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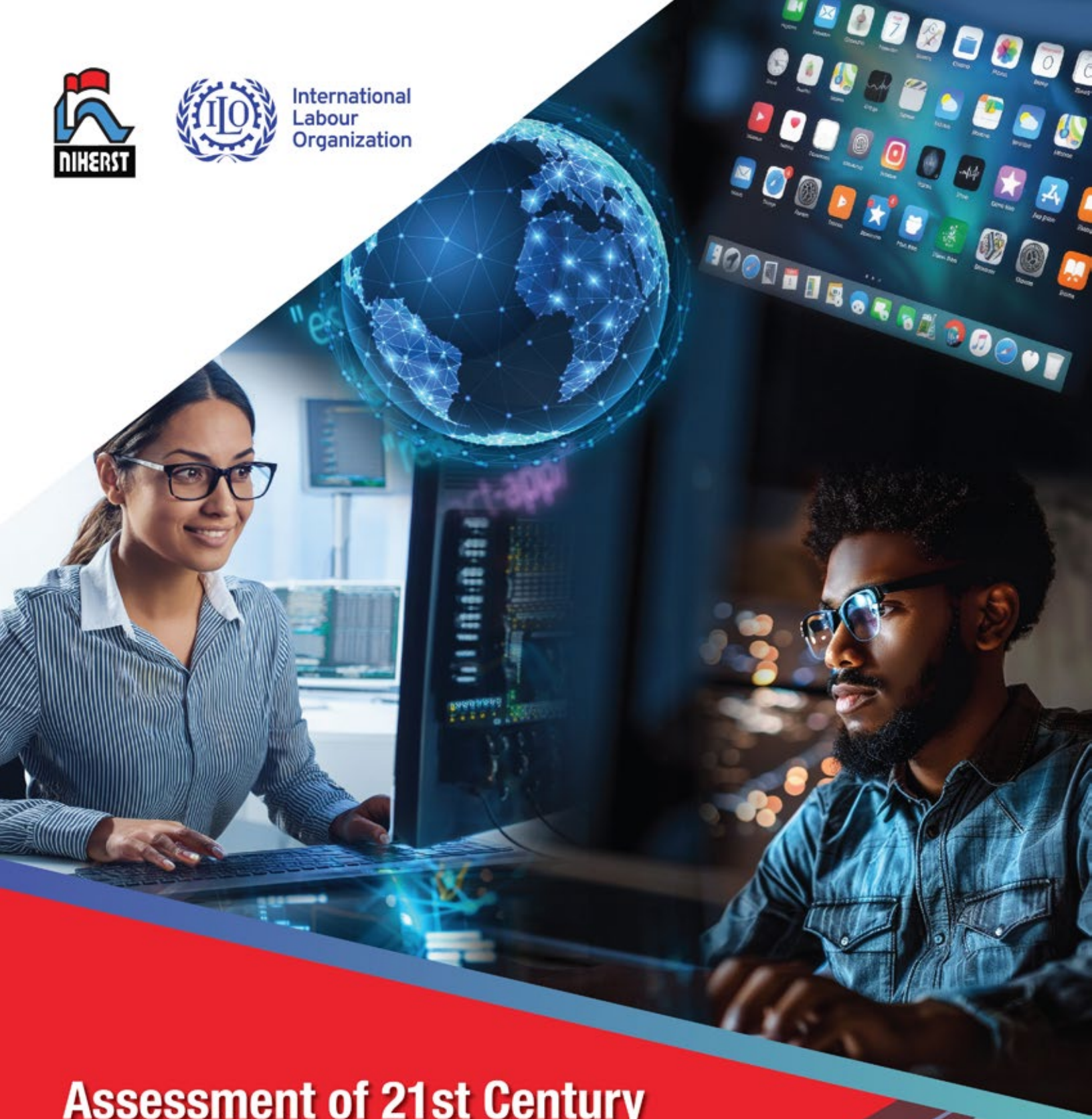

Assessment of 21st Century Skills Across Emerging Sectors

Software Design and Applications Industry

Volume 3

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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 rapidly evolving global economy, software design and application stands at the heart of innovation, productivity and digital transformation. The study presented here offers a comprehensive analysis of the software design and application industry in Trinidad and Tobago, the current landscape, the emerging trends, and the opportunities this industry holds for national development.

The study also highlights the skills - technical and future ready skills - that enable innovation, and points to the challenges employers face in sourcing individuals with the specialised skills required for roles in software development, cybersecurity, and systems analysis. While there is an emerging talent pipeline of young professionals, many need the practical experience and work-readiness to succeed in this fast-paced environment.

As the Acting President of the National Institute of Higher Education, Research, Science and Technology (NIHERST), I am proud to support initiatives that deepen our understanding of dynamic industries and guide the country's path toward a knowledge-based economy. This study is a testament to NIHERST's ongoing commitment to evidence-based research, strategic foresight, and the nurturing of talent and innovation across the nation.

I wish to extend sincere thanks to our institutional partner on this initiative, the International Labour Organization (ILO) for their unwavering support in enabling this series of research studies and in particular this third series which offers a comprehensive study of the Software Design and Application Industry.

I also wish to extend sincere appreciation to the team of researchers in particular the S&T Statistics Department at NIHERST and other contributors whose rigorous efforts have shaped this valuable resource.

May this study serve as a catalyst for informed decision-making, impactful policy, and collaborative progress across public and private spheres.

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 Software Design and Application Sector and is 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 software design and applications 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

The rapid advancement of technology is transforming the software design and applications industry, demanding that individuals continuously update their knowledge and skills to remain competitive. As technologies such as Artificial Intelligence (AI), Machine Learning (ML) and advanced digital systems continue to evolve within the software industry, there is a growing demand for a workforce with both cutting-edge technical expertise and adaptable, future-ready skills. International organisations such as the World Bank and the OECD have highlighted the critical role of Science, Technology, Engineering, and Mathematics (STEM) education in equipping individuals to meet these evolving workforce 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 technology-driven economy. These competencies are particularly relevant in software design and applications industry, where rapid innovation and continuous digital transformation are reshaping software development practices, accelerating product creation, improving system integration and supporting more sustainable solutions across sectors.

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 - the third in this research series - focuses on the software design and applications industry, offering evidence-based results to guide policy development and workforce planning aimed at strengthening national capacity and competitiveness in this key industry.

The ICT sector plays a pivotal role in promoting competitiveness, productivity and digitalisation. The ICT sector of Trinidad and Tobago comprises several industries such as software development, web design, data processing, ICT training and software solutions. In 2022, ICT services contributed 2.9 percent to the country's real gross domestic product (GDP).[1] According to the UNDP Digital Readiness Assessment Report (2022), Trinidad and Tobago demonstrated strong digital readiness and was making systematic progress in key areas of digital

[1] International Monetary Fund Country Report No. 24/151; April 22, 2024

transformation based on identified priority areas. As the demand for emerging technologies and innovative solutions continue to increase the software design and applications workforce, in particular, must evolve to meet the changing needs of the digital economy and to drive continued innovation, competitiveness and growth.

The Assessment of 21st Century Skills across Emerging Sectors study examined the labour needs of five (5) emerging industries including software design and applications. This report presents the key findings from data collected from twelve (12) out of thirty-two (32) software design and applications establishments that participated in the study.

The analysis in this report begins by describing key characteristics of employers in the software design and applications industry, which served to contextualise the research findings and provide a clearer understanding of the local industry landscape. The industry was made up primarily of relatively young micro and small enterprises (MSEs). Over a half of the establishment were in operation under 10 years (54%) and employed less than 10 employees (55%).

The study also explored the composition of the workforce, with a particular focus on STEM-related qualifications and occupations. This analysis is critical for identifying current capabilities and future labour needs. The survey results reveal that a similar percentage of males and females were employed within the software establishments. In terms of occupational groups, the highest representation was recorded for Managers (91%), followed by Professionals (73%) and Technicians and associate professionals (64%).[2] Notably, males outnumbered their female counterparts in all occupational groups except Clerical support workers and Service and sales workers. Regarding qualifications, all (100%) of the establishments employed staff with STEM degrees, with the highest concentration among Managers (82%), followed by Professionals (64%), and Technicians and Associate Professionals (55%). The findings reveal that the number of employees in each STEM occupation group was generally low, except in IT. A further review of the data by gender shows that males were more prevalent in Engineering and IT

[2] The occupational groups featured throughout this report follow from the International Labour Organization *International Standard Classification of Occupations* (2012) and are further defined in Appendix I.

roles, whereas females were more represented in Natural Sciences, and Mathematics and Statistics occupations.

The Assessment of 21st Century Skills Across Emerging Sectors study also examined the labour market dynamics within the software design and applications industry, focusing on current and future workforce needs, particularly in relation to STEM occupations. Some of the key findings on job vacancies, recruitment challenges, core skills and the demand for STEM labour are as follows:

Job Vacancies and Recruitment Challenges

A crucial component of the study was identifying job vacancies and understanding recruitment challenges faced by employers. This data provides insights into labour market gaps – especially in STEM fields- and informs decisions on training, education, and workforce development.

At the time of the survey, job opportunities in the industry were limited, with only 27% of establishments reporting vacancies. Notably, all vacancies were in STEM fields with the vast majority in IT. In terms of recruitment, 55% of the establishments did not fill any vacancies over the last 12 months of the survey period. While 36% filled STEM roles, only 27% filled non-STEM positions. In terms of occupational groups, the highest level of difficulty employers experienced during recruitment was recorded for Plant and machine operators, and assemblers, followed by Managers; Service and sales workers; Technicians and associate professionals; and Professionals. Employers faced greater challenges recruiting for STEM occupations, especially in Computer Science/IT (45%), Natural Sciences (33%), and Engineering (33%). The hardest STEM roles to fill included Web Designers, IT Managers, Programmers, and Software Developers. The main challenge employers faced in filling STEM vacancies was a shortage of applicants with the right attitude, motivation, or personality. To address recruitment challenges, employers recommended introducing more industry-aligned training opportunities, raising awareness among young people about the importance of technology, improving life skills, and restructuring education programmes.

Core Skills and Skills Mismatches

The study also assessed the cores skills of the workforce to identify mismatches between employer expectations and employee capabilities. Skills mismatch represents a discrepancy between the skills demanded by employers and the skills individuals possess. This can impact economic growth by restricting workers'

access to higher-paying jobs and limiting firms' profitability and productivity.[3] The skills examined in this study are based on 19 core skills that are described in Appendix III. The ILO identified these skills as crucial for lifelong learning and adapting to labour market changes. Recognising the fundamental skills needed to reach business objectives and aligning them with the skills of recent applicants and existing employees can facilitate a better understanding of the magnitude and nature of the skills gap.

The majority of employers indicated that it was important for employees to possess all 19 core skills, with the exception of basic skills for green jobs. The most important skill was Communication, followed by Analytical and Critical thinking, Operate safely in an online environment, and Problem-solving and Decision-making. The top three internal drivers of change were technology (58%), people (50%) and profit (25%). Communication (22%), IT (17%), organisational skills (13%), creativity and innovation (13%), and critical and analytical thinking (13%) were viewed as the most important skills for addressing these changes. External drivers of change included competition (67%), technology (67%) and climate change (11%). The most relevant skills to address these external changes were Problem solving (18%), Adaptability (12%), Strategic thinking (12%), Emotional intelligence (12%) and Critical thinking (12%).

Half (50%) or more of software employers reported difficulty finding social and emotional skills, as well as cognitive and metacognitive skills, among recent university graduates applying for jobs in their establishments. The highest percentage of difficulty was observed for Emotional intelligence, followed by Self-reflection and Learning to learn, Analytical and Critical thinking, Creative and Innovative thinking, Strategic thinking, Problem-solving and Decision-making, Collect, organise and analyse information, and Energy and Water efficiency. The least difficulty was recorded for basic digital skills. The majority of the establishments (70%) reported that recent university graduates were somewhat prepared for work.

In terms of existing employees, a half (50%) or more of the employers assigned a high rating to the nineteen (19) core skills among their existing employees except Waste reduction and Waste management and Energy and water efficiency. The

[3] 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)

highest ratings were assigned to Use basic hardware; Use basic software; Conflict resolution and negotiation; Operate safely in an online environment; and Collaboration and Teamwork. Despite these high ratings, there is still evidence of a skills gap in the industry based on the difference between the skill levels employers require to meet business goals and the current capabilities of their existing employees. Notably, more than a half (55%) reported that the lack of skills among workers did not affect their operations while (45%) disagreed.

Demand for STEM Labour

The study also examined the current and projected demand for STEM labour in the software design and applications industry, acknowledging that technological innovation is reshaping workforce requirements. During the survey period, the overall demand for STEM-related occupations was generally among participating establishments. The highest demand was reported for IT occupations, followed by Engineering occupations, while the lowest demand was observed for Food and Agriculture jobs. The most in-demand jobs at the time of the survey were Database Developers (36%) and IT Technicians (27%). Looking ahead, the top three STEM occupations employers identified as priorities over the next five years, based on the strategic direction of their establishments, were Software Developers, Web and Digital Interface Designers and Cyber Security Specialists.

Technological Advancements in Software Design and Applications

A key component of this research is the assessment of technological advancements in software design and applications, with a focus on both the challenges and opportunities they present. Technologies such as artificial intelligence (AI), blockchain and cloud computing are driving productivity and growth and in order to remain competitive, local establishments must adapt by integrating these technologies into their operations. Global technological advancements offer the potential to strengthen local operations and support the expansion of STEM careers.

Policy Relevance and Recommendations

This study serves as a critical resource for shaping national skills policy and supporting the development of a future-ready workforce aligned with Trinidad and Tobago's economic diversification agenda. This publication also captures employers' recommendations on how government, industry and tertiary institutions can work together to strengthen STEM education and the STEM labour force.

Some key recommendations from employers include: increase practical training in tertiary programmes; ensure education programmes are aligned to the needs of the 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.

In addition to these employer-driven suggestions, the report outlines broader recommendations based on the study's findings. These include: 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.

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Abbreviations and Acronyms

AI	Artificial Intelligence
AR	Augmented Reality
CARIRI	Caribbean Industrial Research Institute
CBTT	Central Bank of Trinidad and Tobago
CSO	Central Statistical Office
GORTT	Government of the Republic of Trinidad and Tobago
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IT	Information Technology
IMF	International Monetary Fund
ILO	International Labour Organization
ISCO	International Standard Classification of Occupations
ML	Machine Learning
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
UWI	University of the West Indies
UTT	University of Trinidad and Tobago
VR	Virtual Reality
WEF	World Economic Forum

Introduction

The software design and applications industry is experiencing rapid evolution, driven by digital transformation and rising global demand for advanced software solutions. Emerging technologies such as AI, ML, and cloud computing are fundamentally changing software development, creating new opportunities for growth, efficiency, and global competitiveness. However, despite this momentum, the findings of this study reveal notable gaps between employer expectations and current workforce capabilities, particularly in STEM-related roles that are vital to the industry's continued success. Of particular concern is the low number of establishments with job opportunities during the study period. This low demand for STEM and IT roles is concerning, especially given their critical importance to software innovation and digital advancement. The limited number of vacancies, coupled with ongoing difficulty finding candidates with the right mix of technical expertise and essential social, emotional, and cognitive skills, calls for greater alignment between the current labour market and the evolving needs of the industry.

The Assessment of 21st Century Skills in 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.[4] 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.[5]

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

[4] Government Manifesto on Agriculture and Food Security, 2025. https://uncmanifesto.com/
[5] Government Manifesto on Artificial Intelligence, Digital Transformation, New Media and Social Media, 2025. https://uncmanifesto.com/

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 software design and applications industry. As part of the Artificial Intelligence, Digital Transformation, New Media and Social Media Agenda, the Government plans to establish a National AI Research and Development Centre to nurture homegrown talent in advanced technologies, including software development. This initiative is aimed at promoting innovation, empowering the next generation and building a vibrant future for all citizens. This report serves as a baseline document in support of this national priority, providing evidence-based insights to guide strategic planning and informed decision-making.

As the adoption of advanced technologies becomes more widespread in the workplace, there is a growing need for highly skilled workers to keep up with these technological changes. According to the World Economic Forum's Future of Jobs Report 2025, employers anticipate that 39% of workers' core skills will need to change by 2030. Employer feedback further indicates that technological skills are expected to grow in importance more rapidly than any other skill category, with AI and big data leading the shift, followed by Networks and cybersecurity, and Technological literacy. Moreover, as an integral part of the ICT sector, the software design and applications industry is highly responsive to technological trends, which can drive significant innovation as well as cause disruptive shifts across the industry. Therefore, it is essential to strengthen the skills and competencies of the software design and applications workforce to ensure they are well-equipped to operate in a technology-driven environment.

This research was undertaken to assess the demand for STEM-related skills and labour within Trinidad and Tobago's software design and applications industry. It examined existing vacancies and the challenges employers face in filling these roles. The study also provided a comprehensive analysis of the skills required by businesses to achieve their strategic objectives, comparing these demands with the current capabilities of both recent job applicants and existing employees. In addition, it identified key internal and external drivers of change within businesses and the skills needed to respond effectively. The research explored both current and projected demand for STEM professionals. It also investigated the types of innovations adopted in the global software design and applications industry market along with the associated careers and benefits. Based on the findings, a series of evidence-based recommendations were developed to support policy, education, and workforce planning.

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; 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 software design and applications industry. This section offers data on the number of establishments with current vacancies, difficulty employers experienced when filling vacancies, and the number of 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. Section 4 also features employers' recommendations to overcome difficulties faced during recruitment.

Section 5 presents an assessment of the skills mismatches in the software design and applications industry. The chapter examines the skills employers identified as important for employees to possess to meet organisational goals. 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 presented.

Section 7 offers recommendations provided by employers on how the tertiary education, government and business sectors can help improve STEM competencies.

Section 8 examines significant technological advancements in global software design and application along with key STEM careers linked to these innovations. It also explores the ease and advantages of integrating these technologies into local operations. Furthermore, the section showcases the contribution of the Caribbean Industrial Research Institute (CARIRI) in advancing technological innovation in the in the software design and application industry of Trinidad and Tobago.

Section 9 offers general recommendations based on the research undertaken, stakeholder consultations and the results of the industry survey.

Section 10 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 overall methodology followed the guide on Developing and Running an Establishment Skills Survey of the European Training Foundation and the ILO.[6] 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, briefly presenting 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, survey limitations, and data processing and presentation.

1.1 Objectives of the Study

The objectives of the study are to:

- Provide data on the demand of STEM graduates in emerging sectors
- Provide data on the skills mismatches 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

[6]Developing and Running an Establishment Skills Survey: Guide to Anticipating and Matching Skills and Jobs Volume 5. *European Training Foundation/European Centre for the Development of Vocational Training/ILO 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 draft 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 sample of 32 businesses involved in the Software Design and Applications was contacted to participate in the survey. A survey frame was created using several data sources including the CSO business register. A sample was generated using systematic random sampling. Of the 32 businesses contacted, 12 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 emphasizes the importance of data collection to guide policies that support workforce development, ensuring businesses can meet both their current and future workforce needs.

iv. None of the software design and applications businesses responded to the section on TVET. Overall, the response rate to the TVET section was low across all surveyed sectors.

