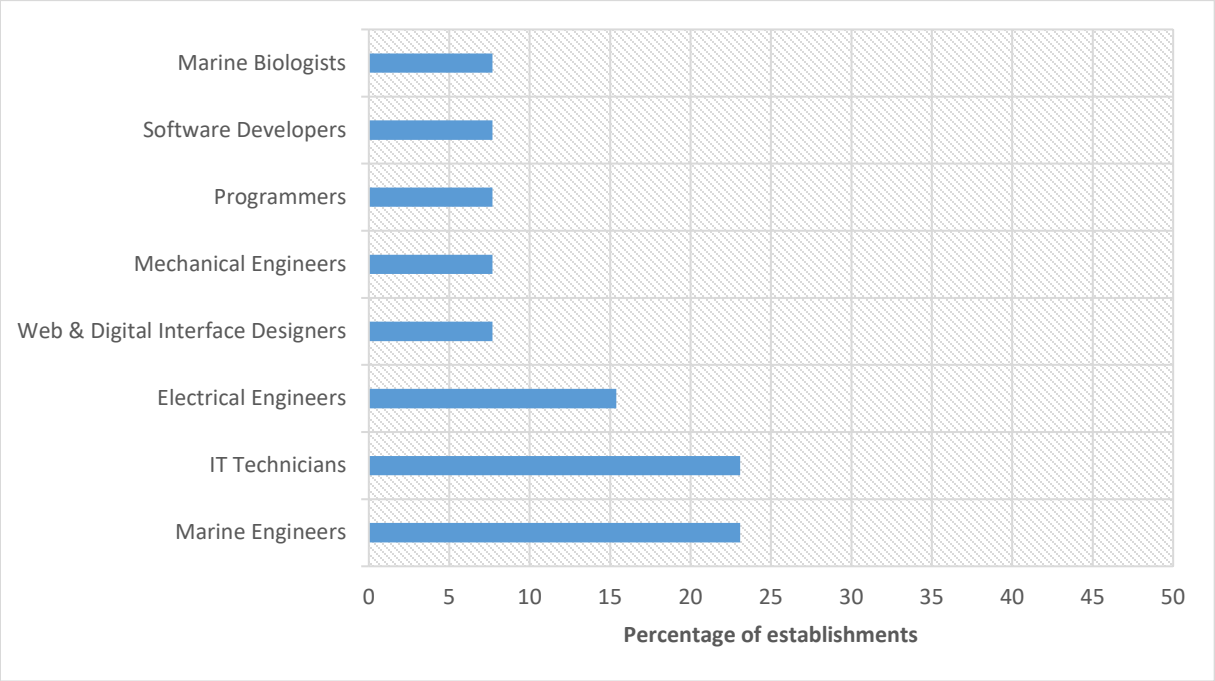
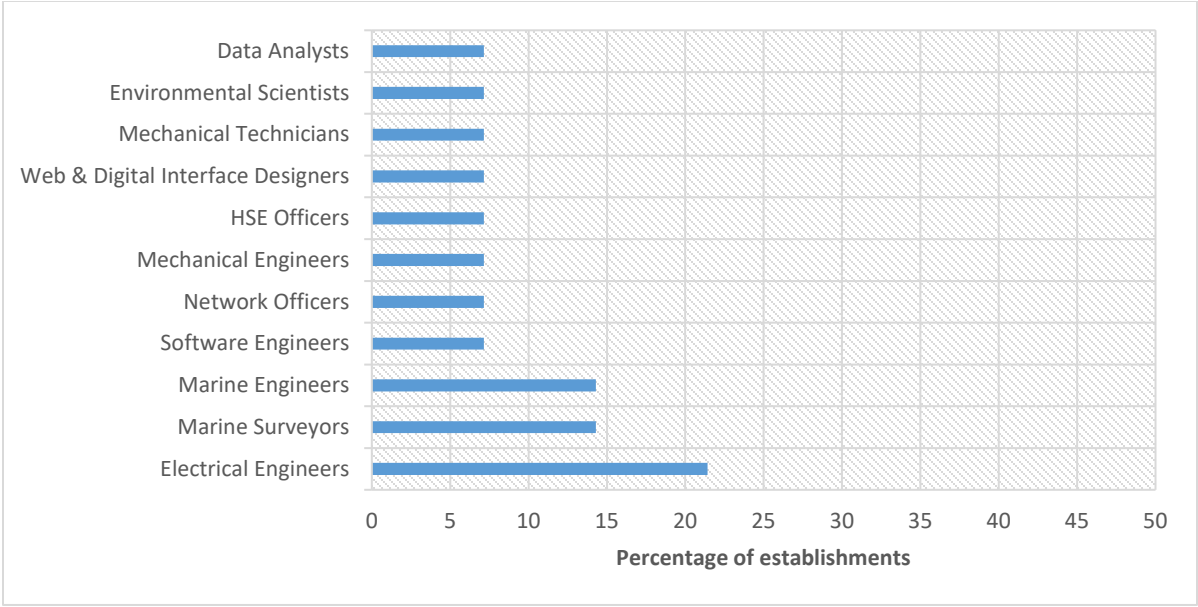


Figure 37: Top STEM occupations currently demanded by establishments



Employers were asked to list the three (3) top STEM occupations for their organisation in the next 5 years based on the strategic direction of their organisation. The three (3) most important STEM occupations were Electrical Engineers (21%), Marine Surveyors (14%) and Marine Engineers (14%) (Figure 38).

Figure 38: Most important STEM occupations for companies in the next 5 years



7. Technical and Vocational Education and Training (TVET)

As part of the assessment of STEM labour needs in the maritime sector the TVET needs were also identified. The survey utilised the STEM in TVET Curriculum Guide developed by the ILO Women in STEM for Workforce Readiness and Development Programme to gather data on STEM competencies among TVET workers.

The STEM in TVET Curriculum Guide identifies four major domains of STEM competencies for better alignment of TVET STEM-oriented learning activities. These include: STEM knowledge, thinking skills, multiliteracies, and socio-emotional intelligence. STEM competencies in these four domains were used in the questionnaire elaborated for this survey and are defined in Appendix II.

Generally, there were few responses to TVET related questions. The data presented below relates to the employers who responded to the survey. Employers with TVET graduates as employees were asked to state the level at which TVET graduates employed over the last 2 -3 years were prepared for work. Figure 39 shows that two-thirds (67%) of the respondents indicated that TVET graduates were well prepared for work while one-third did not provide an answer.