1.7 Data processing analysis and presentation

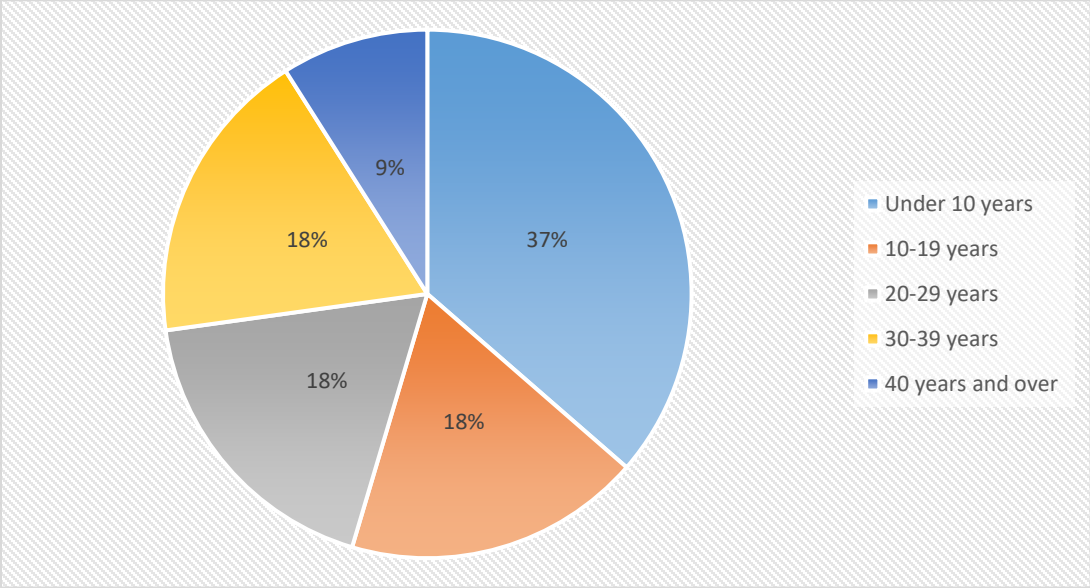
The quality of the data was checked for accuracy. Where there were discrepancies the field interviewer or office staff contacted the respondents for verification. Quantitative and qualitative data was coded and processed on SPSS and Excel. The results of the study are presented in the chapters that follow.

2. Characteristics of Employers

This section describes some of the key characteristics of employers in the Software Design and Application industry 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 for this industry were length of time in operation and employment size.

The first characteristics of employers presented in this section is the length of time in operation. Figure 1 illustrates the percentage of establishments from the software design and applications industry that responded to the survey by the length of time in operation. The data reveals that this industry is relatively young, with 55% of businesses having been in operation for less than 20 years.

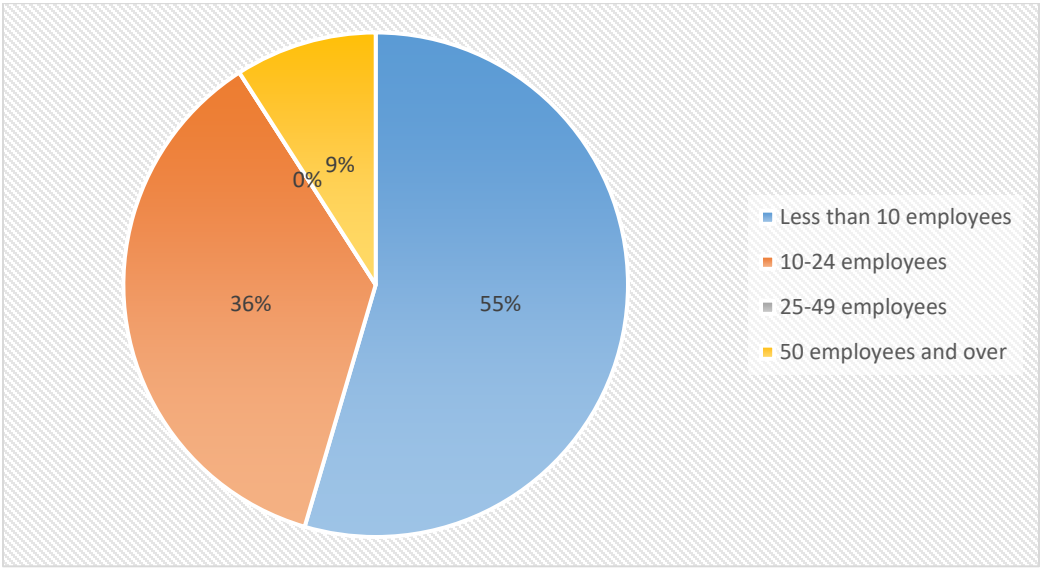
Figure 1: Percentage of establishments by length of time in operation



With regard to employment size, the results show that the software design and applications industry was predominantly made up of Micro and Small Enterprises (MSEs). Figure 2 shows that over a half (55%) of the establishments that participated in the survey had less than 10 employees and 36% 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.[7]

Figure 2: Percentage of establishments by employment size



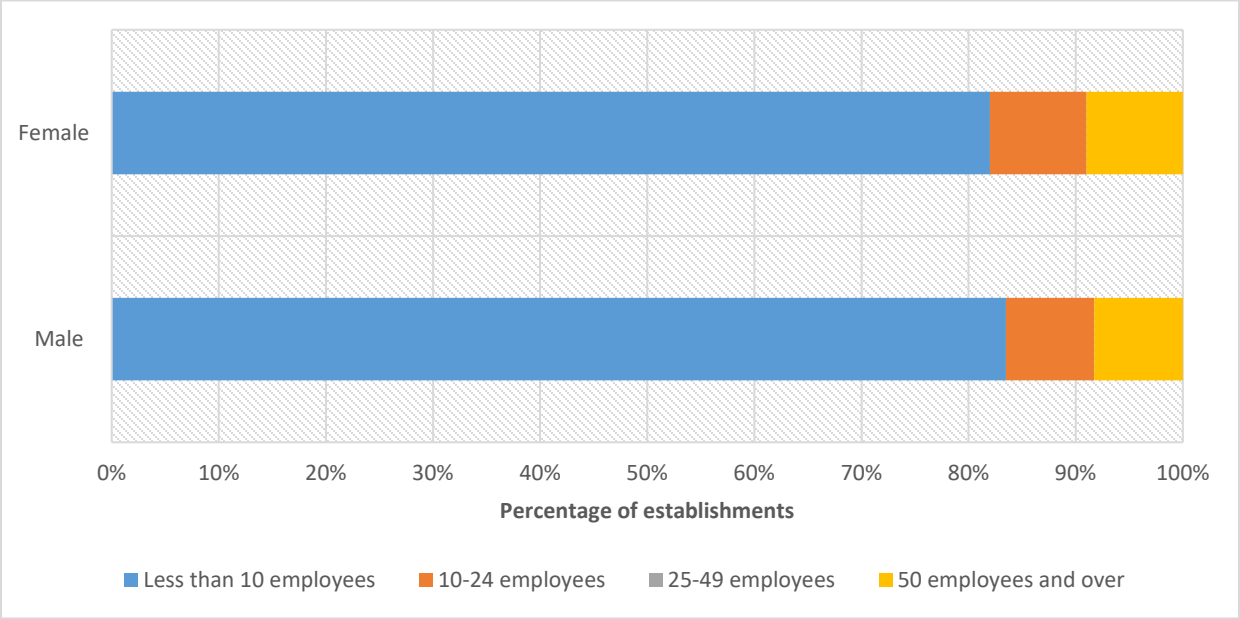
[7] Central Bank of Trinidad and Tobago, Research Papers Vol. 3 No. 2 September 2023

3. Characteristics of the Workforce

Collecting data on the characteristics of the workforce is important 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 3 shows a similar pattern of employment for both male and female in the software design and applications industry. The majority of establishments surveyed had less than 10 male or female employees.

Figure 3: Employment size by sex



The ILO's International Standard Classification of Occupations (ISCO) was used to describe the workforce by occupational groups. Figures 4 – 6 present the workforce of the software design and applications establishments by occupational group and sex. The main findings within occupational groups are summarised below.

- Managers:
  - This occupational group was the highest in terms of representation. All of the establishments (91%) that responded to the question

employed Managers with the majority employing 1-9. Nine percent (9%) did not provide a response.
    - Males outnumbered their female counterparts in managerial positions; 91% of the establishments reported 1 to 9 male managers compared to 73% in the case of females.

- Professionals:
    - This occupational group was the second highest in term of representation. Seventy-three percent (73%) of the establishments employed staff in this category.
    - A higher percentage of establishments (73%) employed males in this category compared to females (45%).

- Technicians and associate professionals:
    - More than half (64%) of the establishments that responded to the survey had workers under this occupational group.
    - Similar to the two previous occupational groups, the percentage of establishment that employed males (55%) was higher than females (36%) in this category.

- Clerical support workers:
    - Less than half (45%) of the establishments employed clerical support workers.
    - By sex, a larger proportion of establishments (36%) employed females in this category compared to males (9%).

- Service and sales workers:
    - Less than two-thirds (27%) of the establishments employed service and sales workers.
    - The percentage of establishments (18%) that reported female workers in this occupational group was twice that of those reporting male workers (9%).

- Skilled agricultural, forestry and fishery workers:
    - None of the businesses that participated in the study employed skilled agricultural, forestry and fishery workers.

- Craft and related trades workers:
    - None of the businesses that participated in the study employed skilled craft and related trade workers.

- Plant and machine operators, and assemblers:
    - None of the businesses that responded to this question employed skilled plant and machine operators, and assemblers.

- Elementary Occupations:
    - Only 9% of the establishments reported workers in this category and they were all females.

Figure 4: Employment by occupational group and sex – Both sexes

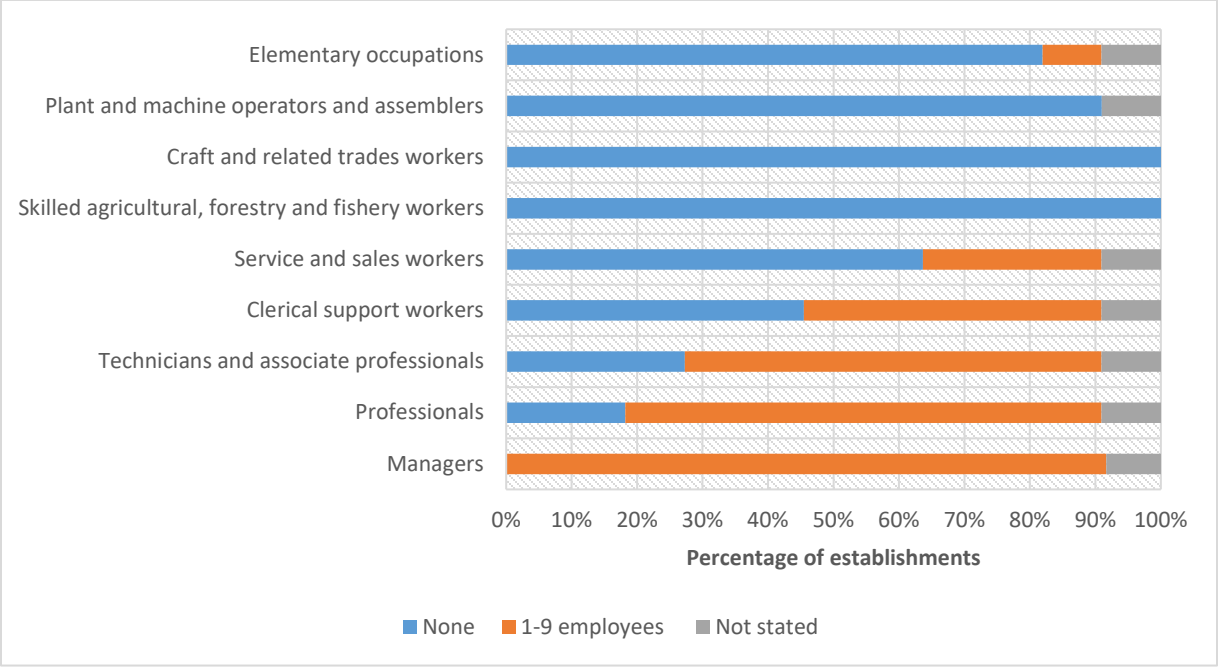


Figure 5: Employment by occupational group and sex – Males

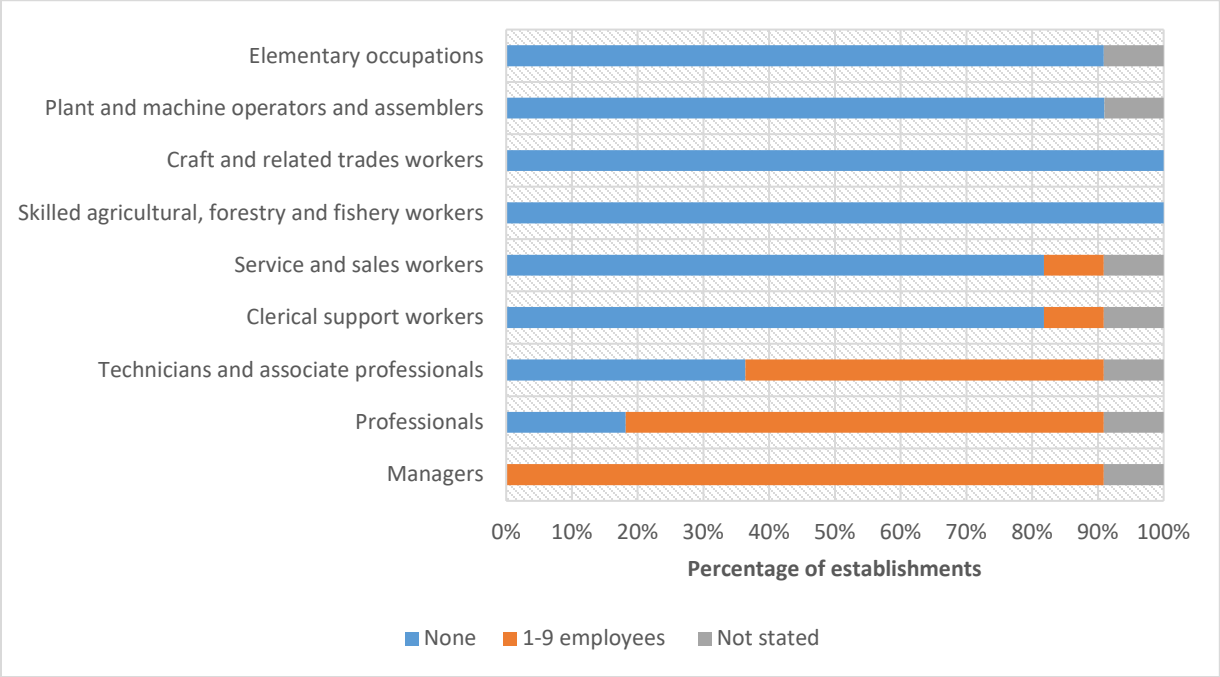
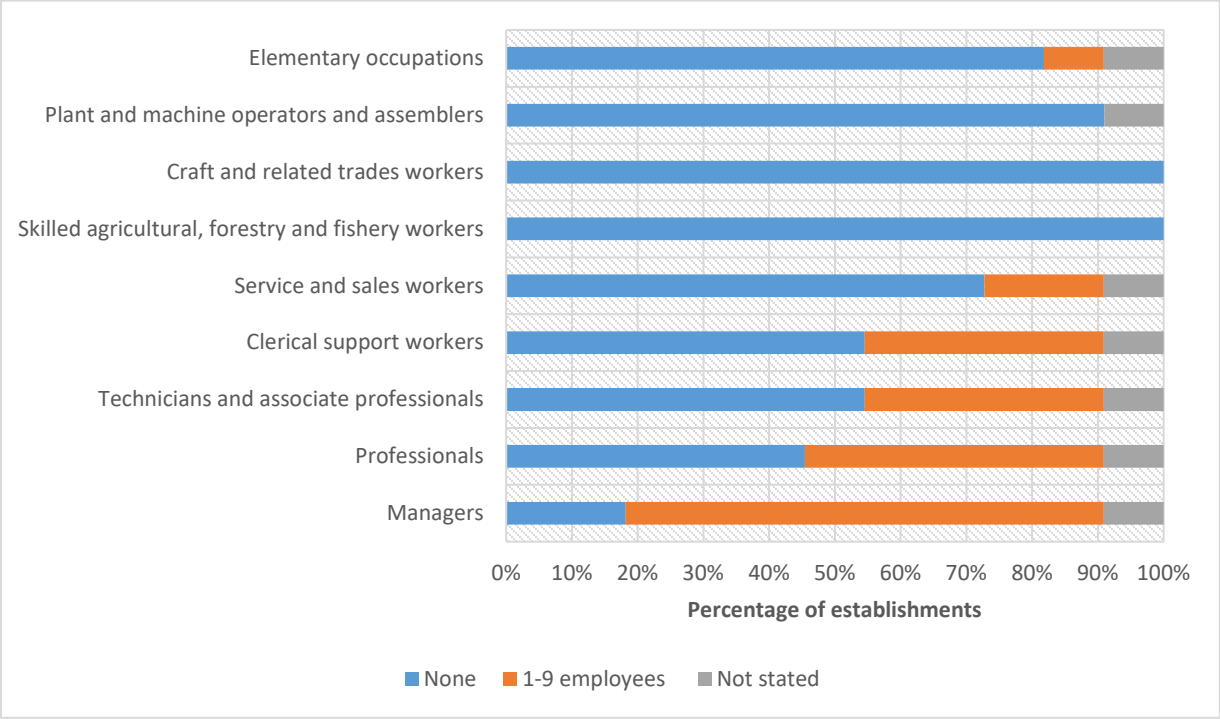
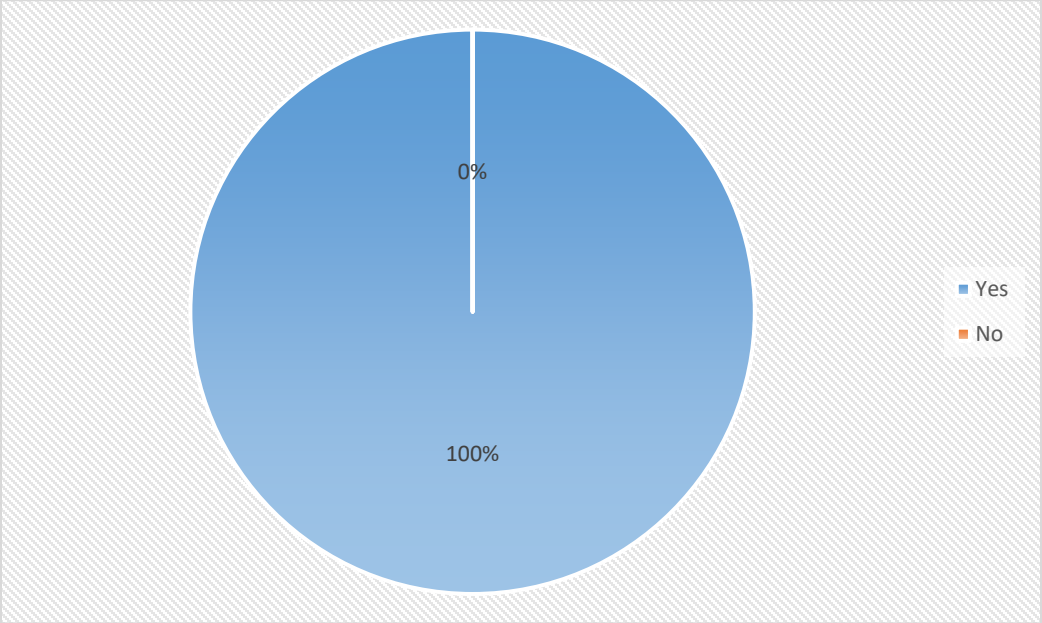


Figure 6: Employment by occupational group and sex – Females



With regard to STEM-qualified employees, all (100%) of the establishments had employees with STEM degrees (Figure 7).

Figure 7: Percentage of establishments with employees with STEM degrees



To effectively assess the STEM labour needs within the software design and applications industry, 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. 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. 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.

Figures 8 – 11 summarise key data on employees with STEM qualifications by occupational group and sex. A review of STEM qualifications within occupational groups shows that a low number of employees possessed a STEM degree within each occupational group (Figure 8). The occupational group that recorded the highest percentage (82%) of employees with STEM degrees was Managers, followed by Professionals (64%) and Technicians and Associate Professionals

(55%). There were no employees with STEM qualifications among the other occupational groups.

A further examination of STEM qualifications by sex shows that overall and within occupational groups, a higher percentage of establishments had male employees with a STEM degree compared to females (Figures 9 & 10).

Figure 8: Percentage of establishments with employees with STEM degrees by gender and occupational group – Both sexes

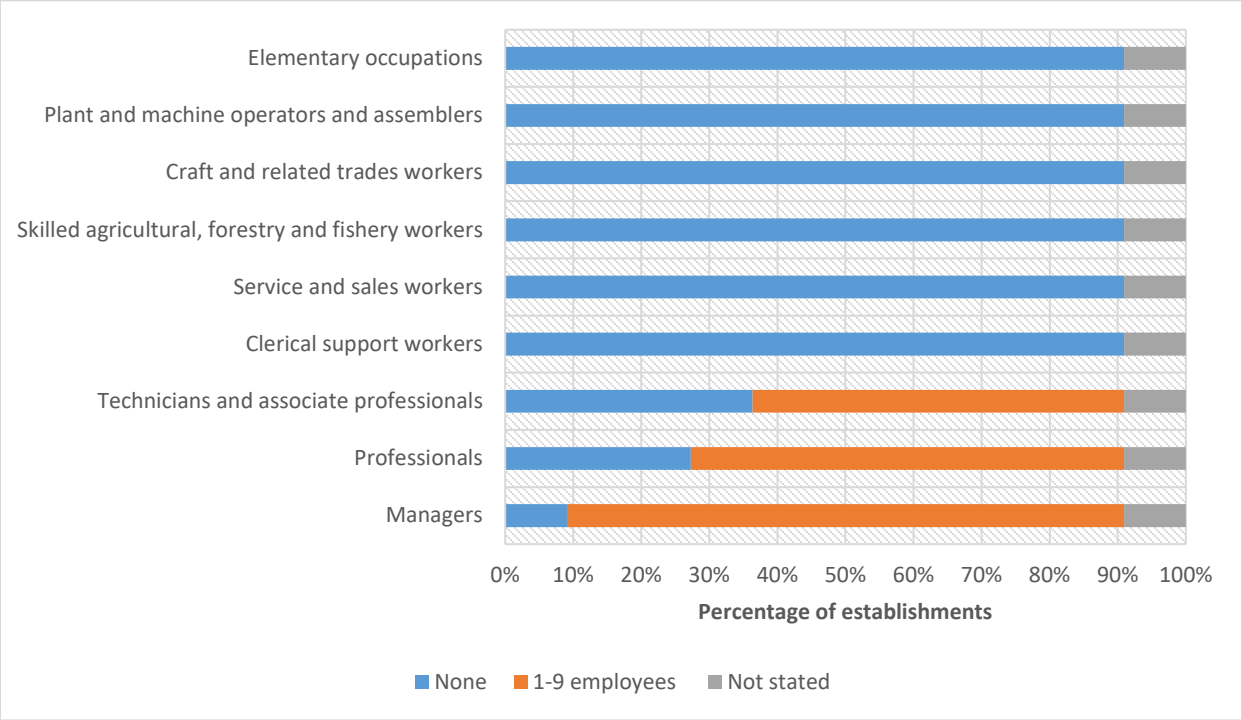


Figure 9: Percentage of establishments with employees with STEM degrees by gender and occupational group – Male

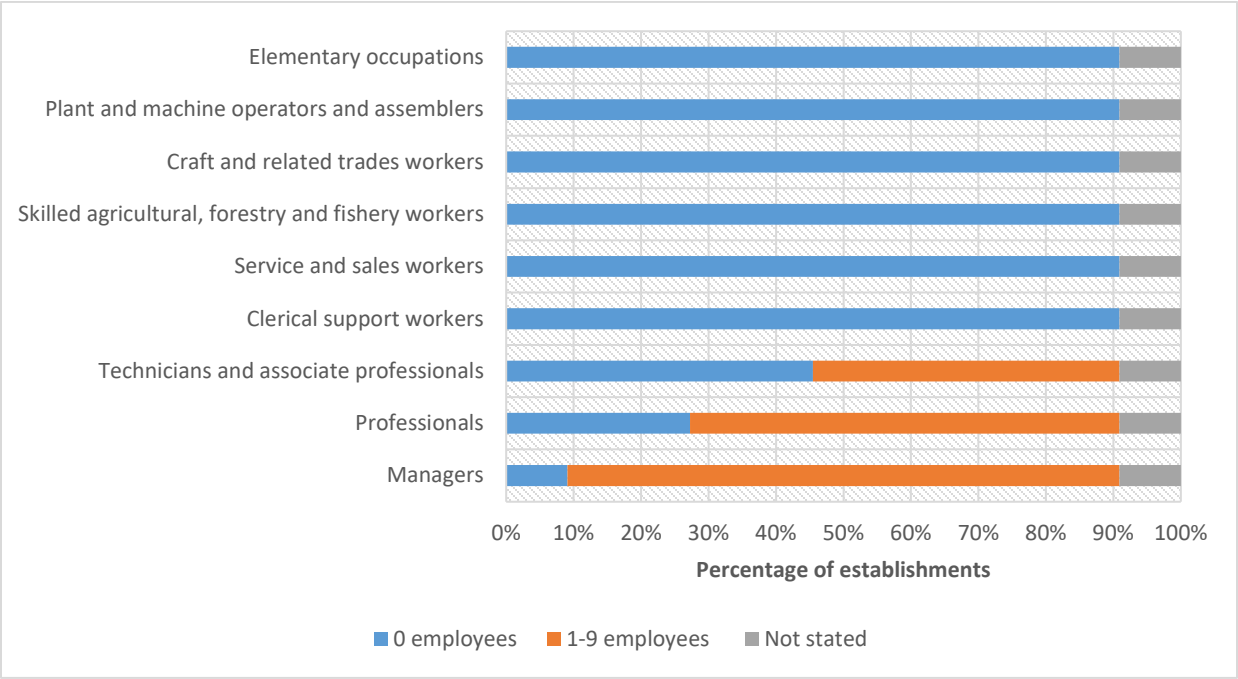
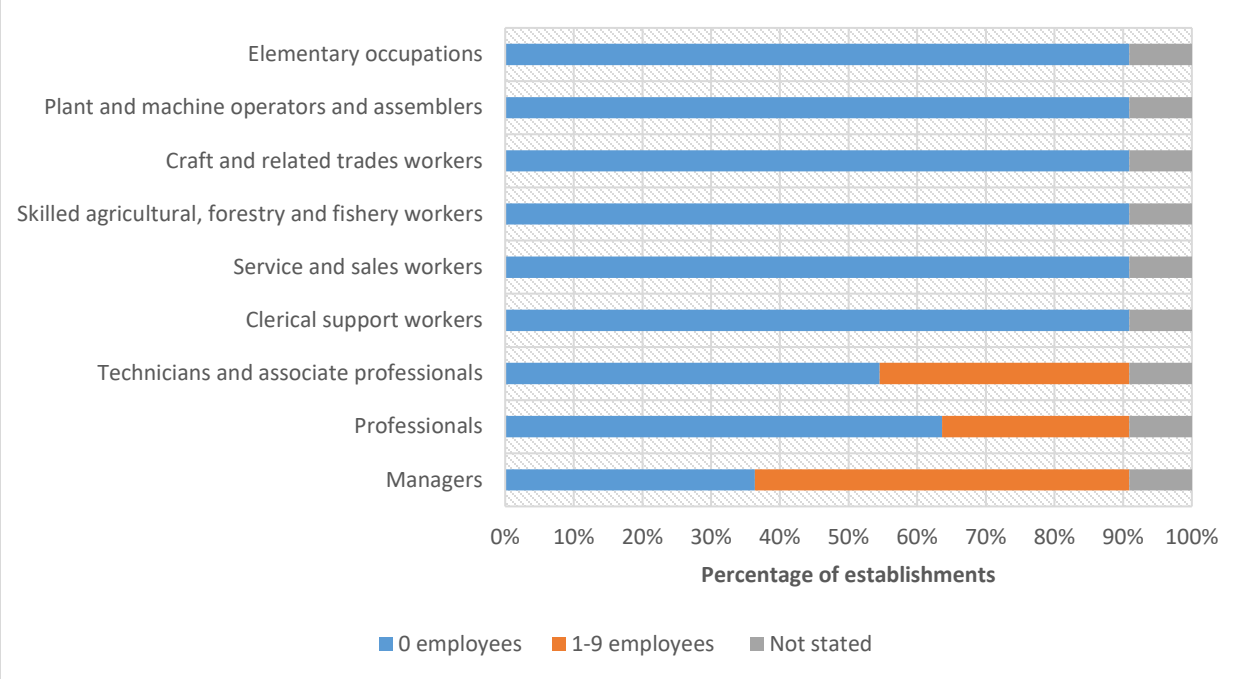


Figure 10: Percentage of establishments with employees with STEM degrees by gender and occupational group – Females



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 11 shows the number of employees in STEM occupation groups within the establishments that participated in the survey. The data reveals that the number of employees in each of the STEM occupation group was generally low. The vast majority (91%) of the establishments reported employees in Computer Science/IT occupations while 9% did not reply. Over a quarter of the establishments had workers in Engineering (27%) and Natural Sciences (27%) occupations while 9% reported employees in Mathematics and Statistics. There were no employees in Medical and Health, Environment Science 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 IT occupations than females (Figures 12 and 13). Females out-numbered males in Natural Sciences and Mathematics and Statistics occupations.

Figure 11: Employees in STEM occupation group by gender – Both sexes

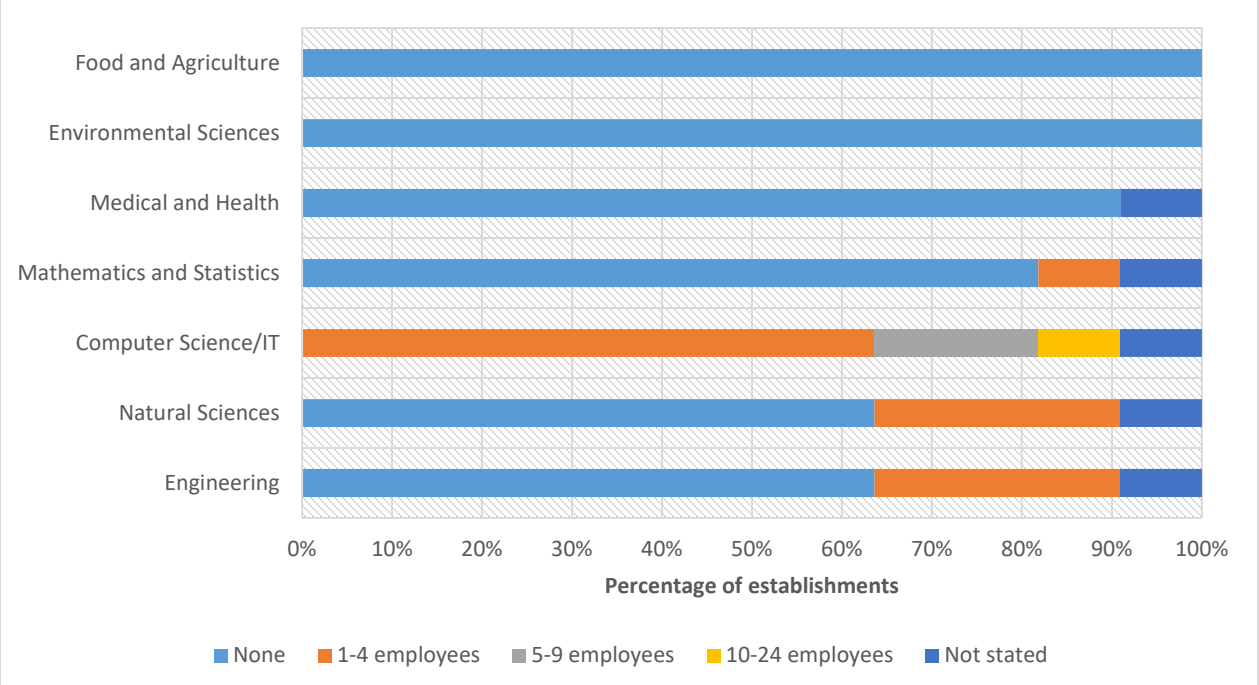


Figure 12: Employees in STEM occupation group by gender – Males

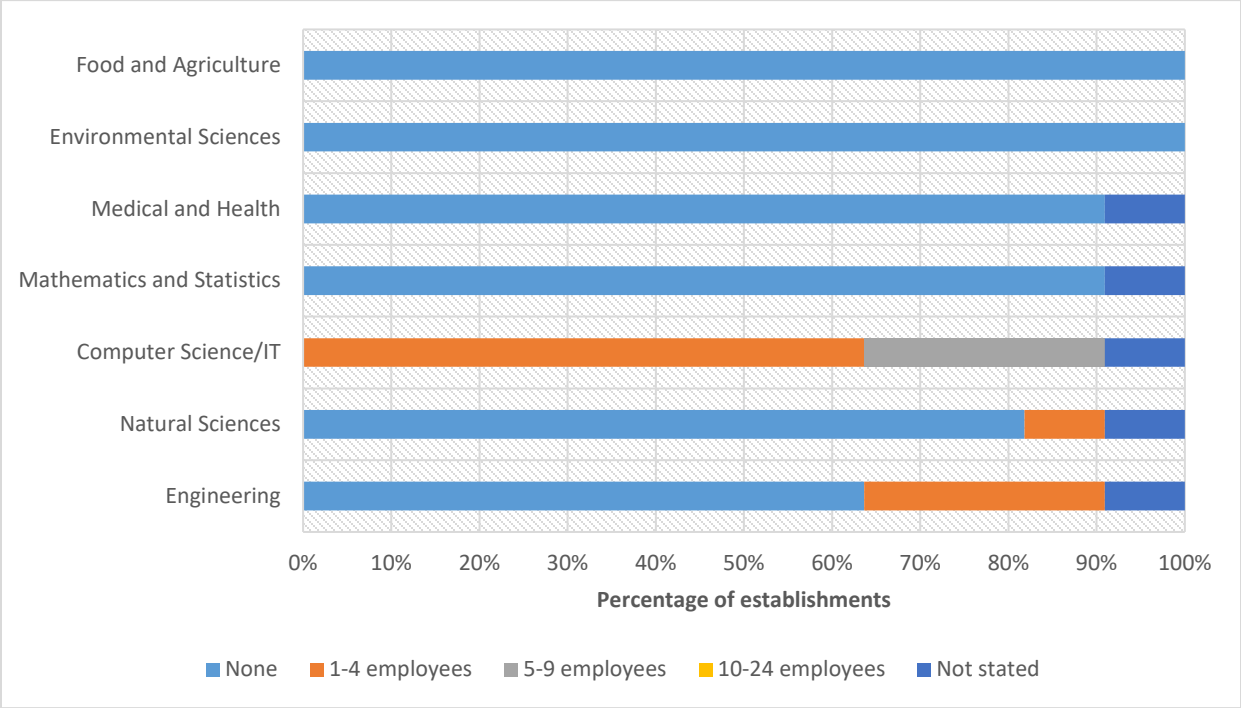
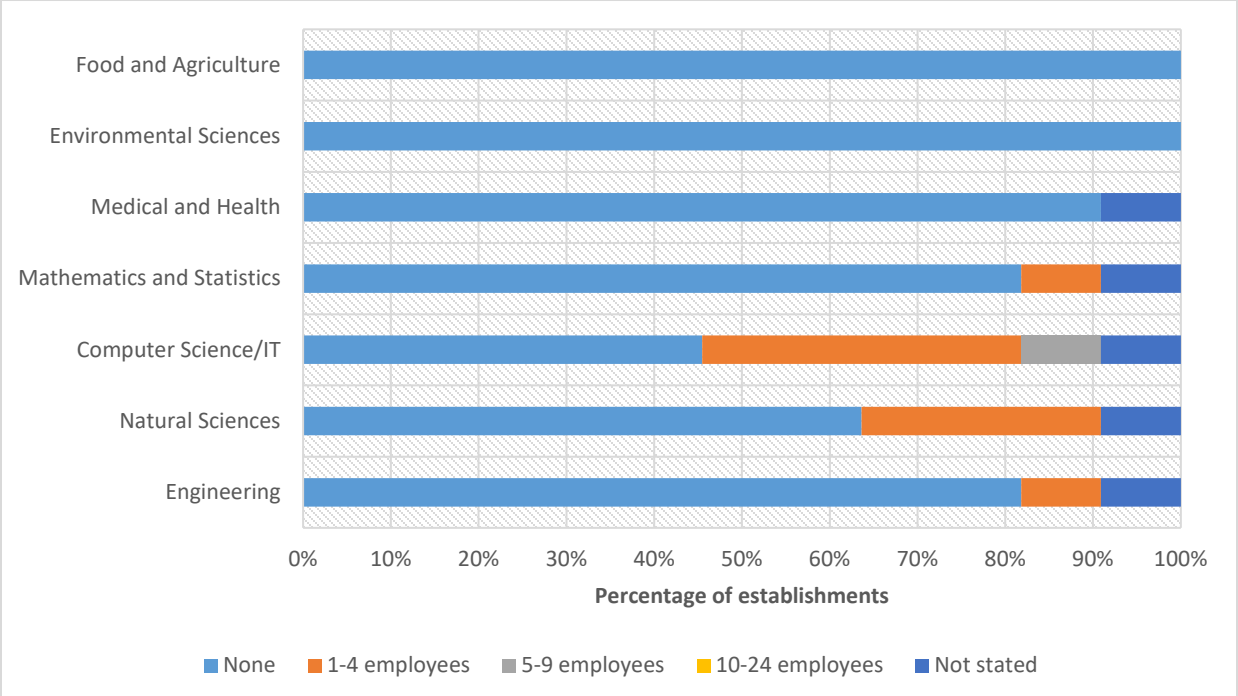


Figure 13: Employees in STEM occupation group by gender – Females

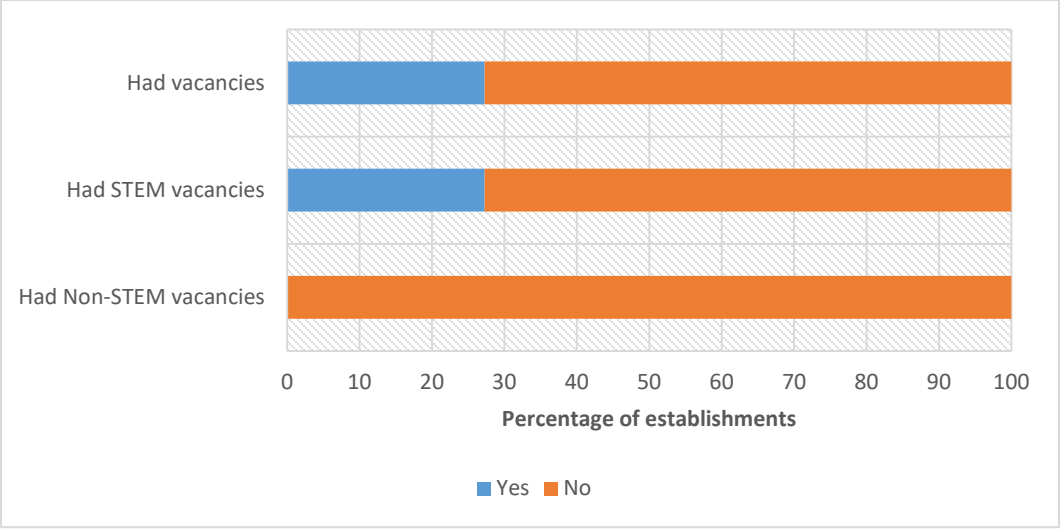


4. Recruitment and Vacancies

This section begins by identifying the proportion of employers with vacancies, particularly in STEM-related occupations, at the time of the survey. 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. Although educational requirements vary, the survey focused on STEM occupations that required a bachelor's degree or higher. 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 software design and applications industry. The section also features the number of vacancies employers filled over the last twelve (12) months during the survey period, as well as any difficulties they encountered in doing so. Additionally, it offers recommendations from employers on actions needed to overcome these difficulties.