Figure 39: Level of preparedness for work among TVET graduates employed over the last 2 – 3 years

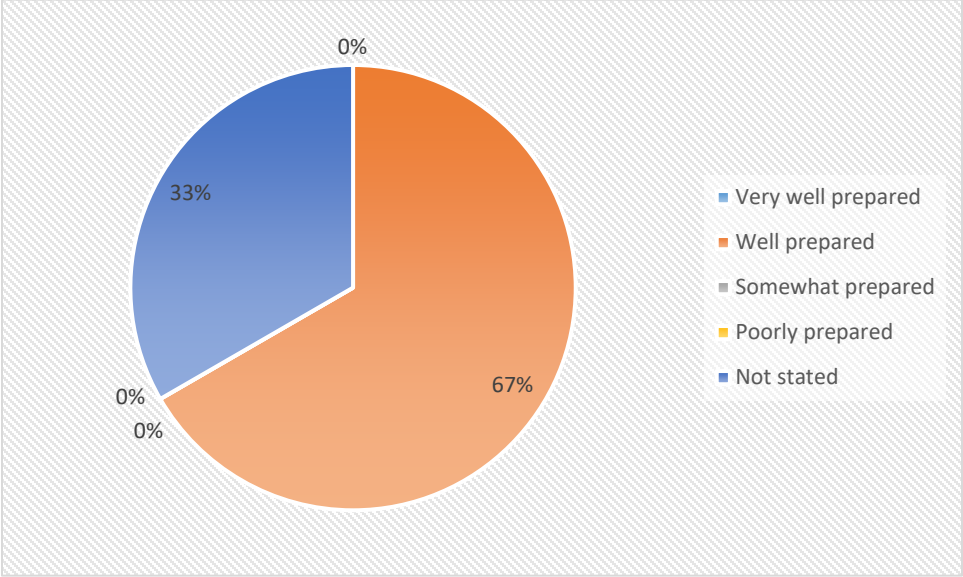


Table 3 shows the level of difficulty companies experienced in finding STEM related competencies among recent TVET graduates applying for job vacancies. A larger proportion (50% or over) of employers did not respond to the question and those who responded experienced some or no difficulty in finding the 25 core skills among recent TVET graduates who applied for jobs.

Table 3: Level of difficulty employers experienced in finding STEM related skills among recent TVET graduates applying for jobs

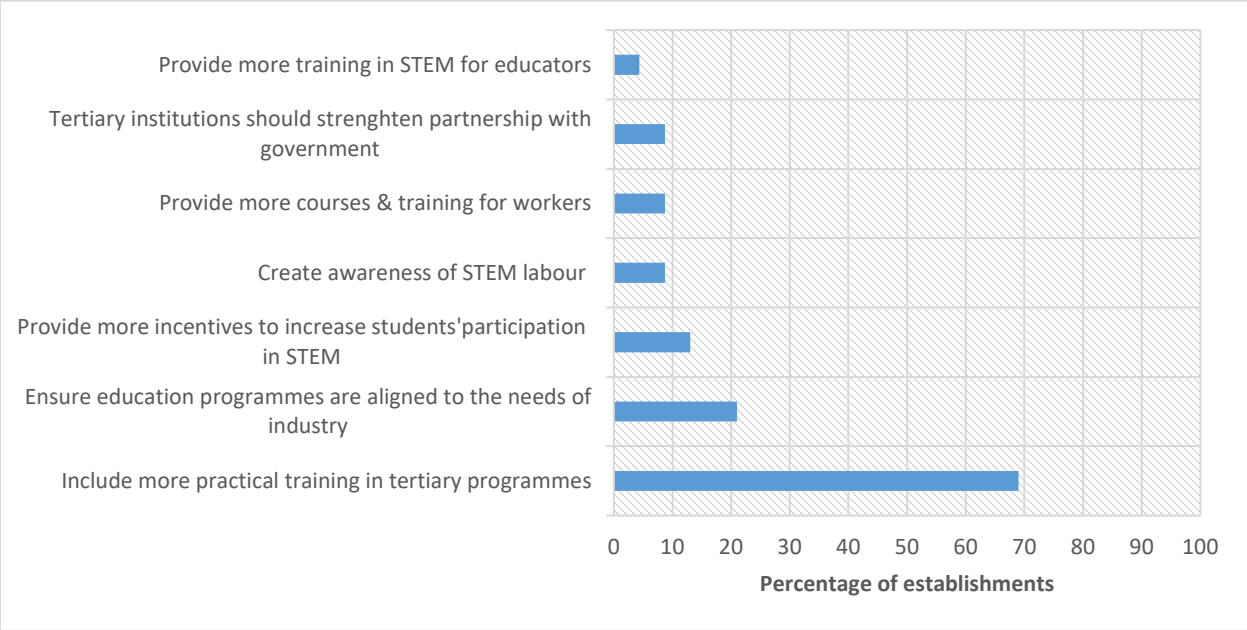
Skills	Difficult	Somewhat difficult	Not difficult	Not stated	Total
1. Critical thinking	0	25	25	50	100
2. Problem Solving	0	25	25	50	100
3. Systems thinking	0	25	25	50	100
4. Creative/inventive thinking	0	25	25	50	100
5. Transdisciplinary thinking	0	25	25	50	100
6. Decision-making	0	25	25	50	100
7. Ethical thinking	0	25	25	50	100
8. Computational thinking	0	25	25	50	100
9. Communication	0	25	25	50	100
10. Collaboration	0	25	25	50	100
11. Empathy	0	25	25	50	100
12. Lifelong/Lifewide Learning	0	25	25	50	100
13. Agency	0	25	25	50	100
14. Resilience	0	25	25	50	100
15. Leadership	0	0	50	50	100
16. Service Orientation	0	0	50	50	100
17. Project Management	0	0	50	50	100
18. Glocal Mindset	0	0	50	50	100
19. Numeracy	0	0	50	50	100
20. Digital Literacy	0	0	50	50	100
21. Civic Literacy	0	0	25	75	100
22. Cultural Literacy	0	0	25	75	100
23. Occupational Health Literacy	0	0	25	75	100
24. Organisational Literacy	0	0	25	75	100
25. Entrepreneurial Literacy	0	0	25	75	100

8. Employers' Recommendations

Employers from the maritime sector provided recommendations on what actions were needed from Government, industry and tertiary institutions to strengthen STEM education and the STEM labour force.

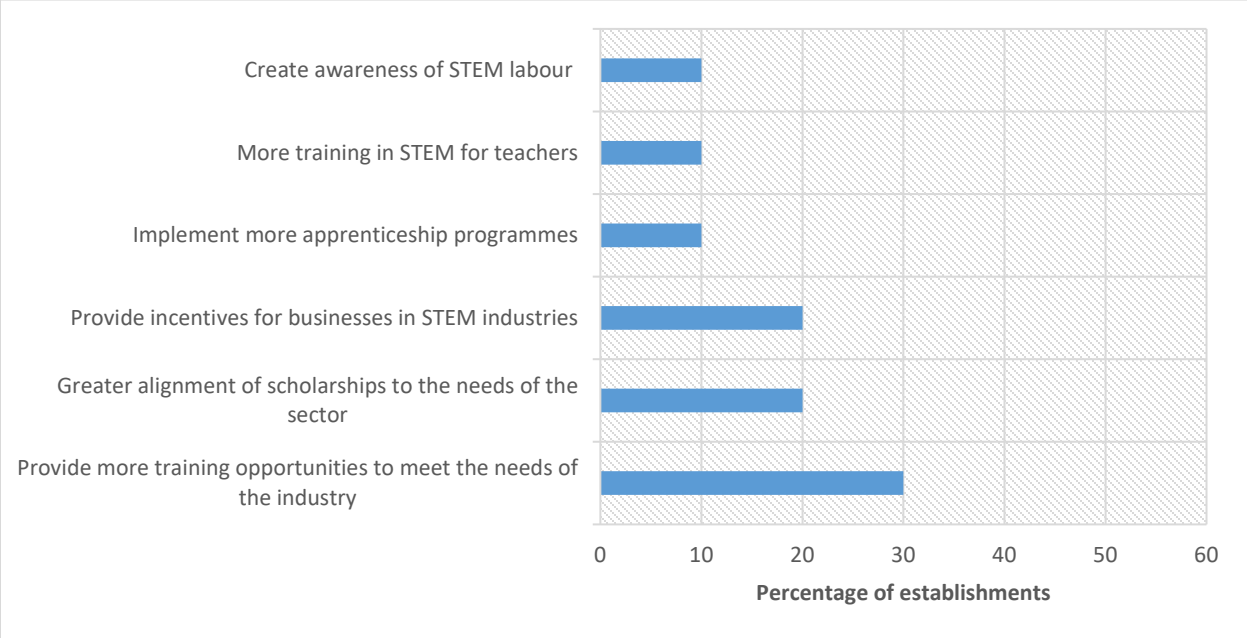
Employers were asked to provide recommendations on how tertiary education programmes can be improved to meet the needs of your industry. The main recommendation cited by employers was to include more practical training in tertiary programmes (69%) (Figure 40). Approximately one-fifth (21%) of the respondents suggested that tertiary education providers should ensure education programmes were aligned to the needs of industry.

Figure 40: Employers' recommendations to improve tertiary education programmes to meet the needs of the industry



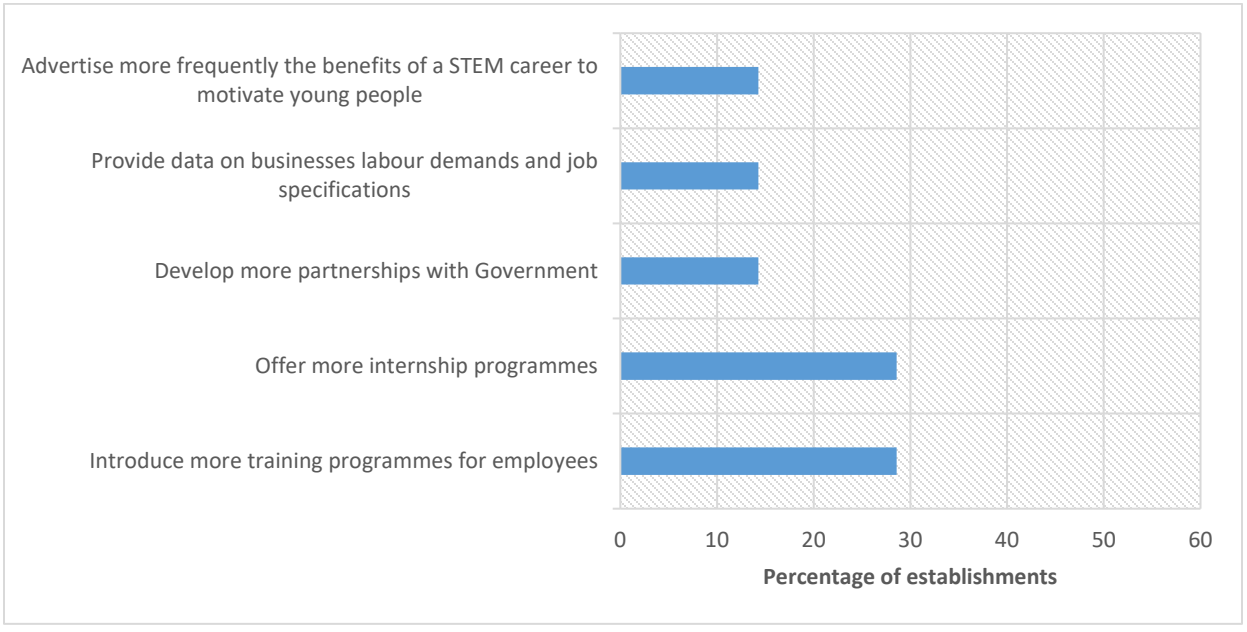
Employers provided several recommendations on how Government could help develop the STEM labour force (Figure 41). A higher proportion of employers stated that Government should provide more training opportunities to meet the needs of the industry (30%) while one-fifth (20%) recommended greater alignment of scholarships to the needs of the sector and a similar percentage suggested that Government provide incentives for businesses in STEM industries.

Figure 41: Employers' recommendations on how Government can help develop the STEM labour force



Employers were also asked to provide recommendations on how private sector could help develop the STEM labour force. Figure 42 shows that 29% of the employers recommended introducing more training programmes for employees and offer more internship programmes.

Figure 42: Employers' recommendations on how private sector can help develop the STEM labour force



With regard to TVET education, employers recommended more training opportunities be included in TVET programmes (Table 4). In addition, Government should assist with online training for the workforce as well as subsidised TVET programmes. Several recommendations were put forth on how the business sector could help develop the TVET labour force. These included: increase wages of TVET employees in the sector; conduct more studies on the needs of the sector; create more training opportunities; and offer TVET courses based on the needs of industries.

Table 4: Employers' recommendations to improve TVET education and labour force

To improve TVET education programmes to meet the current needs of the industry: • Included more training opportunities in TVET programmes
For government to help develop the TVET labour force: • Assist with online training for workforce • Subsidise TVET programmes
For the business sector to help develop the TVET labour force: • Increase wages of TVET employees in the sector • Conduct more studies on the needs of the sector • Create more training opportunities • Offer TVET courses based on the needs of industries

9. Technological Advancements in the Maritime Industry

9.1 Overview

The future presents several challenges, but it also offers vast opportunities for the maritime industry. Emerging technologies such as autonomous vessels, artificial intelligence, blockchain, and green energy solutions are transforming the maritime industry, increasing efficiency and competitiveness, and advancing the move toward zero emissions. To remain competitive and ensure sustainable growth, maritime companies must re-evaluate their current strategies and leverage emerging technologies for sustainable development.

This section highlights how technology has reshaped the maritime sector, increasing efficiency, safety, and sustainability. Drawing on examples from global leaders in maritime innovation, this section illustrates how similar advancements can be adopted to improve local maritime operations and promote the associated STEM careers. Additionally, the section explores the transformation of Trinidad and Tobago's maritime industry, tracing its journey from traditional practices to modern, technology-driven operations.

9.2 Key technologies transforming maritime services

Key technologies reshaping the maritime industry include:

- **Autonomous vessels** are revolutionising maritime. These vessels are designed to operate without human intervention. Autonomous vessels are advancing in response to increased safety and efficiency demands, reducing the need for extensive human oversight and enabling safer long-distance shipping. The vessels rely on real-time data, advanced sensors, and machine learning to navigate and respond to changing conditions autonomously. The benefits of this technological innovation are extensive, offering increased efficiency, accuracy and safety for ships, data-driven operations, remote capabilities, and more.

- **Artificial intelligence (AI)** is a technology that allows computers and machines to simulate human capabilities such as learning, understanding, problem-solving, decision-making, creativity, and autonomy (IBM 2024). Artificial Intelligence (AI) plays a crucial role in fleet management and

preventive maintenance, allowing companies to pre-emptively address mechanical issues before they lead to costly delays. AI-driven predictive maintenance systems leverage data from sensors and on-board systems to identify irregularities before major disruption occurs. This technology improves safety and efficiency, making it a crucial asset in the maritime industry.