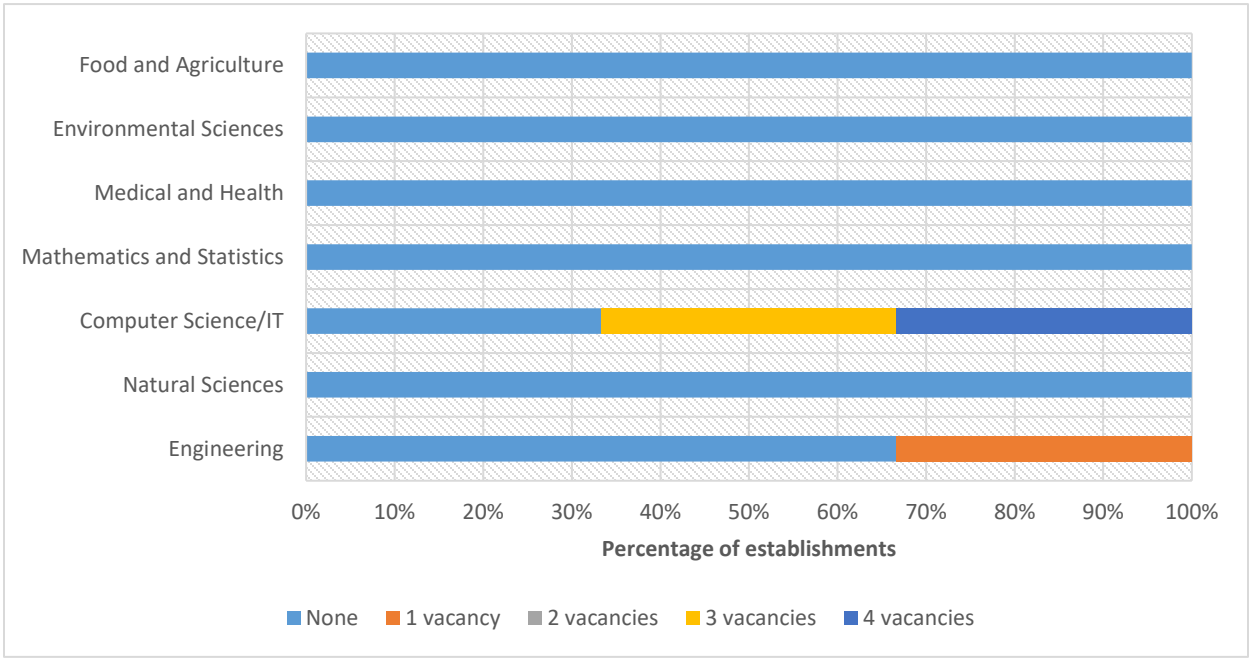
Figure 14 reveals that overall, there was a low number of vacancies in establishments that responded to the survey. A substantially lower percentage (27%) of the establishments reported vacancies during the survey period compared to 73% with no vacancy. By field of study, the survey results reveal that all (100%) vacancies reported by establishments were STEM-related. This implies that there were more job opportunities in the software design and applications industry for graduates in STEM fields compared to graduates in non-STEM fields. While few employers had current vacancies, the skills and hiring challenges remain highly relevant for workforce planning.

Figure 14: Percentage of establishments with current vacancies



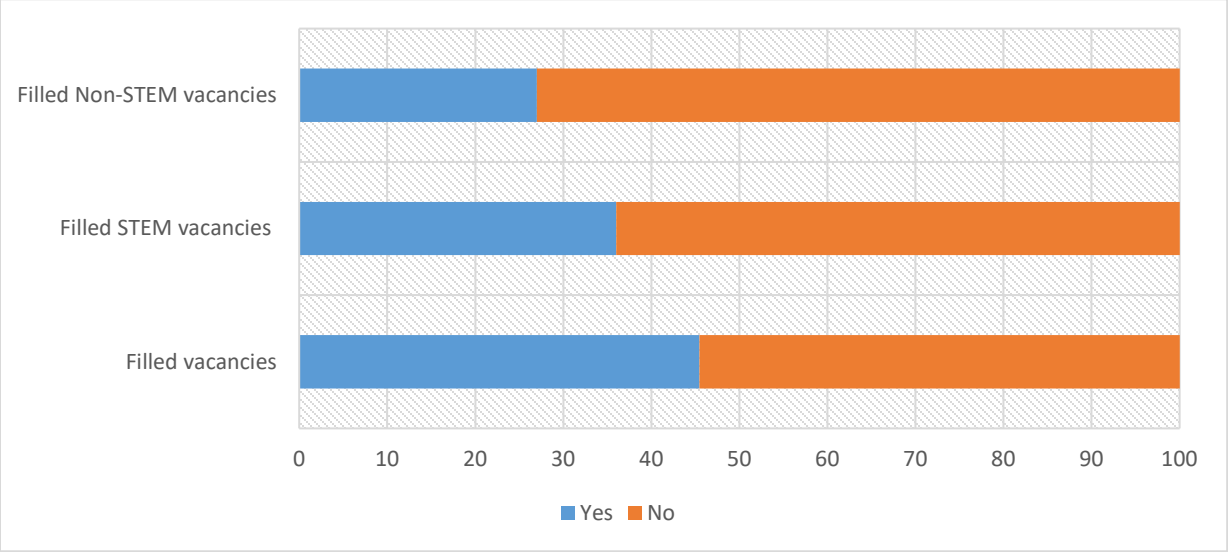
With regard to STEM vacancies, the survey captured data on the number of vacancies within each STEM field. The data shows that all vacancies reported by employers who participated in the study were in the fields of Computer Science/IT and Engineering with the vast majority in Computer Science/IT (Figure 15).

Figure 15: Percentage of establishments by STEM vacancies



In assessing recruitment in emerging sectors, the survey captured data on the percentage of employers that filled vacancies over the last 12 months of the survey period. Figure 16 shows that 45% of employers filled vacancies over the last 12 months while 55% did not. Additionally, a higher percentage of establishments filled STEM vacancies (36%) compared to non-STEAM vacancies (27%).

Figure 16: 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 had experienced any challenges during the recruitment process. 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 data shows that the majority of employers encountered difficulty in filling STEM-related vacancies in all of the applicable occupational categories while the opposite was observed for non-STEM occupations.

Overall, the highest level of difficulty employers experienced during recruitment was recorded for Plant and machine operators, and assemblers, followed by Managers; Service and sales workers; Technicians and associate professionals; and Professionals.

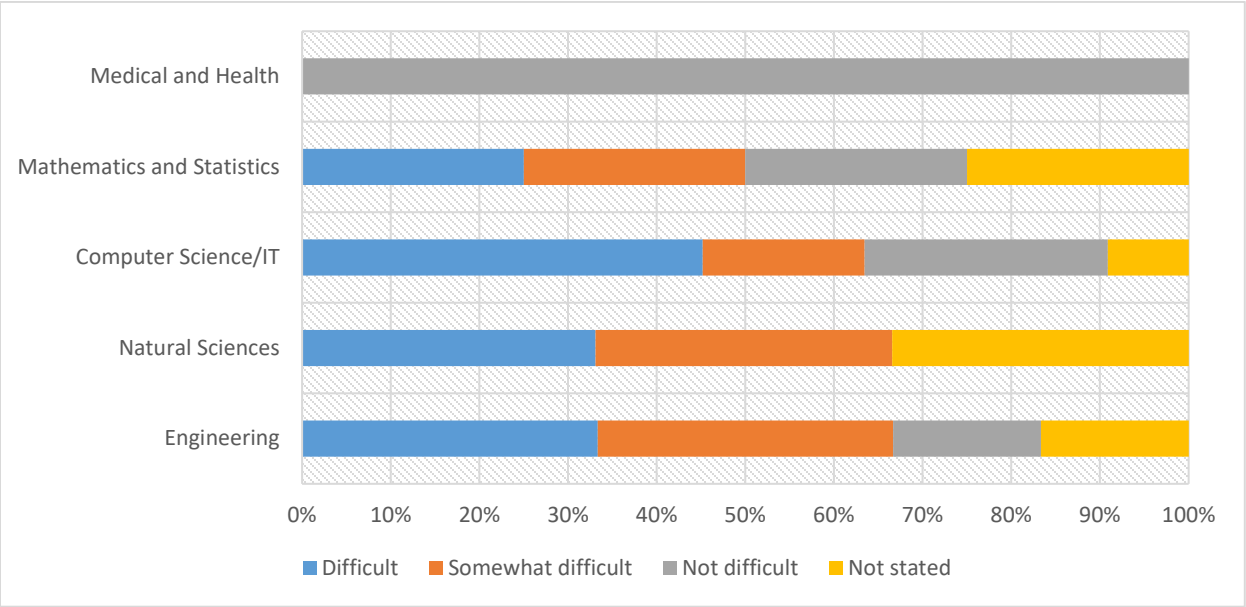
A further breakdown of the level of difficulty employers experienced when trying to fill vacancies in STEM fields in their industry is shown in Figure 17. The highest level of difficulty was observed for Computer Science/IT occupations (45%), followed by Natural Sciences (33%) and Engineering (33%) occupations.

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

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	60	40	100	40	60	100
2. Professionals	50	50	100	25	75	100
3. Technicians and associate professionals	60	40	100	25	75	100
4. Clerical support workers	NA	NA	NA	14	86	100
5. Service and sales workers	67	33	100	25	75	100
6. Skilled agricultural, forestry and fishery workers	NA	NA	NA	0	100	100
7. Craft and related trades workers	NA	NA	NA	0	100	100
8. Plant and machine operators, and assemblers	100	0	100	33	67	100
9. Elementary occupations	NA	NA	NA	50	50	100

NA – not applicable

Figure 17: Level of difficulty employers experienced when filling STEM vacancies



The research also examined the significant factors contributing to the difficulty employers experienced when filling STEM vacancies. Figure 18 depicts the factors affecting recruitment in STEM occupations 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 attitude, motivation or personality which was rated 4 or 5 by the majority (88%) of respondents. Additionally, over a half of the employers assigned high ratings (4 and 5) to lack of work experience (66%), a low number of applicants with the required skills (50%) and a low number of applicants in general (51%). The least significant factor was too much competition from other employers.

Figure 18: Factors contributing to difficulty employers experienced while filling STEM occupations

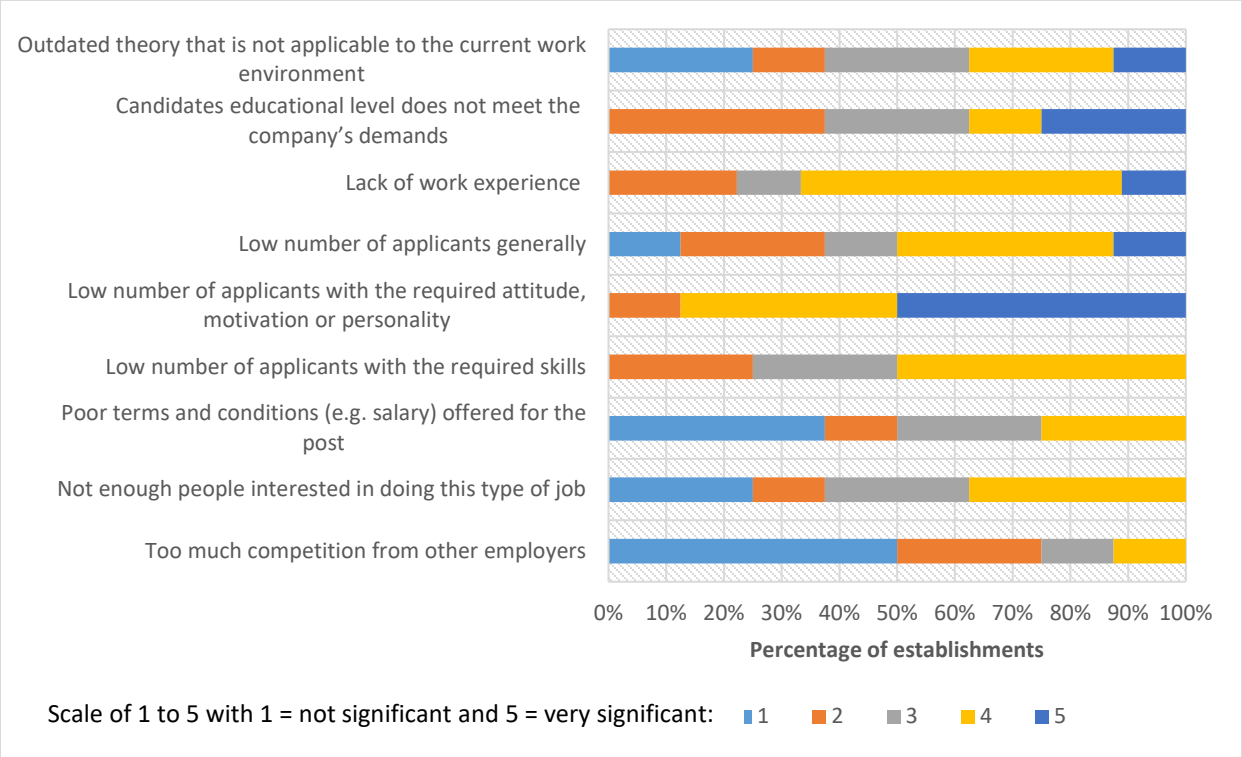


Figure 19 summarises the recommendations employers proposed to overcome problems faced while filling STEM vacancies. The main recommendation from employers to address these difficulties was to create more training opportunities specific to industry needs (45%). Additionally, a smaller percentage of employers endorsed helping young people to understand that IT is the future (9%), improving life skills of young people (9%) and restructuring education programmes to meet industry needs (9%) as solutions to the problems encountered during recruitment for STEM occupations.

Figure 19: Employers' recommendations to overcome recruitment challenges for STEM occupations

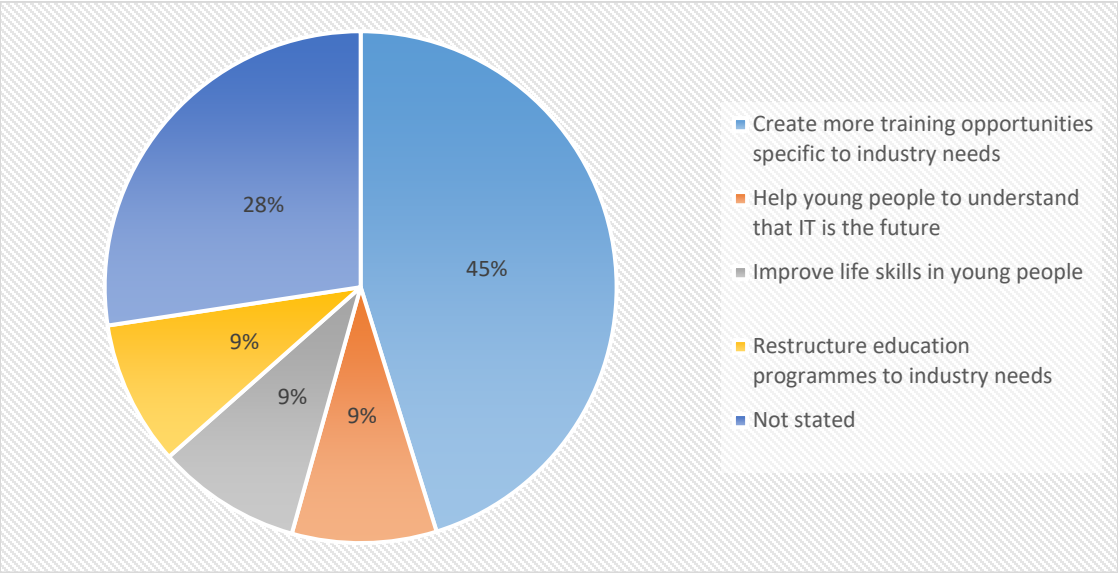
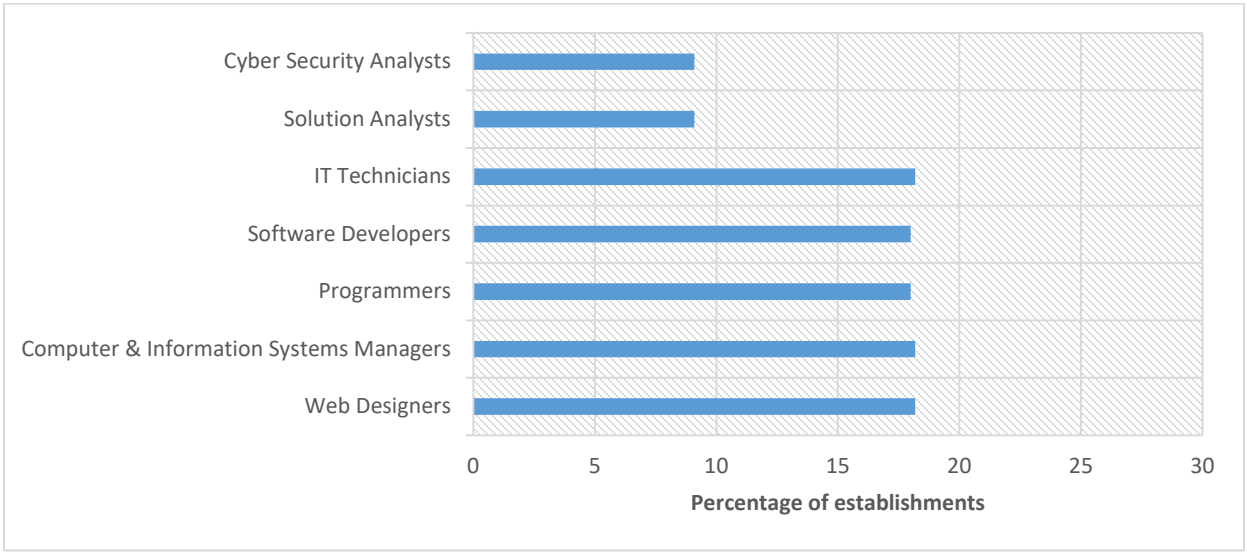


Figure 20 presents the STEM occupations respondents from the Software design and applications industry identified as the most difficult to fill. The five most difficult STEM occupations to fill were IT Technicians (18%), Software Developers (18%), Programmers (18%), Computer and Information Systems Manager (18%) and Web Designers (18%).