- **Blockchain** is a distributed ledger of all transactions across a peer-to-peer network. Blockchain technology is considered by some as the most significant invention after the Internet (Efanov and Roschin 2018). The maritime industry is the backbone of international trade and the global economy. As the industry evolves, technological advancements such as blockchain have become essential for increasing supply chain efficiency. A blockchain network is capable of tracking a variety of activities, including orders, payments, accounts, production and much more. The main role of this technology is to record and track assets and transactions in businesses. By digitising processes, blockchain can significantly reduce cost, time, and errors. This technology increases transparency and trust between suppliers and customers.

- As the demand for sustainability in the maritime industry continues to rise, there is a growing emphasis on reducing greenhouse gas (GHG) emissions through **Green Energy Solutions.** While the shipping industry is essential for global trade, it is also an important source of carbon dioxide (CO_2) emissions. According to the Fourth International Maritime Organization (IMO) GHG Study, global shipping accounted for approximately 2.89% of all GHG emissions in 2018. With 107 countries pledging to achieve net-zero emissions by 2050 and the IMO implementing regulations to significantly reduce sulphur emissions, the maritime industry is under increasing pressure to adopt cleaner technologies and practices. As a result, the maritime sector is creating and investing in green energy solutions to meet these environmental requirements and contribute to achieving environmental sustainability. LNG-powered vessels, exhaust scrubbers, and hybrid technologies are some of the green solutions helping the industry lower its carbon footprint and improve environmental compliance.

- **Drones and Robotics** are transforming the maritime industry by automating tasks that were traditionally labour-intensive. The use of these devices boosts both the efficiency and safety of maritime operations, particularly in areas such as cargo inspection and port security. Drones can access hard-

to-reach areas of a ship and provide visual data for analysis. Robotics plays a key role in cargo handling within ports and terminals. Additionally, Robotics reduce the need for human divers and minimises risks associated with deep-sea exploration and research missions. These technologies are eliminating human errors and reducing costs while increasing efficiency and sustainability. The introduction of robotics technology also aims to address labour issues in the industry.

- The use of **Big Data and Analytics** is increasingly prevalent in the maritime industry. The industry generates a wealth of data. Advanced analytics tools are being used to process and analyse this data in order to evaluate and improve processes, by identifying trends and patterns to make informed decisions. By analysing data such as weather and traffic patterns, the algorithms determine the most efficient routes for its vessels. This not only lowers costs but also reduces fuel consumption and the environmental impact of shipping.

9.3 Growing STEM jobs in the maritime industry

The growing adoption of technologies such as AI, IoT and Blockchain in the maritime sector is driving demand for STEM professionals in areas like fleet management, predictive maintenance, environmental sustainability, and data security. As the industry embraces green technologies and digital transformation, there is an increased focus on data-driven decision-making, climate-friendly solutions, and ensuring the security of complex maritime networks. The table below highlights some of the key STEM careers associated with some of the main technologies discussed earlier in this section.

Table 5: Examples of global technological advancements in maritime and associated STEM professions

Technological Advancements	Examples of STEM Careers
• Autonomous vessels • Artificial intelligence (AI) • Green Energy Solutions • Blockchain • Drones and Robotics • Big Data and Analytics	• Marine Engineers • Data Scientists • Cybersecurity Specialists • Marine Electronic Engineers • Maritime Network Engineers • Data Analysts • AI Specialists • Environmental Engineers • Robotics Engineers • Data Analytics Specialists • Renewable Energy Engineers • Naval Architects • IT Engineers • Naval Engineers • Electrical Engineers • Ocean Engineers

9.4 Examples of leading countries in maritime and technological advancements

This section briefly identifies three leading nations in global maritime operations and summarises the technological innovations they have introduced. It also highlights the STEM career opportunities that have emerged as a result these advancements in the sector.

Table 6: Examples of leading countries in maritime and technological advancements

Country	Technological advancements	STEM careers associated with technological advancements
Norway	Norway is known for its leadership in sustainable maritime innovation; Norway has developed and launched the world's first autonomous electric container ship, the "Yara Birkeland." This vessel represents a milestone in emissions-free shipping, significantly reducing the need for manual oversight while enhancing safety.	Norway's commitment to maritime automation and sustainable energy solutions has driven the demand for specialised careers, such as Marine Data Analysts, AI Specialists, and Sustainable Engineering Professionals.
Singapore	Singapore's maritime sector focuses on integrating smart port technologies. By incorporating IoT and big data analytics, Singapore has optimised port operations, making it a global leader in port efficiency and management.	This approach has increased demand for roles in IT, Data Analysis, and Marine Engineering, which are essential for managing the complex data flows and technological infrastructure within these ports.
China	China has integrated blockchain for secure cargo tracking and AI for fleet management. This strategic use of digital innovations ensures transparency, reliability, and efficiency in maritime operations.	Careers in cybersecurity, blockchain technology, and AI algorithm design have surged, reflecting China's drive to become a tech-centric maritime powerhouse.

9.5 Benefits of adopting emerging technologies in the maritime industry

The adoption of new technologies in the maritime sector provides numerous benefits, including:

- Increased efficiency: Automation and AI reduce operational delays and optimise resource allocation.
- Cost savings: Predictive maintenance and data-driven insights help reduce maintenance costs and prevent expensive repairs.
- Enhanced safety: Autonomous systems reduce the likelihood of human error, leading to safer operations.
- Environmental sustainability: Compliance with global standards through green technologies decreases pollution, aligning with international environmental targets.
- Improved supply chain management: Blockchain and IoT integration offer real-time insights and secure cargo tracking, reducing the likelihood of supply chain disruptions and improving customer confidence.

9.6 Ease of adoption by local businesses

- Trinidad and Tobago's maritime sector can adopt technologies such as AI, IoT and Blockchain with a strategic focus on partnerships, investment in workforce development, and infrastructure improvements. While the initial costs of implementing these technologies are high, grants, incentives, and public-private partnerships can offset expenses and support the transition. Generally, the benefits gained from adopting these technologies will far outweigh the costs associated with acquiring them.
- Education and training programmes in AI, IoT, Blockchain, etc. can empower local talent with the essential knowledge and skills needed to thrive in environments driven by these technologies. Trinidad and Tobago could benefit from developing STEM and technical training initiatives in collaboration with local universities such as The University of the West Indies and The University of Trinidad and Tobago, helping to address skill shortages and future needs.
- Upgrades to port infrastructure are essential to accommodate autonomous vessels and smart technologies such as Smart port management systems, automated port operations and Environment monitoring systems. As part of

the transition, regulatory frameworks must be updated to ensure seamless integration of advanced tech.

9.7 Case Study: Transformation of the Port Authority of Trinidad and Tobago

This case study examines the transformative efforts of the Port Authority of Trinidad and Tobago (PATT) in modernising the Port of Port of Spain (PPOS). By leveraging advanced technologies and innovative practices, PATT has increased operational efficiency, improved customer service, and strengthened sustainability in Trinidad and Tobago's maritime Sector.

Background

The Port of Port of Spain is one of the busiest in the Caribbean, serving as a critical hub for regional and international trade. Historically, this port faced challenges, including congestion, inefficient cargo handling, and limited transparency across its operations. In response, PATT embarked on a digital transformation to improve service efficiency, enhance competitiveness, and align with global sustainability goals.