Figure 20: 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.

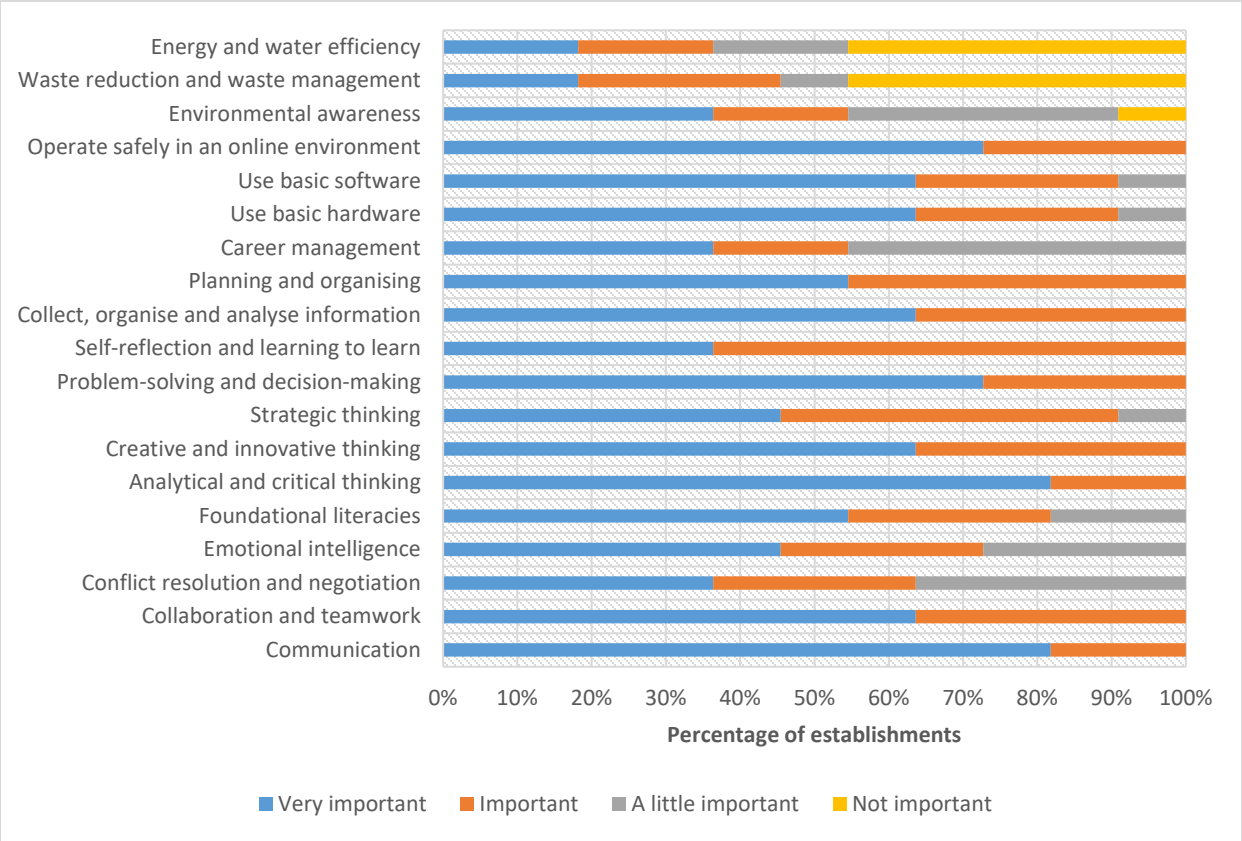
The purpose of this chapter is to assess the existing skills mismatches in the software design and applications industry. This section presents the skills employers identified as critical for employees to possess to meet organisational goals and objectives. Additionally, data on the internal and external drivers of change and the requisite skills needed to address these drivers is summarised in this section. 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. Lastly, the section provides data on the level of preparedness of university graduates for the workplace.

5.1 Demand for Skills by Employers

Figure 21 lists the 19 core skills and employers rating on the level of importance for employees to have these skills in order to achieve the business goals and objectives. The majority of employers indicated that it was important (very important + important) for employees to possess all of the skills listed in Figure 22, except Waste reduction and waste management and Energy and water efficiency. Over 90% of the employers who participated in the survey stated that it was important for employees to have the following skills to meet their business goals and objectives: Communication (100%); Collaboration and Teamwork (100%); Analytical and Critical thinking (100%); Creative and innovative thinking (100%); Problem-solving and decision-making (100%); Self-reflection and Learning to learn (100%); Collect, organise and analyse information (100%); Planning and Organising (100%); Operate safely in an online environment (100%); Strategic thinking (91%); Use basic hardware(91%); and Use basic software(91%). The most important skills were Communication, and Analytical and Critical thinking which were both rated as very important by 82% of the employers. The skills that received the lowest ratings in terms of importance were mainly 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 21: Employers' rating of skills employees should have to meet business goals



5.2 Drivers of Change and Skills Required

In order to establish the skills that were important in the software design and applications 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 22. The top three (3) internal drivers of change were technology (58%), people (50%) and profit (25%). Overall, Communication (22%) was viewed as the most important skill to address internal drivers of change, followed by IT (17%), Organisational

(13%), and Creativity and innovation (13%) (Figure 23). The following were the main skills identified to address each internal driver:

1. Technology – IT (33%)
2. People – Communication (29%)
3. Profit – Communication (50%)

Figure 22: Top internal drivers of change in establishments

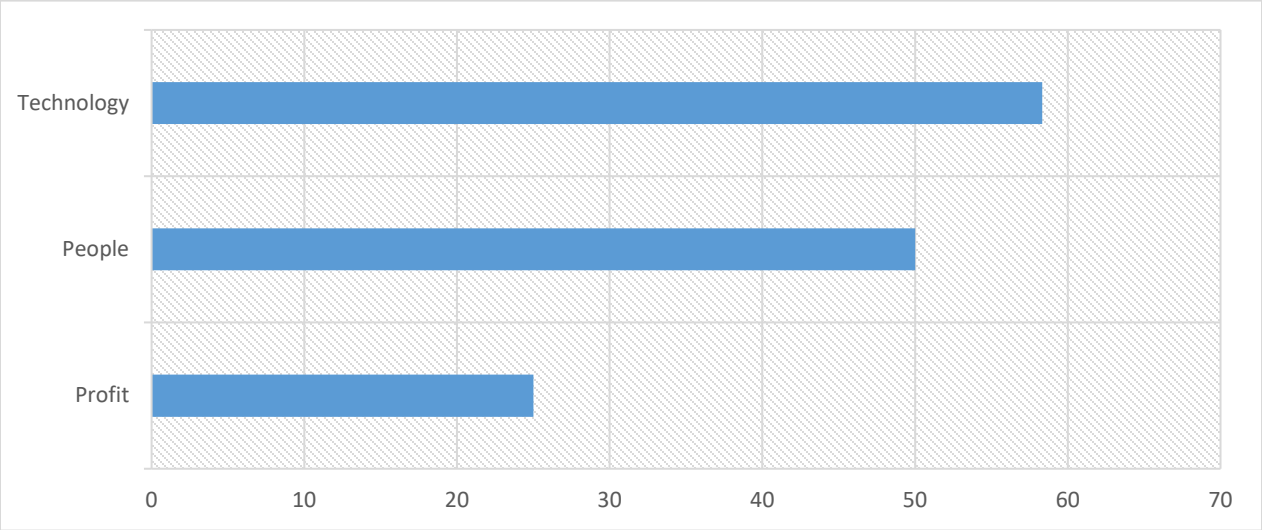
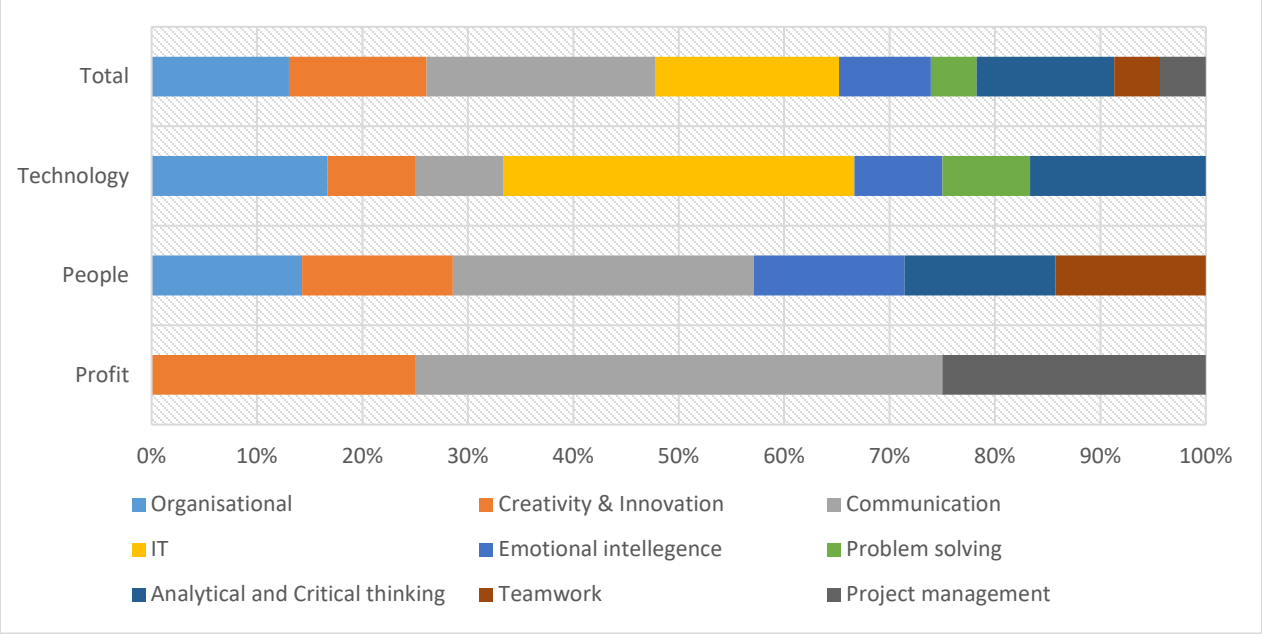


Figure 23: Main skills required to address internal drivers of change



In terms of external drivers of change in software design and applications establishments, employers were asked to list the top two (2) drivers of change and the skills required to address each driver. The survey results revealed that the top two (2) external drivers of change were Competition (67%) and Technology (67%) (Figure 24). Figure 25 depicts the skills employers identified as necessary to address external drivers of change. Overall, the top two (2) skills recorded were Creativity and Innovation (18%), and Adaptability (12%). The following were the main skills identified to address each internal driver:

1. Technology – Emotional Intelligence (25%)
2. Competition – Creativity and Innovation (29%) and Strategic thinking (29%)
3. Climate change – Project Management (100%)
4. Economy – Leadership (100%)

Figure 24: Top external drivers of change in establishments

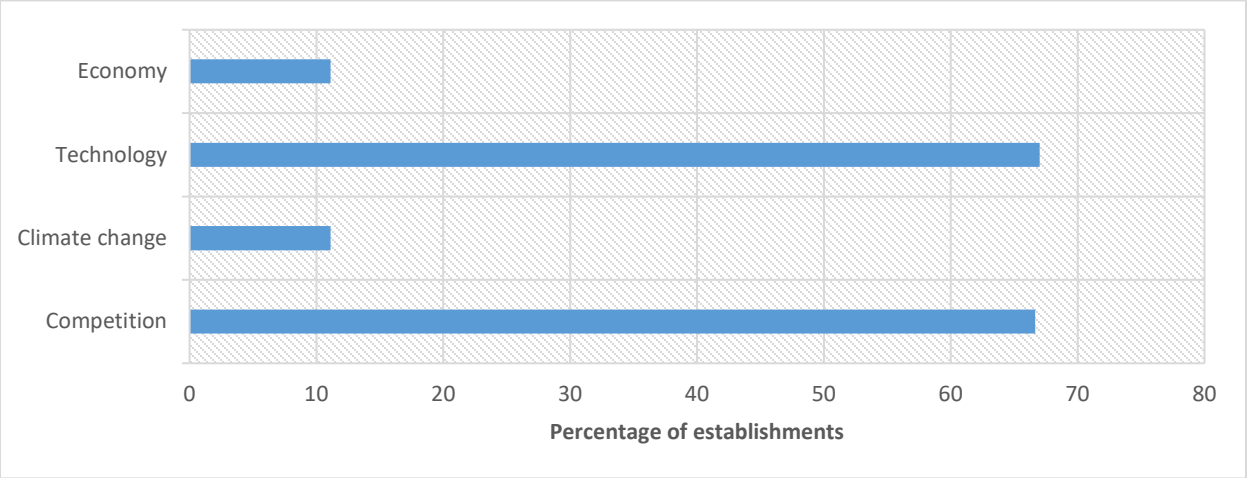
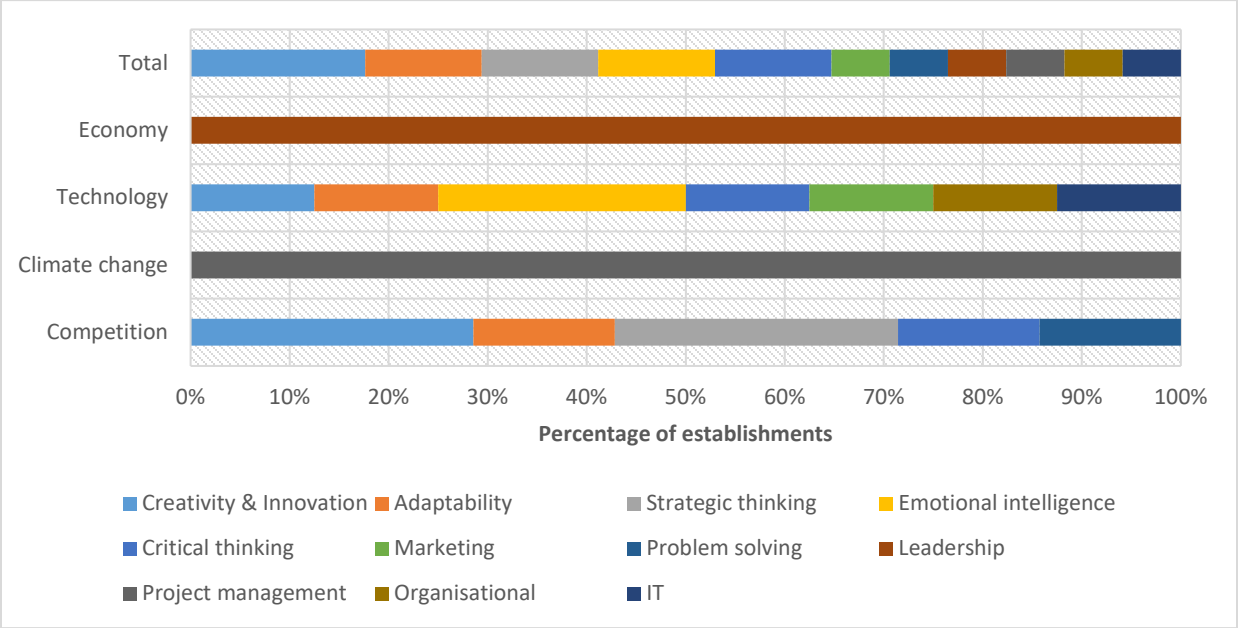


Figure 25: Main skills required to address external drivers of change



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

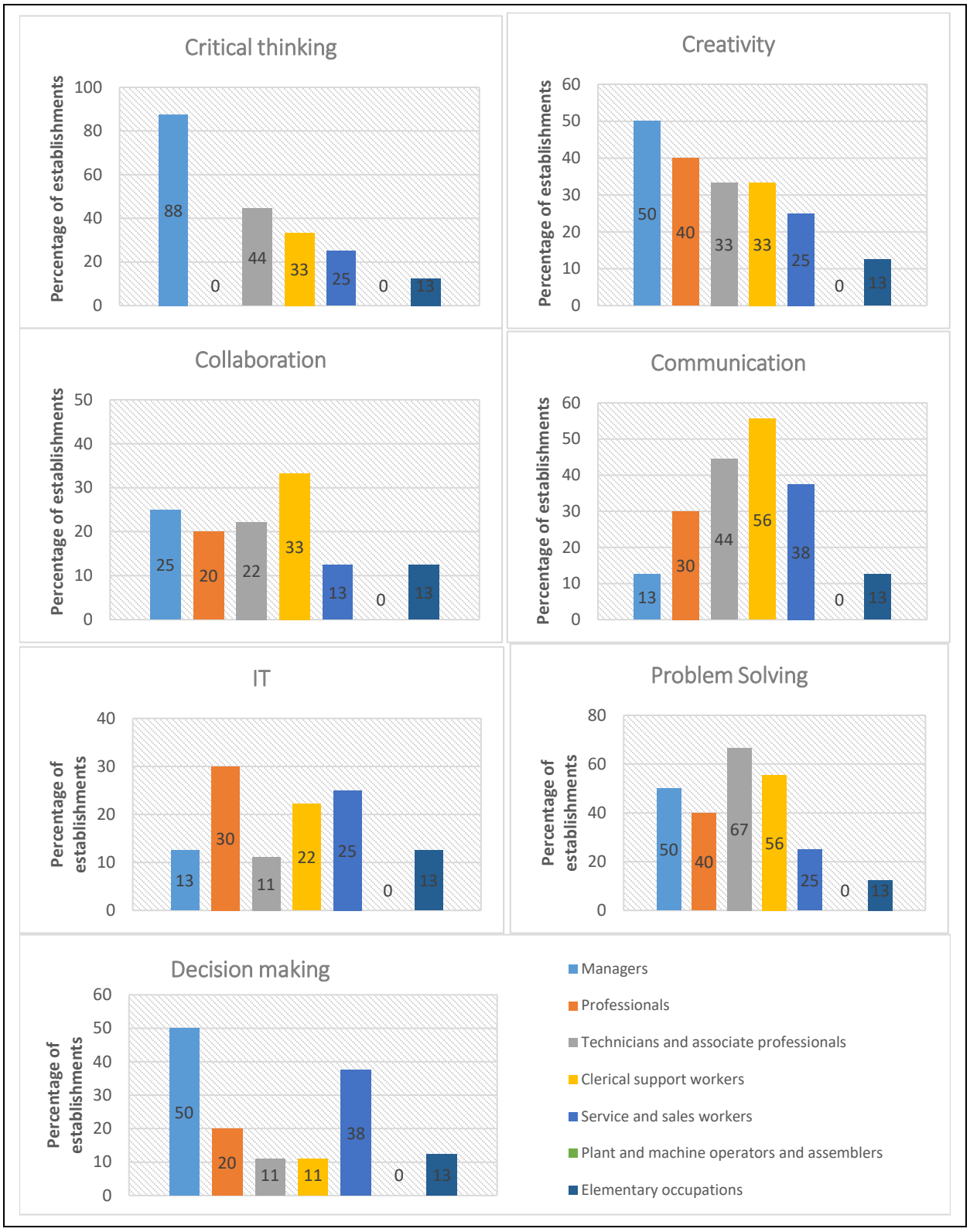
5.3.1 Recent Job Applicants

Figure 26 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. Overall, the most difficult skill to find among recent applicants was problem solving, followed by critical thinking, creativity and communication. A review of the data within occupational group, shows that the highest level of difficulty was recorded for Managers, followed by Clerical support workers, Technicians and associate professionals, and Professionals. The main skills employers found difficult to find in the different occupational groups are outlined below:

- Managers - Critical thinking (88%), Creativity (50%), Problem solving (50%) and Decision making (50%)
- Professionals - Creativity (40%), Problem solving (40%), Communication (30%) and IT (30%)
- Technicians and associate professionals – Problem solving (67%), Critical thinking (44%) and Communication (44%)

- Clerical support workers - Communication (56%) and Problem solving (56%)
- Service and sales workers – Communication (38%) and Decision making (38%)
- Skilled agricultural, forestry and fishery workers, and Craft and related trades workers - not applicable
- Plant and machine operators, and assemblers - not stated
- Elementary occupations - minimum difficulty in obtaining the seven identified core skills.

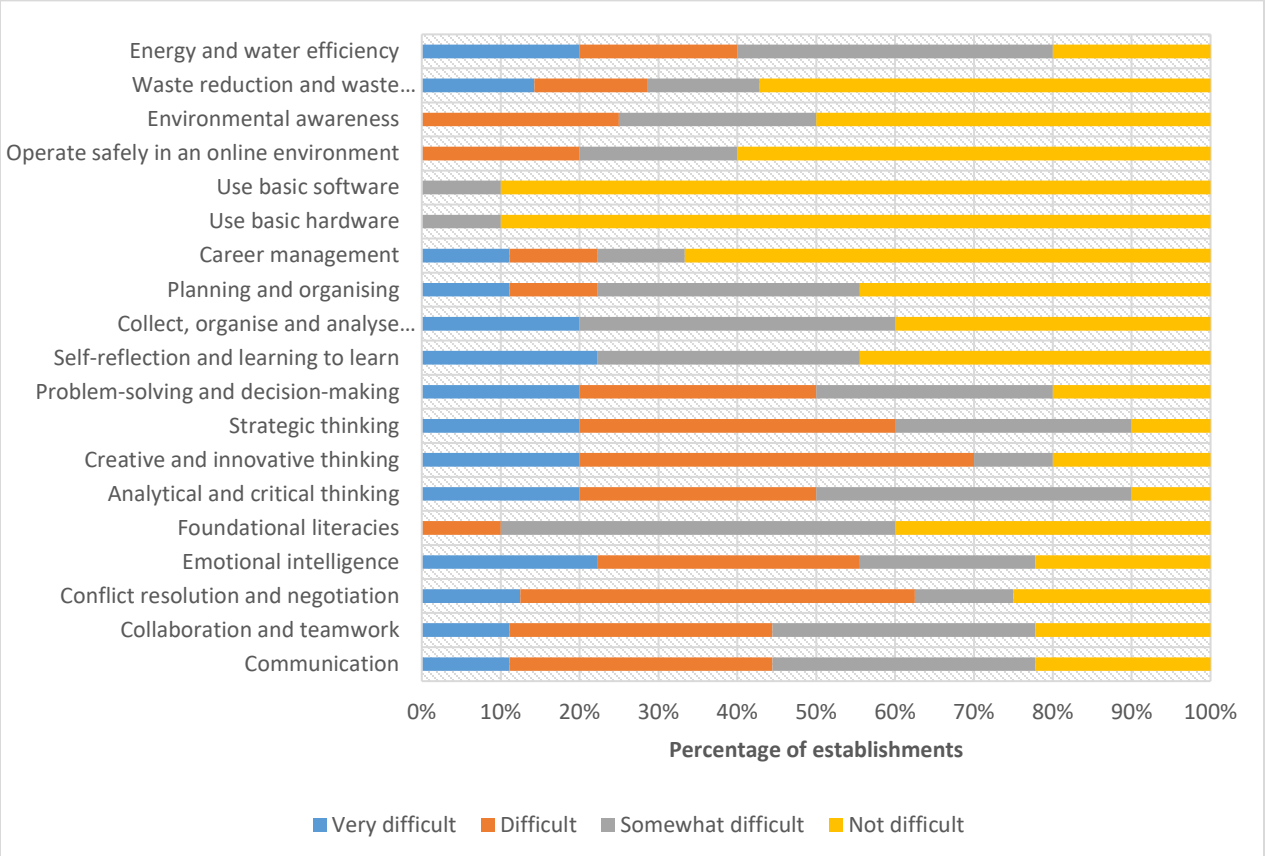
Figure 26: Employers' rating on the difficulty experienced to obtain skills from recent applicants by occupational groups



5.3.2 Recent University Graduates Applicants

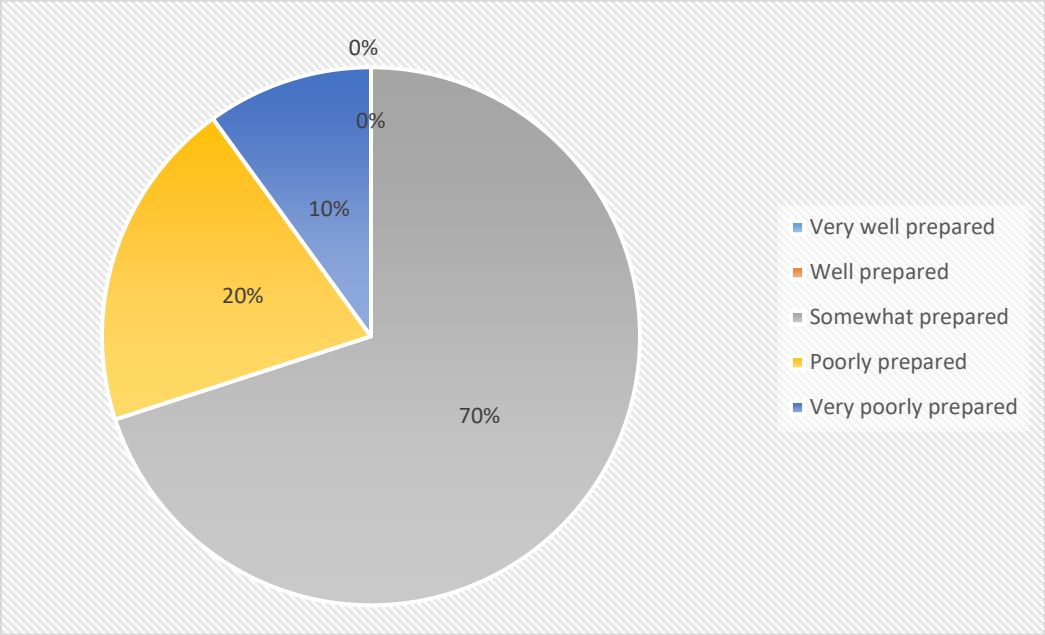
To identify mismatches in skills demanded by employers and skills possessed by recent graduates, employers were asked to rate the level of difficulty they experienced in finding core skills among recent university graduates seeking employment in their businesses. Figure 27 shows that a half (50%) or more of the employers who responded to the question reported that they experienced some level of difficulty in finding 14 of the 19 skills among this group of job applicants. The highest percentage of difficulty (very difficult + difficult) was observed for Creative and Innovative thinking (70%); Conflict resolution and negotiation (63%); Strategic thinking (60%); Problem-solving and Decision-making (50%); and Analytical and Critical thinking (50%). Employers experienced less difficulty in finding Basic digital skills and Basic skills for green jobs among recent university graduates. The least difficulty was recorded for the Use basic hardware (90%); Use basic software (90%); Career management (67%); Operate safely in an online environment (60%); and Waste reduction and waste management (57%).

Figure 27: Level of difficulty employers experienced in obtaining core skills from recent university graduates



Further to the skills shortages identified in the previous page the survey also gathered information on employers' views on the level of preparedness for work among university graduates employed over the last two (2) years (Figure 28). The majority of employers (70%) reported that recent university graduates were somewhat prepared for work while 20% and 10% indicated that graduates were poorly prepared and very poorly prepared, respectively. It is of grave concern that none of the respondents indicated that recent university graduates were well prepared (very well prepared + well prepared) for the world of work.

Figure 28: Level of preparedness of for work among university graduates employed over the last two years



5.3.3 Existing employees

Matching the skills of existing employees to the needs of establishments is important for achieving strategic goals and objectives. Employers were asked to rate the level of skills among their employees for the 19 core skills on a five-point scale ranging from very low to very high. Figure 29 shows that a half (50%) or more of the employers assigned high ratings (very high + high) to 14 of the 19 skills among their employees. The highest rating was assigned to Use basic hardware (91%); Use basic software (91%); and Collaboration and teamwork (91%). The lowest rating was recorded for two basic skills for green jobs: Waste reduction and waste management (18%) and Energy and water efficiency (18%). These skills were also rated as low importance by the majority of employers (Figure 21).

Figure 29: Employers' rating of level of the skills of employees

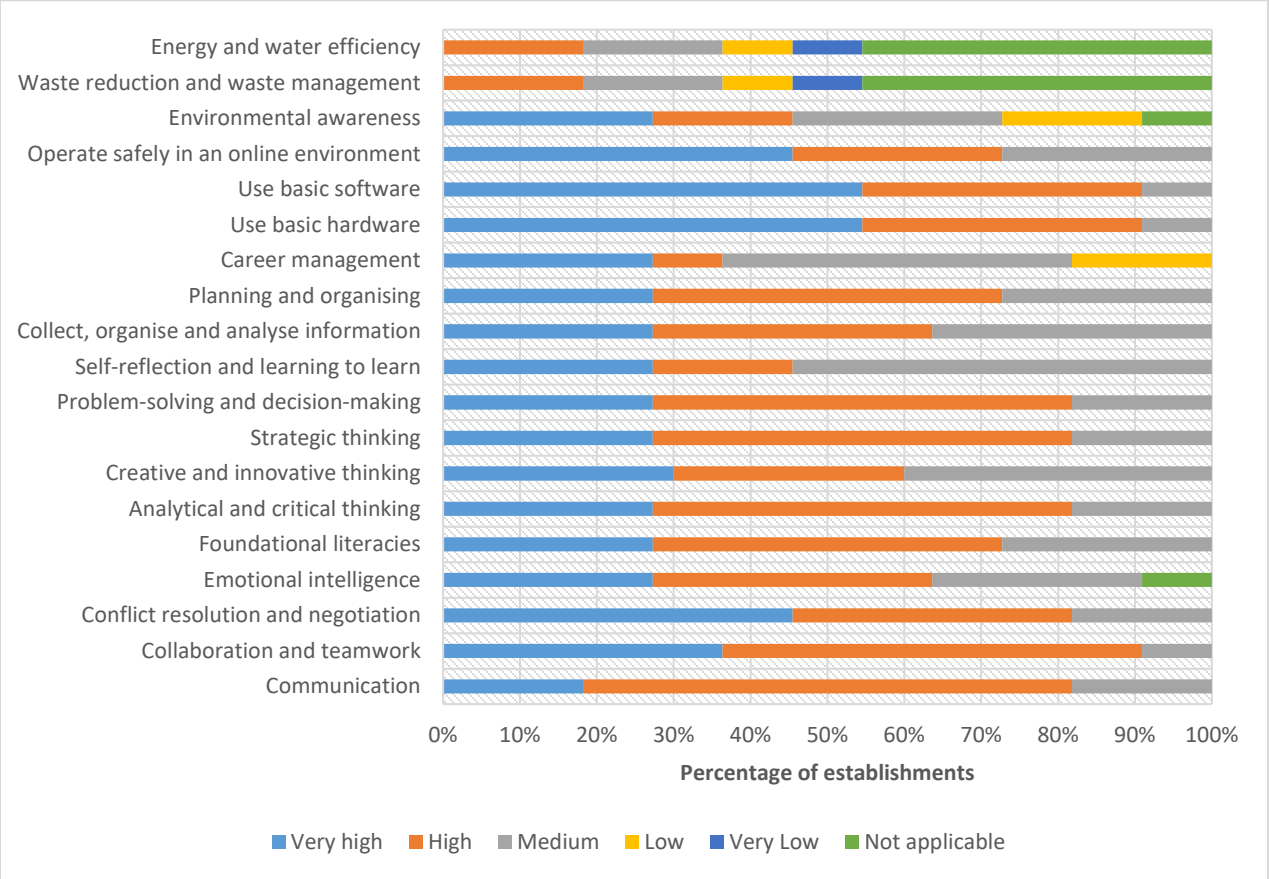
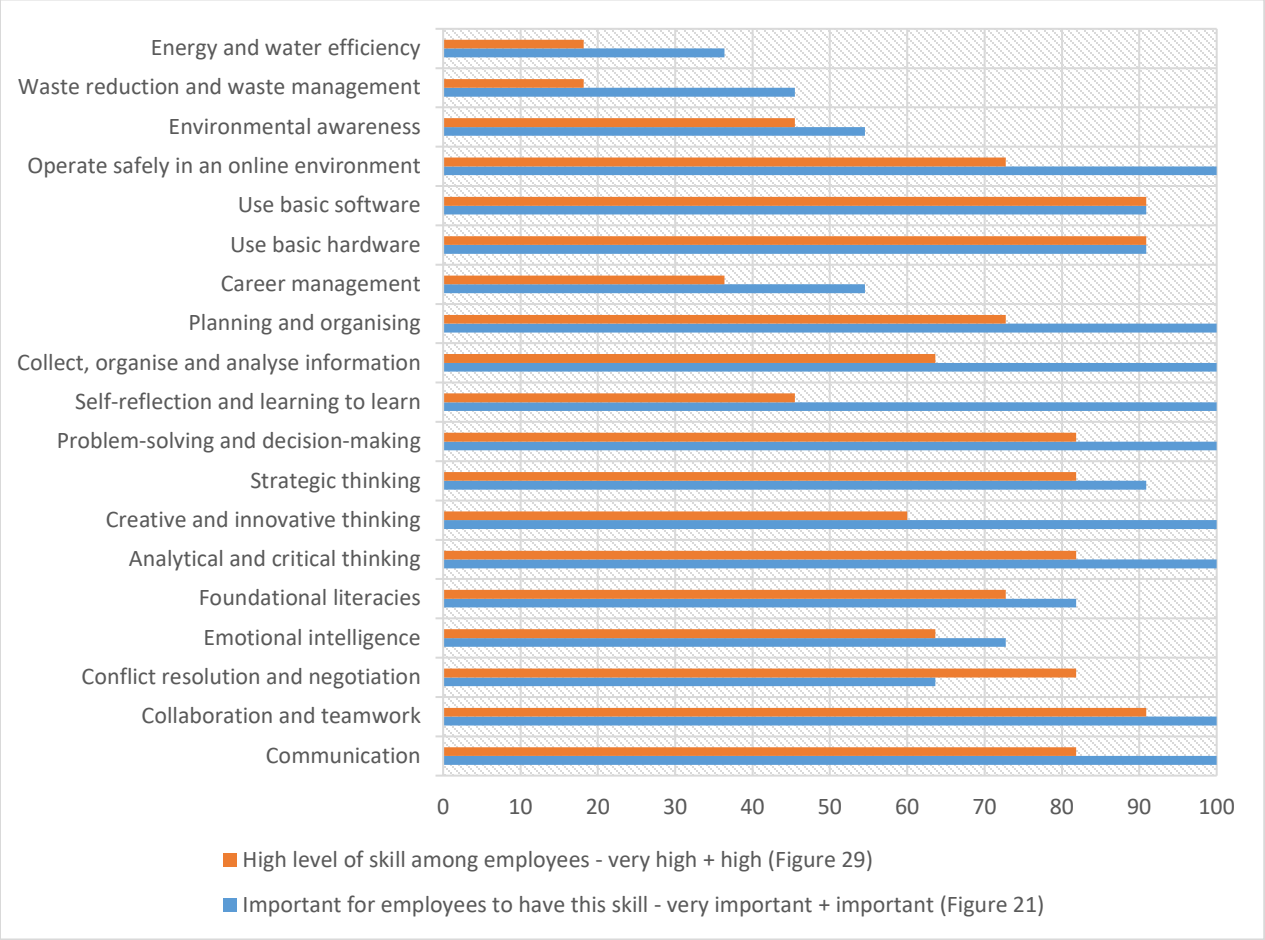


Figure 30 highlights the skills gap within the industry by comparing the key skills that employers deemed important (very important + important) for meeting business goals (Figure 21) with the actual skill levels of their current employees (Figure 29). The data shows that for 16 of the 19 skills, the level of skills employers required employees to possess was higher than what employees actually possessed. The largest gap was recorded for Self-reflection and learning to learn (55%), followed by Creative and innovative thinking (40%) and collect, organise and analyse information (36%). The only skill in which employees' competence surpassed the level desired by employers to reach business goals was Conflict resolution and negotiation. There was no gap for two of the three digital skills: Use basic hardware and use basic software.