Challenges

Before its transformation, the Port of Port of Spain faced several operational inefficiencies:

- Congestion - Poor coordination between stakeholders led to delays in cargo handling and prolonged ship turnaround times.
- Manual Processes - The port was heavily reliant on paperwork and manual systems, leading to slowdowns and increased risks of human error.
- Sustainability Issues - The use of outdated, energy-intensive machinery and inefficient processes increased operational costs and environmental impact.

Solutions Implemented

To address these challenges, PATT implemented several key technologies:

- NAVIS Sparcs N4 General Cargo Module (GCM):
  PATT upgraded its terminal operating system (TOS) with the NAVIS Sparcs N4, a global standard in TOS, to enhance the management of cargo

movement. The upgrade to the GCM enabled the port to digitise services, providing real-time cargo tracking, enhanced visibility, and improved inventory control for customers. This technology also allows for online submission of manifests and scheduling of appointments, streamlining port operations (Port Authority of Trinidad and Tobago, 2023).

- Energy-Efficient Cargo Handling Equipment:
  PATT introduced new Ship-to-Shore Container Handlers (STS 005 and STS 006), Reach Stackers (RS), and Empty Container Handlers (ECH) to significantly improve cargo-handling efficiency. These upgrades are part of a broader effort that includes acquiring new super post-panamax gantry cranes and other equipment, which contribute to reducing carbon emissions and energy consumption (Port Authority of Trinidad and Tobago, 2023; Portside Caribbean, 2023).

- Port Community Systems (PCS):
  In 2023, Trinidad and Tobago signed a contract with SOGET port operating system, a global leader in PCS, to implement a Personal communication service at major air and sea ports. This system aims to enhance trade efficiency by integrating various platforms like Automated Systems for Customs Data (ASYCUDA) and Trinidad and Tobago Business Link (TTBizLink), ultimately streamlining operations and improving transparency in the movement and clearance of goods.

- IoT and Real-Time Monitoring:
  Internet of Things (IoT) sensors were deployed to enable real-time monitoring of cargo and equipment. This allowed PATT to implement predictive maintenance systems, reducing equipment downtime and enhancing overall operational efficiency.

- Wireless Handheld Devices and CCTV:
  PATT enhanced security and operational transparency by using wireless handheld devices to monitor vehicle activity at entry and exit points. Additionally, a full-coverage CCTV system was installed to provide comprehensive monitoring of port operations.

Results

The technological upgrades and innovations led to significant improvements in port operations:

- Operational Efficiency- The implementation of NAVIS N4 and IoT sensors reduced ship turnaround times, optimised cargo handling, and minimised operational delays. The automation of cargo processing streamlined the movement of goods and reduced reliance on manual systems.
- Customer Satisfaction- The digitisation of services provided customers with real-time access to cargo information, including tracking and scheduling, improving the overall customer experience and transparency.
- Sustainability- The introduction of energy-efficient equipment and digital processes lowered the port's carbon footprint, aligning PATT with global trends towards green logistics and environmental sustainability.
- Competitiveness- The modernisation efforts made the Port of Port of Spain a more attractive destination for international shipping lines, increasing trade volumes and strengthening its position as a regional hub.

Conclusion of the case study

The transformation of the Port of Port of Spain highlights the significant role of technology in reshaping maritime operations. By implementing advanced systems such as NAVIS Sparcs N4, IoT, and energy-efficient equipment, along with the PCS, PATT has achieved substantial improvements in efficiency, customer service, and environmental sustainability. This case study exemplifies how digital transformation can enhance competitiveness and sustainability in the maritime industry.

10. General Recommendations

The recommendations below are guided by the research undertaken during this study, stakeholder consultations and the results of the industry survey. The recommendations are intended to help to increase STEM capacity and capabilities of the workforce.

STEM Education and Training:

1. Increase the practical/training component in tertiary education programmes. This is widely recognised as essential for preparing graduates better for the workplace. By integrating more hands-on experiences, students can put theory into practice in real-world situations, helping them gain the necessary skills and experience to transition smoothly into the workplace.

2. Greater alignment of tertiary programmes to the needs of industry. Achieving greater alignment of tertiary education programmes with industry needs is crucial for ensuring that graduates are equipped with the skills and knowledge demanded by industry. This alignment can lead to increase employment, productivity and growth.

3. Increase incentives and promotion for students to pursue studies and careers in STEM fields demanded by industry. Increasing incentives and promoting STEM studies and careers that are demanded by industry is essential for addressing labour gaps. This can also result in higher employment rates for graduates and greater success for businesses.

4. Increase incentives for greater participation of females in the maritime field as the survey results show that males outnumbered females in most job categories. As technology continues to transform the workplace, IT-related jobs will be heavily demanded in the future and therefore it is essential to encourage greater female participation in these roles to prevent their exclusion from opportunities that are key to achieving a higher standard of living.

5. Increase research on STEM careers emerging from technologically advanced maritime sectors and promote these careers locally. This is crucial for preparing the workforce for the technological transformation needed to ensure business continuity. Furthermore, these findings should be available to educators, employers, students and all key stakeholders.

6. Introduce more maritime programmes based on current and future needs of industry. Presently the UTT is the only public institution offering a maritime programme. In order to capitalise on advancing technologies and associated careers, more programmes will need to be developed in response to growing technological and environmental demands.

7. Make STEM fun so that children can enjoy and as a result pique their interest in STEM. Increasing students' interest in STEM is essential to increasing their participation in STEM education and their pursuit of STEM careers.

8. Fully integrate STEM skills into the curriculum at an early age. Students will have a greater understanding, appreciation and interest in STEM from a young age. Furthermore, integrating STEM skills into the curriculum at an early age would help develop STEM skills that are essential in an increasingly technology-driven world.

9. Create/introduce more resources that help parents and teachers make STEM more relatable and fun for children. This would help students develop an appreciation and enthusiasm for STEM, which can lead greater interest and participation in the field.

10. Foster partnerships between government, businesses, universities and all stakeholders to continue promoting and enabling skills development. These collaborative efforts help bridge the gap between education and industry needs and increase the STEM capacity of the workforce.

STEM Labour Force Development:

1. Provide more training and apprenticeship programmes based on the needs of the industry. This will ensure that graduates are able to transition smoothly into the workplace and reduce the mismatch of skills.

2. Provide more career guidance for young people through mentorship, structured programmes or career paths. This would help increase the participation of young people in STEM careers and satisfy anticipated future demand for STEM jobs.

3. Retrain employees to meet the current and future demand of the workplace. This is essential for addressing labour shortages and remaining competitive, in a rapidly evolving industry.

4. Provide more support and incentives to promote STEM. Providing incentives to pursue STEM careers is crucial for driving innovation and competitiveness in businesses.

5. Encourage more labour force studies on STEM skills and STEM jobs. Undertaking more labour force studies on STEM skills and STEM jobs is crucial for understanding labour market trends and gaps. This data will enable policymakers to develop policies and programmes to address these gaps and facilitate greater alignment of education and training with industry needs.

6. Provide data on technological advancements within the sector and the benefits of investing in these technologies for employers. Many employers operate small businesses and therefore it is important to raise awareness of emerging technologies that are transforming the industry and the benefits of adopting these technologies. This could stimulate demand for STEM jobs that are needed to keep up with emerging technologies and ensure the industry's long-term sustainability.

7. Increase investment in Research, Development, and Innovation to drive the maritime industry into the technological age. Technological advancements are key to transforming the sector into an automated, low-carbon, and energy-efficient industry. This investment would also stimulate the demand for STEM talent associated with emerging technologies.

8. Promote STEM jobs maritime employers identified as key for future growth. This will increase employability of students and increase the STEM talent in the workforce.

9. Given the lack of response for the TVET section, undertake studies that focus solely on TVET.

11. Conclusion

In conclusion, this study offers a comprehensive assessment of the current and future STEM labour needs within the maritime sector of Trinidad and Tobago. Several recent studies have reported that technological change would lead to significant declines in certain job categories in the coming years as automation in the workforce continues to evolve. The most competitive businesses will be those that are able to develop core skills among their employees. The World Economic Forum reported that analytical thinking, creativity and flexibility were among the top skills needed in 2025. The survey results highlight key insights into the existing skillsets of the workforce and the emerging demands for STEM competencies as the industry evolves. The findings of this study underscore the crucial role that technological advancements, such as automation, AI, IoT, and blockchain, will play in reshaping the workforce. Moreover, the study emphasises that the most competitive businesses in the sector will be those that invest in developing core skills among their employees, enabling them to effectively adapt to the evolving demands of the work environment.

The demand for specific STEM workers, particularly in fields like Engineering and IT, is evident, with Marine Engineers and IT Professionals identified as the hardest roles to fill. This presents a challenge, as employers faced greater difficulties when recruiting for STEM positions compared to non-STEM roles. Despite the relatively low number of STEM vacancies in local maritime establishments, the demand for STEM professionals is expected to grow in the coming years. The results reveal that employers anticipate increased demand for Electrical Engineers, Marine Surveyors and Marine Engineers in the next five years. This indicates a clear need for targeted workforce development and training strategies in these STEM fields to meet the evolving needs of the industry.

Furthermore, the study highlights a skills gap between what employers require and the skills possessed by the current workforce. While many employers rated the core competencies of existing employees highly, there was still a noticeable gap in certain critical areas, particularly in foundational skills such as communication, collaboration, emotional intelligence, and adaptability. The ability to address these gaps will be crucial for employers seeking to maintain their competitiveness and their ability to adapt to future challenges. While employers indicated that the mismatch of skills has not yet severely affected operations, there is a potential risk that these gaps could impact their future growth and sustainability if left unaddressed. Leveraging STEM talent effectively within the maritime sector could play a pivotal role in transitioning toward a knowledge-based, innovation-driven

economy. Failure to capitalise on STEM capabilities could result in missed growth opportunities, reduced competitiveness, and an inability to address industry challenges effectively.

Broadening the demand for STEM skills within the maritime sector is critical not only for the sector's development but also for ensuring the broader economic growth and sustainability of the nation. The implications of these findings are profound, highlighting the need for targeted interventions to address skills gaps and foster a future-ready workforce. The implications of these findings are significant and wide-ranging. First, there is an urgent need for a strategic approach to workforce planning and development that aligns education and training programmes with the demands of the maritime industry. This includes improving the STEM curriculum at various levels, particularly in Engineering, IT, and Environmental Sciences, to ensure a STEM talent pipeline that can effectively meet the industry's evolving needs. Collaboration between industry stakeholders; education and training institutions; and government will be key to developing relevant training and apprenticeships programmes. Through collaboration, there will be greater alignment between education and training programmes and industry requirements, thereby, ensuring that the future workforce is equipped with the skills demanded by the industry and helping to reduce the skills gap.

Moreover, addressing the skill shortages in key STEM areas will require a multi-faceted approach, which would involve increased promotion of STEM education and careers to increase the talent pool in the maritime industry. Employers will also need to upskill and reskill their existing workforce to ensure they can adapt to new technologies and work processes as the industry becomes more automated. This approach would also ensure that employees are equipped to thrive in a technology-driven environment and are less prone to being replaced by automation, thus preventing job displacement and reducing the risk of unemployment. More targeted investments in digital skills training, particularly related to emerging technologies in areas such as AI, blockchain, green technologies and data analytics, are also crucial for building a robust talent pipeline. Understanding the STEM jobs and skills associated with digital innovations and identifying the gaps in the current STEM ecosystem will provide valuable data to help develop targeted interventions for the creation of a supportive environment for technological advancement.

The study's findings also have broader implications for national development goals. By fostering a STEM workforce equipped with core skills and competencies, Trinidad and Tobago can strengthen its position in the global maritime industry, contributing to economic growth, innovation, and sustainability. Additionally, the

adoption of green technologies and the shift toward more climate-friendly maritime operations will require a workforce skilled in environmental engineering and related disciplines, further reinforcing the importance of STEM education and training.

Ultimately, the findings from this study will inform policy decisions and guide the development of programmes aimed at addressing the skills disparities in the maritime sector. Data-driven policies and strategies will ensure that both the current and future workforce are well equipped to meet the challenges posed by technological advancements and global sustainability goals. By addressing these labour needs proactively, Trinidad and Tobago can increase the productivity, innovativeness and competitiveness of its maritime industry, driving economic growth and development in this critical sector.

Appendix I: Occupational Groups

1. **Managers -** Includes occupations whose main tasks consist of planning, directing, coordinating and evaluating the overall activities of government, enterprises and other organisations, or of organisational units within them, and formulating and reviewing their policies, laws, rules and regulations. Formal preparation for these occupations may be supplemented or replaced partly or wholly by on-the-job training and/or experience. Examples**:** Managing Directors, Senior Officials, Hotel Managers and ICT Managers.

2. **Professionals -** Includes occupations whose main tasks require a high level of professional knowledge and experience. The main tasks consist of increasing the existing stock of knowledge, applying scientific and artistic concepts and theories, teaching about the foregoing in a systematic manner or engaging in any combination of these activities. Competent performance in most occupations in this occupational group requires skills which have been acquired from tertiary-level education leading to a university or post-graduate university degree. On-the-job training and/or experience may supplement formal preparation or replace it partly or wholly. Examples**:** Farming, forestry and fisheries professionals, Mechanical Engineers, Software Developers and Visual Artists.

3. **Technicians and Associate Professionals -** Includes occupations involving the performance of mostly technical and related tasks connected with research and the application of scientific or artistic concepts, operational methods, and government or business regulations. Most occupations in this occupational group require skills which have been acquired from post-secondary education leading to an award not equivalent to a first university degree. On-the-job training and/or experience may supplement formal preparation or replace it partly or wholly. Examples**:** Civil engineering technicians, Agricultural technicians, Ships' deck officers and pilots and Web technicians.

4. **Clerical Support Workers -** Includes occupations which involve the recording, organising, storing, computing and retrieving of information and performing a number of clerical duties in connection with money-handling operations, travel arrangements, requests for information and appointments. Most occupations in this occupational group require skills which have been acquired from secondary-level education lasting about five years. On-the-job training and/or

experience may supplement formal preparation or replace it partly or wholly. Examples**:** Secretaries, Office Clerks, Hotel receptionists and Transport clerks.