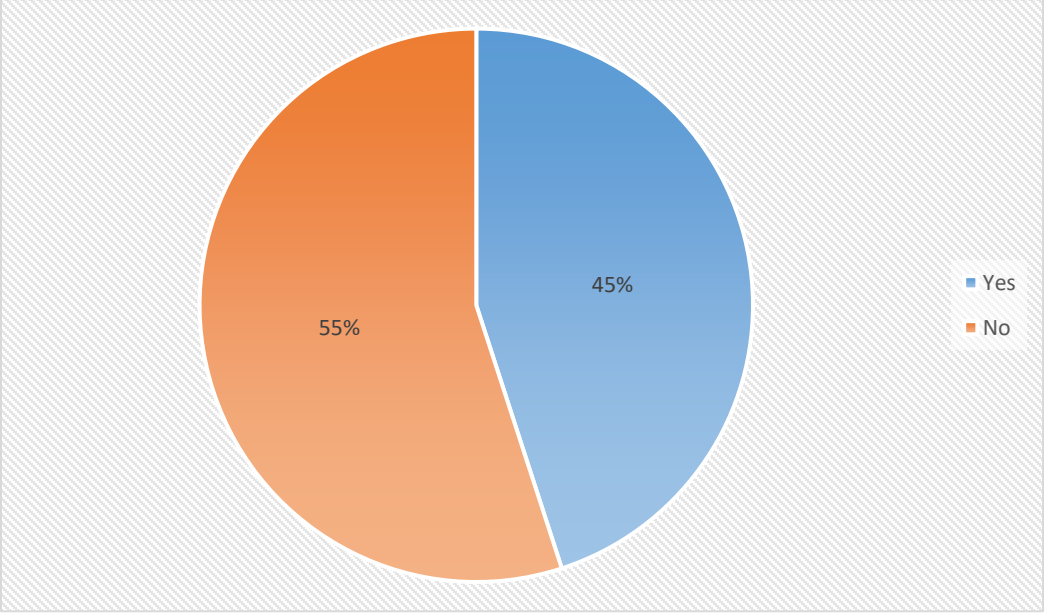
Figure 30: Comparison of employers' rating of skills required to meet business goals and current level of the skills of employees



5.4 Impact of skill-shortages on establishments

The effects of the lack of requisite skills within the workforce can hinder business operations. With respect to the software design and applications establishments that completed the survey, more than a half (55%) reported that the lack of skills among workers did not affect their operations while (45%) disagreed (Figure 31).

Figure 31: Lack of skills among workers affected business operation



6. Demand for STEM Labour

A critical component of the assessment of STEM labour needs in emerging sectors was identification of the current and future demand for STEM workers within software design and applications 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 within the workforce. In terms of future demand, forecasting the jobs of the future will help establishments adapt to global changes that are transforming economies, businesses, workforce structures and society as a whole.

Figure 32 shows the current demand for STEM occupations reported by the employers in the software design and applications industry. The demand for STEM jobs varied within the different STEM fields. The highest demand for STEM jobs was recorded for Computer Science/IT (73%) occupations, followed by Engineering (38%). The lowest demand was observed in the fields of Medical and Health; Environmental Science and Food and Agriculture.

In terms of STEM jobs, the top job currently demanded was Database Developers (36%), followed by IT Technicians (27%). Cyber Security Specialist, Network Systems Administrator Software Engineers, Web & Digital Interface Designers and Software Developers all recorded the same level of demand (18%) (Figure 33).

Figure 32: Current demand for STEM occupations

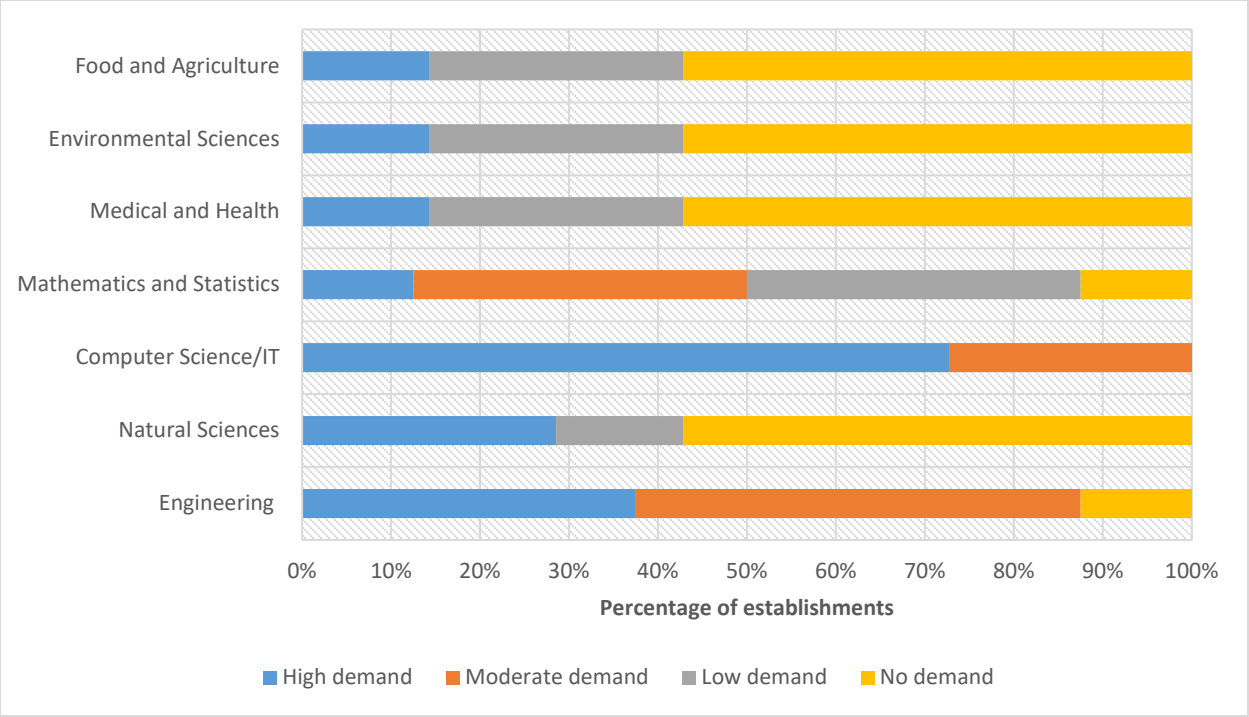
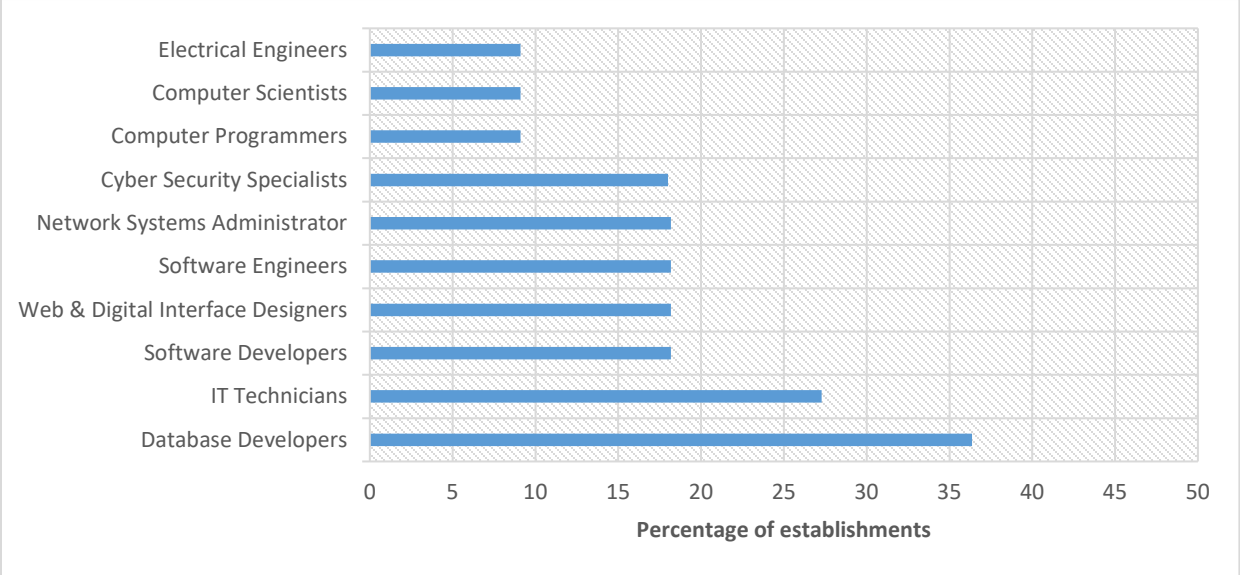
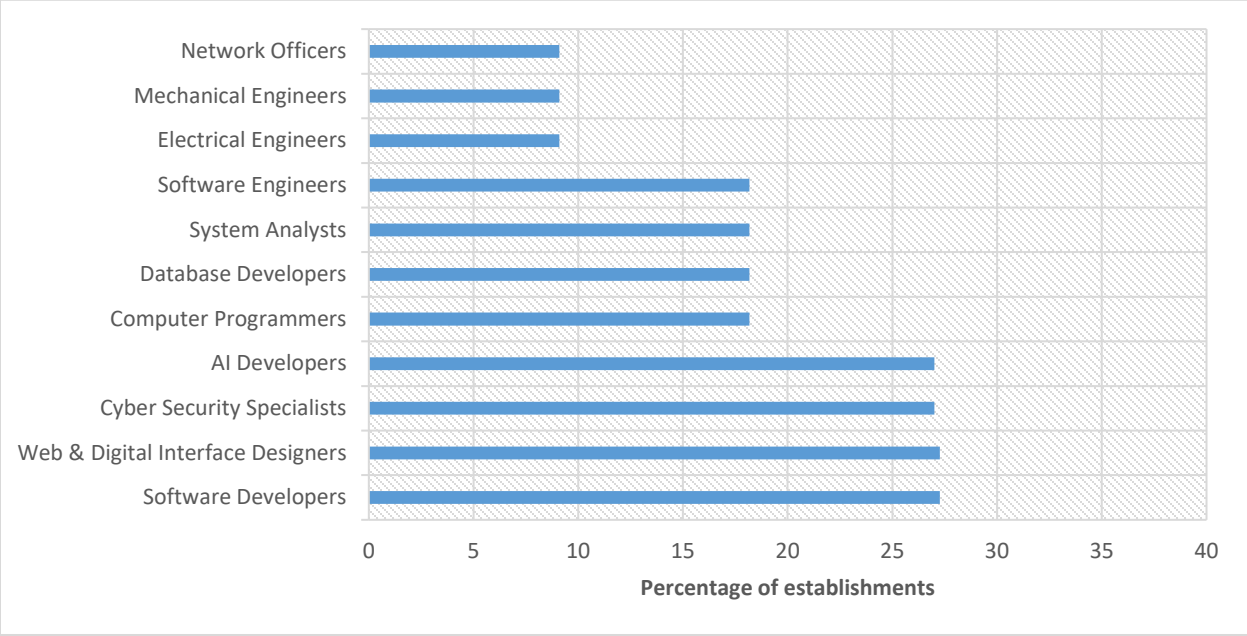


Figure 33: Top STEM occupations currently demanded by establishments



Employers were asked to list the most important STEM occupations for their organisation in the next five (5) years based on the strategic direction of their business. The most important STEM occupations listed were AI Developers (27%), Cyber Security Specialists (27%), Web and Digital Interface Designers (27%) and Software Developers (27%) (Figure 34).

Figure 34: Most important STEM occupations for establishments in the next five years

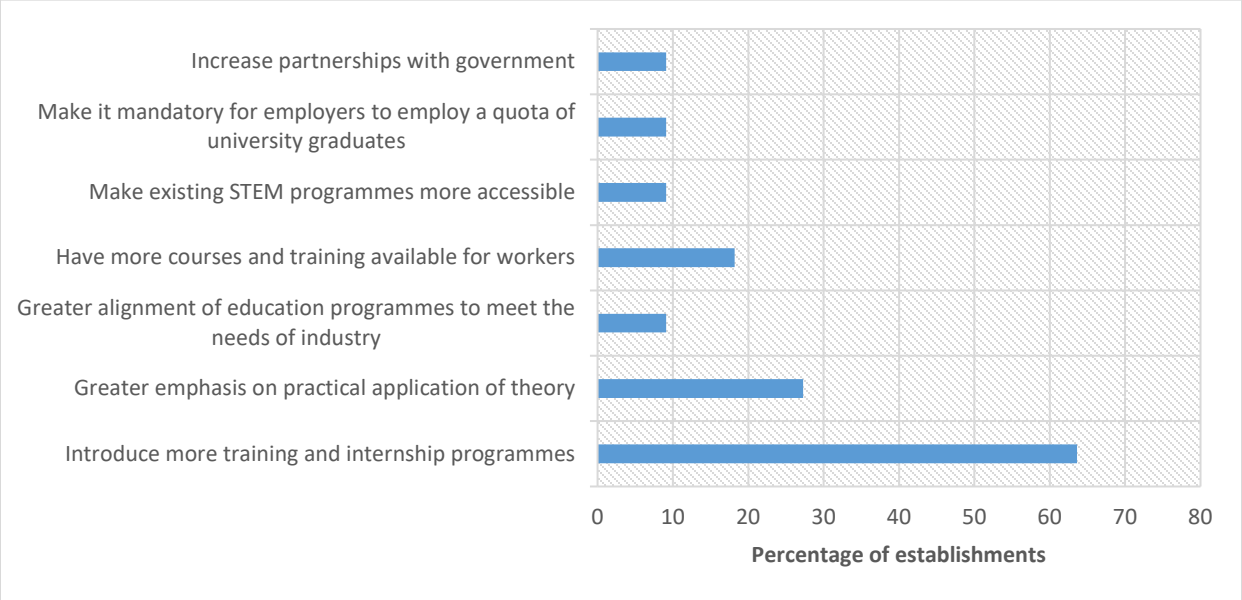


7. Employers' Recommendations

Employers from the software design and applications industry provided recommendations on what actions were needed from Government, industry and tertiary institutions to strengthen STEM education and the STEM labour.

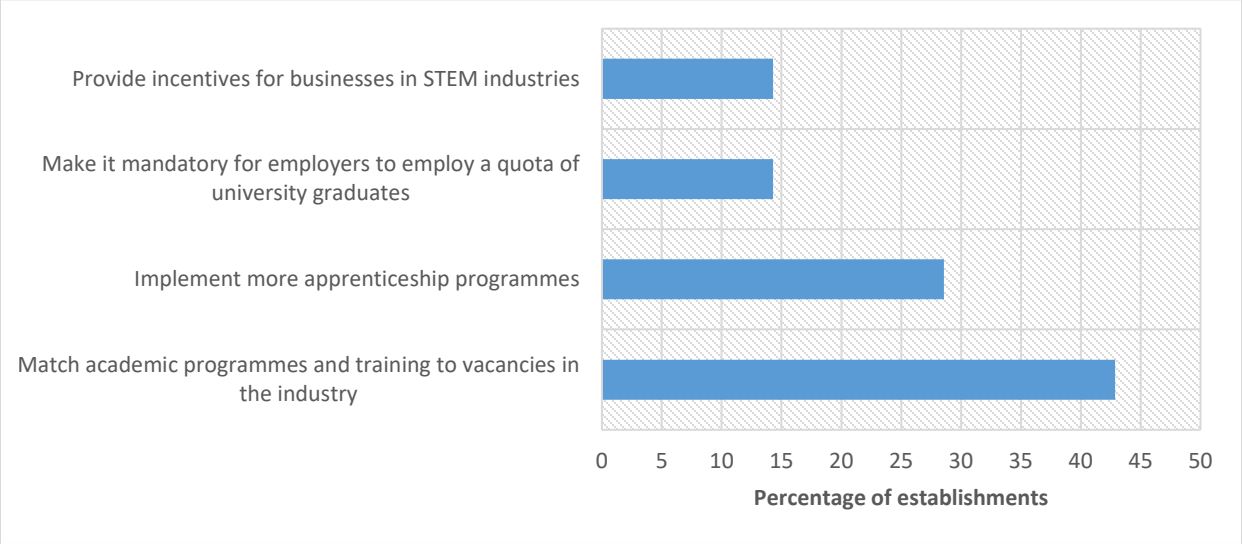
Employers were asked to provide recommendations on how tertiary education programmes could be improved to meet the needs of their industry. The main recommendation cited by employers was to include more training and internship opportunities in tertiary programmes (64%) (Figure 35). Over a quarter of the respondents suggested that there should be more emphasis on practical application of theory (27%).

Figure 35: Employers' recommendations to improve tertiary education programmes to meet the needs of the industry



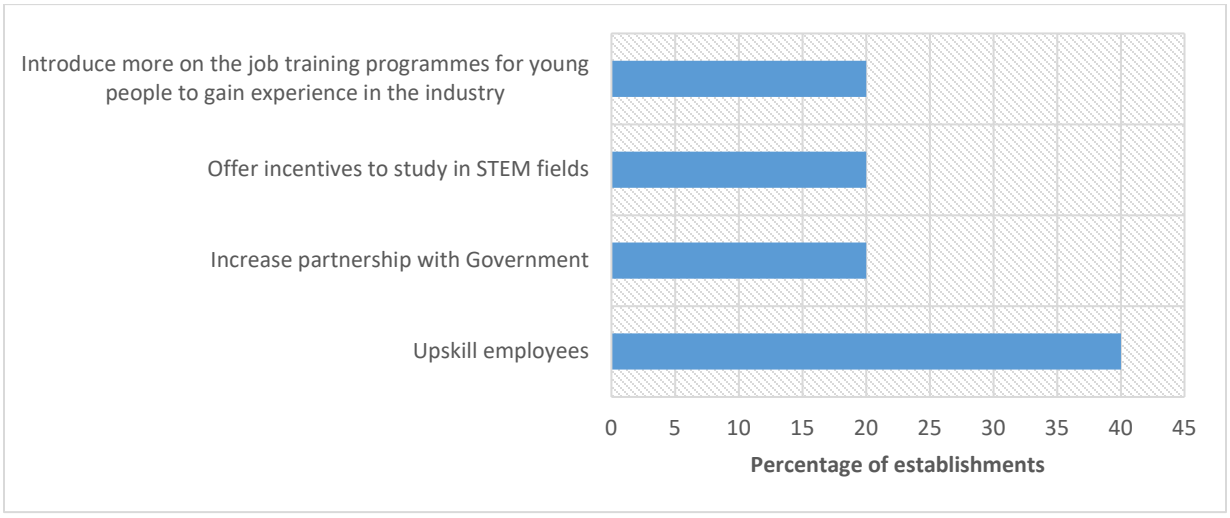
Employers provided several recommendations on how Government could help develop the STEM labour force (Figure 36). A higher proportion of employers stated that Government should match/academic programmes to vacancies in the industry (43%) while a quarter or more (29%) recommended implementing more apprenticeship programmes. Less than one fifth (14%) of the employers suggested that Government provide incentives for businesses in STEM industries and a similar percentage suggested that Government should make it mandatory to employ a set quota of university graduates.

Figure 36: 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 37 shows that two-fifths (40%) of the employers endorsed upskilling employees and one-fifth (20%) in each case recommended increase partnership with government, offer incentives to study in STEM fields and introduce more on the job training programmes for young people to gain industry experience.

Figure 37: Employers' recommendations on how private sector can help develop the STEM labour force



8. Development of the Software Design and Applications Industry

8.1 Overview

This section explores how emerging technologies are transforming software development globally and their immense potential for local application. Software development is a dynamic industry, that is constantly changing and adapting to new technologies. Breakthrough technologies such as Artificial Intelligence (AI), blockchain and cloud computing, have reshaped this sector globally, driving economic growth and competitiveness while opening the door to many exciting career opportunities. This section outlines some key transformative technologies driving software development forward, explores the associated careers and highlights the wide-ranging benefits they could bring to local businesses. It also presents examples of countries that are leading in software development, along with a case study on the Caribbean Industrial Research Institute (CARIRI). This research offers valuable insights into the relevance and potential benefits of adopting emerging technologies in the local software design and applications industry.

8.2 Key technologies transforming the software design and applications industry

Some key innovations include:

- **Artificial Intelligence (AI) and Machine Learning (ML)**
  The integration of Artificial Intelligence and Machine Learning in software development is growing. AI is revolutionising the software development process through the introduction of tools and techniques that are increasing productivity, accuracy and innovation (Finio & Downie 2024). Machine learning, meanwhile, is driving predictive analytics and enabling the creation of personalised software experiences. The advancements in predictive analytics and machine learning have improved coding, testing and deployment of software. From automating repetitive tasks to solving complex problems, AI and ML are reshaping software engineering. By incorporating AI, Software Engineers can create systems that can learn, adapt, and evolve—resulting in software that is more intelligent and resilient (King 2024). For example, AI-powered tools like GitHub Copilot and Tabnine assist software engineers by generating code snippets and completing lines

of code, minimising the time spent on writing repetitive codes and significantly speeding up the development process. Automation of these processes improves efficiency and productivity while reducing human error, resulting in cleaner and more optimised code.

- **Low-Code and No-Code Development Platforms**
  The rise of low-code and no-code platforms is making software development more accessible, allowing users with limited coding background to create robust applications. Low-code and no-code platforms are development environments that allow users to create applications with minimal hand-coded computer programming. Users create applications through graphical user interfaces and configuration. These platforms allow users, even those with minimal coding expertise, to create applications by dragging and dropping pre-built components. The benefits of low-code and no-code platforms include increased productivity, lower development costs, greater accessibility, accelerated innovation, and improved collaboration between technical and non-technical stakeholders. It is projected that the percentage of new applications created by organisations using low-code or no-code technologies will increase to 70% in 2025 from less than 25% in 2020 (Gartner, 2020). Low-Code and No-Code platforms are particularly beneficial for SMEs which may require customised software solution but often lack the resources and skills to develop them.

- **Serverless Computing and Edge Computing**
  Serverless and edge computing are transforming modern software development. Serverless platforms enable users to focus on developing code without managing servers while edge computing brings computation closer to the data source, minimising delays and reducing bandwidth consumption. Serverless computing offers scalability and cost benefits but depends on centralised cloud data centres, which may not meet the needs of applications requiring ultra-low latency. Edge computing solves this issue by processing data closer to the source. By processing data locally on edge devices, developers not only minimise latency but also increase efficiency and responsiveness which is essential to meet the demands of a technology driven world. This is critical for applications such as autonomous cars that require real-time decision and smart cities that can analyse data in real-time and send out alerts, etc.

- **Augmented Reality (AR) and Virtual Reality (VR)**
  VR and AR refer to 'technology blending the digital and physical worlds by superimposing digital information over human perception of physical reality'.[8] VR uses computer technology to create simulated environments that completely immerse the user, cutting them off from reality while AR enhances real world experiences by adding digital elements to it. AR and VR technologies now play a significant role in delivering immersive applications within software development. These technologies introduce new levels of interactivity and engagement to software applications making them more dynamic and impactful.

- **Blockchain Technology**
  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). Blockchain technology, initially known for operating cryptocurrencies, is now driving innovation across the software development landscape. Software developers are increasingly using blockchain platforms to create decentralised applications (dApps). The incorporation of Blockchain offer greater transparency and security, making them valuable in areas that require immutable and verifiable record-keeping. For example, smart contracts are a key application of blockchain technology, that allow software developers to build self-executing agreements that operate without intermediaries. This not only reduces costs but also builds trust through increased automation and transparency.

- **DevOps and DevSecOps**
  DevOps has significantly improved collaboration between development, operations and security, and its progression into DevSecOps is becoming increasingly widespread (Aarnia Software, 2024). The integration of DevOps practices is reshaping how software is conceptualised, developed, and deployed. DevSecOps embeds security into every stage of the software development lifecycle, identifying vulnerabilities early and reducing risks later down the line. The shift toward DevSecOps increases security and efficiency.

[8] European Foundation for the Improvement of Living and Working Conditions (Eurofound), Eurofound Glossary (2022), https://www.eurofound.europa.eu/en/eurofound-glossary#V

- **Cloud-Native Architecture**
  The cloud-native paradigm is transforming software development. It is an approach to designing, building, and deploying software applications specifically to run in cloud environments. While traditional architectures relied on fixed, high-cost infrastructure and require significant manual effort to scale or adjust, cloud-native systems are built to take full advantage of the cloud's flexibility and cost-efficiency. By harnessing the capabilities of modern cloud platforms, developers can create cost-efficient, scalable and resilient applications that meet today's digital demands. The benefits of cloud-native architecture include scalability, resilience, flexibility, cost-efficiency, speed and innovation.

8.3 Growing STEM jobs in the software design and applications industry

The increasing integration of advanced technologies such as AI, VR, Edge Computing and DevOps, is driving a surge in demand for skilled professionals in the software design and applications industry. The table below outlines some of the key STEM careers linked to these technological advancements.

Table 3: Key STEM careers associated with technological advancements in the software design and applications industry

Key technological advancements	Examples of STEM careers
• AI and ML • VR and AR • Blockchain • Low-Code and No-Code Development Platforms • Serverless Computing and Edge Computing • DevOps and DevSecOps • Internet of Things (IoT) • Microservices • Quantum Computing • Cloud Computing	• Software Engineers: Software Engineers design, develop, and test larger computer systems and applications, with software development being a vital part of the broader field of software engineering. Software Engineers collaborate with other team members in the workplace • Software Developers: They are similar to Software Engineers. Software Developers are responsible for creating, maintaining, and improving software applications. They write, manage and debug the code in computer programmes. They often work in an environment that encourages creativity and innovation. • AI Specialists and Machine Learning Engineers: Contribute to the development

Key technological advancements	Examples of STEM careers
	of intelligent systems that automate processes and optimise decision-making. They write code for programmes designed to improve the efficiency of tasks that were previously performed by humans. • DevOps Engineer: Experts in both software development and IT operations. They promote collaboration between the development and operations teams to streamline the creation and maintenance of software. • Blockchain Developers: Blockchain technology is increasingly used to improve transparency and security. Developers are needed for creating and implementing decentralised solutions, particularly in Fintech and logistics. Blockchain developers focus on building decentralised applications (dApps) using blockchain technology. • Cloud Computing Professionals: The growing adoption of cloud platforms has generated a need for experts in cloud architecture and management, enabling businesses to scale operations efficiently. These developers develop applications and services that run on cloud computing platforms. • Cybersecurity Analyst: With digital technologies becoming integral to business operations, the demand for cybersecurity professionals has increased. As there is an increased need for protecting sensitive data and securing digital infrastructure. These experts monitor systems for weaknesses and security breaches, investigate incidents, and develop policies to reduce the risk of cyberattacks. • AR/VR Developers: Create immersive experiences for users. They design, create,

Key technological advancements	Examples of STEM careers
	and test software that enriches user experiences • Game developers use coding languages to build and develop gaming software. They collaborate with other team members to bring their ideas to life. • Computer Programmer: Writes, tests and maintains the source code of computer programmes and software applications. They collaborate with software developers to develop software solutions and programmes.

8.4 Examples of leading countries in software design and applications

This section highlights countries that have set benchmarks in software design and applications through the integration of ground-breaking technologies. It also explores the emerging STEM career opportunities resulting from these advancements in software design and applications.

Table 4: Examples of leading countries in software design and applications and associated STEM careers

Country	Technological advancements
United States	The United States dominates the global software industry with innovations from major players like Google, Microsoft, and Amazon. Google's GPT models have revolutionised natural language processing, while Microsoft Azure supports businesses worldwide with cloud infrastructure. Investments in STEM education, alongside initiatives like the National AI Initiative Act, have led to career opportunities in AI ethics, quantum computing, data science, and cybersecurity.
India	India has built a global reputation for IT services and software development. Companies like Infosys and Tata Consultancy Services leverage a highly skilled and cost-effective workforce. Tech hubs like Bengaluru foster collaborations between academia and industry, creating jobs in cloud management, software engineering, and data analytics. Programmes like "Digital India" have accelerated growth by improving internet access and digital literacy.
China	China leads in AI, big data, 5G and e-commerce through companies like Alibaba and Tencent. These firms use machine learning to transform logistics and customer personalisation. The "AI 2030" plan has catalysed research, driving job creation in cybersecurity, AI development, and blockchain technologies.
Germany	Germany is the largest software market in Europe. While the country has some of Europe's top software companies, such as SAP, the industry is characterised by a large number of dynamic, specialised SMEs known as the Mittelstand. These SMEs are driving the demand for software solutions and increasing the number of customers. The software industry in Germany is flourishing with increasing focus on innovative technologies such as artificial intelligence.

8.5 Benefits of applying emerging technology to the local software design and applications industry

Trinidad and Tobago's software design and applications industry has evolved from basic IT services to a growing hub of software development and technological innovation. Increasing the adoption of new technologies in the sector can result in numerous benefits, including:

- Increased efficiency and productivity: Technologies such as AI and ML are minimising the time spent on writing repetitive codes and significantly speeding up the development process.
- Cost savings: By eliminating the need for expensive infrastructure, cloud computing lowers operational costs and supports scalability.
- Greater competitiveness: Emerging technologies such as cloud computing, AI and automation increase competitiveness by streamlining development workflows, speeding up development and deployment, improving quality of products, and promoting innovation to meet growing demands.
- Job creation and skills development: New technologies create demand for specialised roles, including software engineers, AI engineers and cybersecurity experts, boosting employment and skills in Trinidad and Tobago.
- Greater accuracy and trust: Automating processes not only improves accuracy by eliminating human error, but also increases transparency, helping to build trust among users and customers. For example, blockchain ensures secure, transparent transactions, building trust with international clients and fostering global partnerships.
- Improved customer experience: Some new technologies enhance customer experience and response time resulting in higher customer satisfaction and demand. For example, VR/AR introduce new levels of interactivity and engagement to software applications making them more impactful for customers.
- Innovation and growth: technological advancements open new opportunities and markets for business growth and drives innovation.

Adoption by local businesses

Trinidad and Tobago's software industry could successfully adopt advanced technologies like AI, blockchain and cloud computing through initiatives such as strategic partnerships, investment in workforce development, and infrastructure upgrades.

- Financial incentives, such as government grants, subsidies, and public-private partnerships, can help mitigate the high initial costs associated with implementing these technologies.
- Training programs aimed at equipping local talent with essential skills in emerging technologies are vital. Collaborations with among research institutions such as CARIRI, NIHERST, the UWI and UTT, can help address skill shortages and ensure that the workforce is well-prepared to meet the growing demands of the software industry.
- Significant upgrades to the country's digital infrastructure are necessary to support the widespread use of advanced technologies. This includes investing in high-speed internet, cloud-based platforms, and scalable IT systems to provide local businesses, particularly small and medium-sized enterprises (SMEs), with access to affordable, cutting-edge technology.
- Public-private partnerships can further reduce the barriers to technology adoption by providing businesses with access to shared resources, technical expertise, and co-funding opportunities. Additionally, targeted educational campaigns and demonstration projects can help raise awareness of the value and practical benefits of digital transformation, encouraging more businesses to invest in these technologies.

8.6 Case Study: CARIRI's role in software innovation

This section examines the efforts of the Caribbean Industrial Research Institute (CARIRI) in transforming Trinidad and Tobago's software industry. By leveraging technological innovation, targeted training programmes, and strategic partnerships, CARIRI has significantly improved the industry's capacity to compete globally. The initiatives spearheaded by CARIRI have fostered entrepreneurship, strengthened the talent pool, and driven economic growth in the digital age.

Background

Established in 1970, CARIRI is a key player in advancing technology and innovation in Trinidad and Tobago. It serves as a research and development hub, offering training and business support to local industries. CARIRI's ICT Division serves as a

cornerstone of technological innovation and agile software development in Trinidad and Tobago. The Division is focused on delivering customised solutions across industries and advancing national development through the integration of cutting-edge technologies.

CARIRI's programmes support areas such as e-commerce, Fintech, and software development, creating a fertile environment for start-ups and established businesses alike.

Challenges:

In the past the Trinidad and Tobago's software industry faced significant barriers such as:

- Limited digital infrastructure
- Shortage of skilled IT professionals
- Low adoption of global standards

Solutions:

CARIRI adopted an approach to solve these challenges and stimulate growth:

- Digital Innovation Hubs: These hubs provide entrepreneurs with access to cutting-edge tools, mentorship, and resources, bridging the gap between ideas and commercialisation.
- Coding and Innovation Programmes: Since 2018, over 2,000 students have been trained in programming, software development, and emerging technologies. These programmes are integrated into school curricula in partnership with the Ministry of Education, fostering early engagement with STEM fields.
- Incubation and Mentorship Programs: CARIRI established initiatives like the Business Hatchery and Innovation Incubator to support start-ups with technical guidance, market insights, and access to funding. This support has driven the growth of businesses in Fintech and e-commerce.
- Partnerships with Educational Institutions: Collaborations with universities such as the University of the West Indies (UWI) ensure that students and professionals gain specialised training in areas critical to the software industry.

Results:

The initiatives implemented by CARIRI have yielded measurable outcomes:

- Increased Start-ups: CARIRI's support programmes have contributed to a surge in local start-ups, particularly in the Fintech and e-commerce sectors.
- Skilled Workforce Development: Thousands of students and young adults have gained expertise in programming, coding and AI, enabling the industry to meet global standards.
- Global Recognition: CARIRI's programmes have positioned Trinidad and Tobago as one of the leaders in software innovation within the Caribbean, attracting international partnerships and investments.
- Enhanced Business Competitiveness: Local companies now leverage modern technologies to innovate and scale operations, improving their standing in global markets.

Conclusion:

The efforts of CARIRI in advancing digital innovation have significantly contributed to the development of Trinidad and Tobago's software design and applications industry. Through strategic initiatives in workforce development, the establishment of digital innovation hubs, and the promotion of technology-driven entrepreneurship, CARIRI has improved the industry's ability to compete globally. These efforts continue to support the evolution of the software industry in Trinidad and Tobago.

9. 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 software design and applications field as the survey results show that males outnumbered females in higher roles, including managerial, professionals, and technicians and associate professionals. 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 higher 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 software design and applications industry 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 STEM programmes based on current and future needs of industry. This would lead to increase productivity and profitability for businesses and employability of graduates.

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. Fostering 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. Furthermore, retraining supports employee retention and boosts productivity.

4. Provide more support and incentives to promote STEM occupations. 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 more information and access to technological advancements so that it is easier to integrate into businesses and employers 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 development of software design and applications. Technological advancements are key to transforming the sector into an automated, resource-efficient and competitive industry. This investment would also stimulate the demand for STEM talent associated with emerging technologies.

8. Promote STEM jobs the software design and applications 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, undertake studies that focus solely on TVET.

10. to establish and regularly update a comprehensive business registry for this sector to enable accurate and more seamless measurement of growth, both at the sectoral level and within individual businesses.

10. Conclusion

In conclusion, this study offers a comprehensive assessment of the current and future STEM labour needs within the software design and applications industry 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 WEF reported that analytical thinking, creativity and flexibility were among the top skills needed in 2025. The results of this survey highlight key insights into the skill set of the current workforce and the emerging demand for STEM competencies as the industry evolves. The findings of this study underscore the crucial role that technological advancements, such as AI, ML, IoT and Cloud Computing, 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 findings of the study reveal that the although the software design and applications sector is relatively small, there is a strong demand for IT professionals within the industry. The high demand for IT professionals in the sector is promising in terms of sustainable growth, given the rapid technological advancement and the evolving landscape of future jobs. Moreover, as the country continues to embrace digitalisation and innovation there is a strong case for expanding STEM roles in software design and applications. IT positions were identified as some of the most difficult STEM roles to fill which highlights a critical skills gap that must be addressed to support technological advancement in the industry. Moreover, the number of STEM professionals is expected to grow in the coming years, with employers anticipating increased demand for occupations such as AI Developers, Cyber Security Specialists, Web and Digital Interface Designers and Software Developers, over 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. As the software design and applications industry is inherently rooted in ICT, leveraging STEM talent effectively within the industry will play a pivotal role in keeping up with technological innovations and remaining competitive.

Furthermore, the study highlights a gap between the skills demanded by employers and the level of skills among the current workforce. While most employers believed that it was important for employees to possess all 19 core skills to achieve business

objectives and the majority rated the core competencies of existing employees as medium to high, the overall skill levels still fell short of what was required to meet organisational goals. There were noticeable gaps among new job applicants and existing employees in critical areas, such as self-reflection and learning to learn; creative and innovative thinking; problem solving; and critical thinking. Furthermore, the majority of employers indicated that universities only prepared graduates for the world of work to some extent, this suggests that there is a disconnect between education and industry. 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 over a half of the 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.

STEM skills within the software design and applications industry 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 significant. 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 software design and applications industry. This includes improving the STEM curriculum at various levels 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 software design and applications 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 software development, cybersecurity, and data analytics, are also crucial for building a robust talent pipeline.

The software design and applications industry is a dynamic and rapidly evolving industry that has immense potential to transform Trinidad and Tobago's digital economy. Software is cross-cutting, from healthcare and education to finance and manufacturing, they all rely on software for efficient and effective operations. Additionally, technology careers span across all industries and can be undertaken in a variety of workplace settings. However, to fully take advantage of the benefits of innovations in software development, it is essential to have a strong STEM workforce and ecosystem. 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. Doing so will not only increase innovation, competitiveness and profitability in the industry but also contribute significantly to broader economic growth and development.

Ultimately, the findings from this study will inform policy decisions and guide the development of programmes aimed at addressing the skills disparities in the software design and applications industry. 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 software design and applications industry, driving growth and development in this critical sector and strengthen its position in the global market.

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 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	• 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	• 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	• Actuaries • Mathematicians • Operations Research Analysts • Statisticians • Data Scientists • Mathematical Science Occupations, All Other

Science	Computer Science/ IT	Engineering	Mathematics
Specialists, Including Health • Geoscientists, Except Hydrologists and Geographers • Hydrologists • 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	• Network and Computer Systems Administrators • Computer Programmers • Software Developers • Software Quality Assurance Analysts and Testers • Web Developers • Web and Digital Interface Designers • Computer Occupations, All Other	• Environmental Engineers • Health and Safety Engineers, Except Mining Safety Engineers and Inspectors • Industrial Engineers • 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	

Science	Computer Science/ IT	Engineering	Mathematics
• 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 • Environmental Science Teachers, Postsecondary • Physics Teachers, Postsecondary • Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products • Sales Engineers		• 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 • 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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