5. **Service and Sales Workers -** Includes occupations involving personal and protective services related to travel, housekeeping, catering, personal care, or protection against fire and unlawful acts, or demonstrating and selling goods in wholesale or retail shops and similar establishments, as well as at stalls and in markets. Most occupations in this occupational group require skills which have been acquired from secondary-level education lasting about five years. On-the-job training and/or experience may supplement formal preparation or replace it partly or wholly. Examples**:** Travel Attendants, Conductors, Guides, Cooks, Waiters and Bartenders.

6. **Skilled Agricultural, Forestry and Fishery Workers -** Workers in this group grow and harvest field or tree and shrub crops, gather wild fruits and plants, breed, tend or hunt animals, produce a variety of animal husbandry products, cultivate, conserve and exploit forests, breed or catch fish and cultivate or gather other forms of aquatic life in order to provide food, shelter and income for themselves and their households. Most occupations in this occupational group require skills which have been acquired from secondary-level education lasting about five years. On-the-job training and/or experience may supplement formal preparation or replace it partly or wholly. Examples**:** Market gardeners, Crop growers, Poultry producers and Deep-sea fishery workers.

7. **Craft and Related Trades Workers -** Workers in this group apply specific knowledge and skills to construct and maintain buildings, form metal, erect metal structures or set machine tools. They make, fit, maintain and repair machinery, equipment or tools, carry out printing work, and produce or process foodstuffs, textiles, or wooden, metal and other articles, including handicraft goods. Most occupations in this occupational group require skills which have been acquired from secondary-level education lasting about five years. On-the-job training and/or experience may supplement formal preparation or replace it partly or wholly. Examples**:** Riggers, Cable splicers, Aircraft engine mechanics and repairers and Musical instrument makers and tuners.

8. **Plant and Machine Operators and Assemblers -** Workers in this group operate and monitor industrial and agricultural machinery and equipment on the spot or by remote control, drive and operate trains, motor vehicles and mobile machinery and equipment, or assemble products from component parts according to strict specifications and procedures. Most occupations in

this occupational group require skills which have been acquired from secondary-level education lasting about five years. On-the-job training and/or experience may supplement formal preparation or replace it partly or wholly. Examples**:** Cocoa, coffee and chocolate processing machine operators, Assemblers, Mobile farm and forestry plant operators and bus drivers.

9. **Elementary Occupations -** Covers occupations which involve the performance of simple and routine tasks which may require the use of hand-held tools and considerable physical effort. Most occupations in this occupational group require skills which have been acquired from primary education. On-the-job training and/or experience may supplement formal preparation or replace it partly or wholly. Examples**:** Cleaners and helpers in offices, hotels and other establishments, Crop farm labourers, Kitchen helpers, Messengers, package deliverers and luggage porters.

Source: International Labour Organization. 2012. *International Standard Classification of Occupations*

Appendix II: STEM Occupations

Science, Technology, Engineering and Mathematics (STEM) occupations include computer and mathematical, architecture and engineering, and life and physical science occupations, as well as managerial and postsecondary teaching occupations related to these functional areas and sales occupations requiring scientific or technical knowledge at the postsecondary level.

Science	Computer Science/ IT	Engineering	Mathematics
• Natural Sciences Managers • Animal Scientists • Food Scientists and Technologists • Soil and Plant Scientists • Biochemists and Biophysicists • Microbiologists • Zoologists and Wildlife Biologists • Biological Scientists, All Other • Conservation Scientists • Foresters • Epidemiologists • Medical Scientists, Except Epidemiologists • Life Scientists, All Other • Astronomers • Physicists • Atmospheric and Space Scientists • Chemists • Materials Scientists • Environmental Scientists and Specialists, Including Health • Geoscientists, Except Hydrologists and Geographers • Hydrologists	• Computer and Information Systems Managers • Computer Systems Analysts • Information Security Analysts • Computer and Information Research Scientists • Computer Network Support Specialists • Computer User Support Specialists • Computer Network Architects • Database Administrators • Database Architects • Network and Computer Systems Administrators • Computer Programmers • Software Developers	• Architectural and Engineering Managers • Architects, Except Landscape and Naval • Landscape Architects • Cartographers and Photogrammetrists • Surveyors • Aerospace Engineers • Agricultural Engineers • Bioengineers and Biomedical Engineers • Chemical Engineers • Civil Engineers • Computer Hardware Engineers • Electrical Engineers • Electronics Engineers, Except Computer • Environmental Engineers • Health and Safety Engineers, Except Mining Safety Engineers and Inspectors • Industrial Engineers	• Actuaries • Mathematicians • Operations Research Analysts • Statisticians • Data Scientists • Mathematical Science Occupations, All Other

Science	Computer Science/ IT	Engineering	Mathematics
• Physical Scientists, All Other • Agricultural Technicians • Food Science Technicians • Biological Technicians • Chemical Technicians • Environmental Science and Protection Technicians, Including Health • Geological Technicians, Except Hydrologic Technicians • Hydrologic Technicians • Nuclear Technicians • Forest and Conservation Technicians • Forensic Science Technicians • Life, Physical, and Social Science Technicians, All Other • Computer Science Teachers, Postsecondary • Mathematical Science Teachers, Postsecondary • Architecture Teachers, Postsecondary • Engineering Teachers, Postsecondary • Agricultural Sciences Teachers, Postsecondary • Biological Science Teachers, Postsecondary • Forestry and Conservation Science Teachers, Postsecondary • Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary • Chemistry Teachers, Postsecondary	• Software Quality Assurance Analysts and Testers • Web Developers • Web and Digital Interface Designers • Computer Occupations, All Other	• Marine Engineers and Naval Architects • Materials Engineers • Mechanical Engineers • Mining and Geological Engineers, Including Mining Safety Engineers • Nuclear Engineers • Petroleum Engineers • Engineers, All Other • Architectural and Civil Drafters • Electrical and Electronics Drafters • Mechanical Drafters • Drafters, All Other • Aerospace Engineering and Operations Technologists and Technicians • Civil Engineering Technologists and Technicians • Electrical and Electronic Engineering Technologists and Technicians • Electro-Mechanical and Mechatronics Technologists and Technicians • Environmental Engineering Technologists and Technicians • Industrial Engineering Technologists and Technicians	

Science	Computer Science/ IT	Engineering	Mathematics
• Environmental Science Teachers, Postsecondary • Physics Teachers, Postsecondary • Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products • Sales Engineers		• Mechanical Engineering Technologists and Technicians • Calibration Technologists and Technicians • Engineering Technologists and Technicians, Except Drafters, All Other • Surveying and Mapping Technicians	

Source: Bureau of Labour Statistics, Department of Labour, US. 2021. *'Occupational Employment and Wage Statistics Survey'*

Appendix III: 19 Core Skills

1. **Analytical and critical thinking** - The ability to assess issues appropriately and adequately, and analyse relevant information to form an opinion or take an individual or a collective decision. The ability to think clearly, logically and rationally; to evaluate and interpret information; and to objectively analyse and evaluate an issue to make a judgement.

2. **Career management** - The ability to establish, plan and work towards the achievement of short- and long-term goals having both tangible and intangible success criteria. The ability to exchange information and ideas with individuals and groups that share a common interest, developing relationships for mutual benefit. The ability to use labour market information and intelligence to help identify work opportunities, understand work contexts and work conditions and apply job-search skills.

3. **Collaboration and teamwork** - The ability to work in diverse teams effectively and respectfully, assuming shared responsibility for outputs and demonstrating willingness and flexibility. The ability to identify and acknowledge the feelings, experiences and viewpoints of others, showing care, affection and kindness.

4. **Collect, organise and analyse information** - The ability to search, select, evaluate and organise information in order to effectively and efficiently mobilise relevant information. The ability to re-structure and model sourced information to produce personal interpretations of data.

5. **Communication** - The ability to listen effectively in order to decipher meaning; articulate thoughts and ideas effectively; exchange information; and express opinions, desires, needs and fears using oral, written and non-verbal skills in diverse environments for a range of purposes.

6. **Conflict resolution and negotiation** - The ability to reach a consensus between divergent interests by utilising logical argument and influencing others to cooperate, thereby resolving disagreement or dispute.

7. **Creative and innovative thinking** - The ability to utilise a wide range of idea creation techniques, so as to generate, articulate and apply inventive and original ideas and perspectives, thereby solving complex tasks and life issues through original ideas.

8. **Emotional intelligence** - The ability to identify, understand and manage one's own emotions, as well as helping others to do the same. It can comprise of four domains: self-awareness, self-management, social awareness, and relationship management, which together have 12 competencies, including empathy, adaptability, achievement orientation and positive outlook.

9. **Energy and water efficiency** - The ability to use energy and water efficiently in ways that sustain the natural and physical environment.

10. **Environmental awareness** - The ability to understand and demonstrate an awareness of the physical environment and the need for it to be protected.

11. **Foundational literacies** - Literacy, numeracy, health, financial, scientific, cultural, and civic
    - Literacy: the ability to understand, identify, interpret, create and communicate effectively utilising inscribed, printed, or electronic signs or symbols for representing language.
    - Numeracy: the ability to understand and have the confidence and skill to work with numbers and mathematical approaches in all aspects of life.
    - Health literacy: the ability to gain access to, understand and utilise information in ways which promote and maintain good health.
    - Financial literacy: the ability to understand and apply financial management skills appropriately and to be able to make a financial plan, manage debt, calculate interest, understand the time value of money in order to make informed and effective decisions about personal financial resources.
    - Scientific literacy: the ability to understand those scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity.
    - Cultural literacy: the ability to understand the perspectives of people from diverse backgrounds instead of considering one's cultural beliefs and practices as the correct ones.
    - Civic literacy: the ability to participate effectively in civic life through knowing the rights and obligations of residents at local, state and national levels.

12. **Operate safely in an online environment** - The ability to safely use basic online functions, applications, digital learning and communication platforms and media to explore, analyse and share information safely and ethically.

13. **Planning and organising** - The ability to plan and organise tasks in order to fulfil the job responsibilities satisfactorily within a given time and appropriately for a complex environment and situation.

14. **Problem-solving and decision-making** - The ability to identify and assess issues and problems, utilise available resources to generate and "brainstorm" potential solutions, evaluate the pros and cons of solutions and decide on a solution

15. **Self-reflection and learning to learn** - Self-reflection is the ability to apply reason to thought and behaviour, reflecting upon personal characteristics, assessing progress and identifying areas of for self-improvement. Learning to learn is the ability to apply the cognitive process of personal learning (what and how we learn) and to make use of guidance to continuously pursue learning new knowledge and skills and strive for improvement.

16. **Strategic thinking** - The ability to think conceptually, imaginatively, systematically and opportunistically, leading to a clearly defined set of goals, plans, and the new ideas required to survive and thrive in competitive and changing environments.

17. **Use basic hardware** - The ability to operate a personal computer, tablet, mobile phone or other digital device using the hardware functionalities, such as a keyboard, mouse, navigation buttons and touchscreen technology, where appropriate.

18. **Use basic software** - The ability to use and troubleshoot basic programs and applications, and able to word process, manage files, and access and adjust privacy settings.

19. **Waste reduction and waste management** - The ability to use, manage and dispose of resources in ways that sustain the natural and physical environment.

Source: International Labour Organization. 2021. *Global framework on core skills for life and work in the 21st century*

Appendix IV: STEM Competencies that Support TVET

1. **Creative/Inventive** - Thinking Combine or connect ideas and information in unique and novel ways to generate new ideas, applications, products, processes, or services

2. **Critical Thinking** - Apply logic and reasoning to make sense of data or information by posing questions, putting forward arguments, exploring counterexamples, searching evidence, identifying relationships, recognising patterns and trends, evaluating pros and cons, and synthesising information

3. **Systems Thinking** - Understand the bigger context of a system, its emergent properties, and behaviour over time by knowing the connections, interrelationships, and dynamics of its constituent parts

4. **Problem Solving** - Identify feasible and efficient solutions to solve problems and to create new opportunities

5. **Transdisciplinary Thinking** - Put together relevant concepts and processes from multiple disciplines to generate solutions and new applications

6. **Decision-making** - Make a logical choice of action by looking at evidence, exploring alternatives, considering likely impact, evaluating options and providing justifications

7. **Computational Thinking** - Develop or apply computational models, tools and techniques to interpret and understand data, solve problems, and guide decision-making

8. **Ethical Thinking** - Use value system as guide for making choices that adhere to acceptable standards and protocols.

9. **Numeracy** - Apply mathematical ideas in personal, occupational, societal, and scientific contexts by reasoning, creating representations, or using measuring instruments or calculating tools

10. **Digital Literacy** - Search, evaluate, create, and share digital information using ICT device, equipment, tools, platforms, and applications for communication, collaboration, or problem solving

11. **Civic Literacy** - Contribute to the broader goals of the community by participating proactively in community affairs and observing social responsibility

12. **Cultural Literacy** - Be sensitive and respectful of the culture where an individual is immersed in

13. **Occupational Health Literacy** - Understand and apply occupational safety standards and protocols as well as take care of one's health and well-being to maintain productivity

14. **Entrepreneurial Literacy** - Detect an opportunity and make it grow in a sustainable way applying relevant knowledge, skills, and attitudes

15. **Organisational Literacy** - Negotiate way within an organisation by understanding its structure, dynamics of its members, communication channels, and appropriate procedures

16. **Communication** - Convey and exchange thoughts, ideas and information effectively through various mediums and approaches

17. **Collaboration** - Work effectively in a team to achieve shared goals either through face-to-face or virtual interaction

18. **Empathy** - Sense, share and respond positively to the feelings of another

19. **Agency** - Manage own behaviour and emotions to act professionally and independently, make choices freely, and pursue goals persistently

20. **Lifelong/Lifewide Learning** - Find opportunities to enhance one's knowledge and skills for continual learning; Maintain curiosity, passion, and growth mindset; Connect learning to a purpose and real-world context

21. **Resilience** - Thrive or prosper despite difficult circumstances; Be adaptable and flexible

22. **Leadership** - Lead others to attain shared goals by managing relationships, respecting diversity, recognising talent, and empowering people

23. **Service Orientation** - Support a culture of service excellence within the organisation by producing products or providing services that exceed the expectations of the customers

24. **Project Management** - Use resources (human, material, and time) wisely to deliver work-related tasks or projects

25. **Glocal** - Mindset Be adaptive to global standards but remain responsive to local needs

Source: International Labour Organization. 2021. *STEM in TVET Curriculum Guide*

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