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# ECOSYSTEM MAPPING OF INNOVATION ENTREPRENEURSHIP AT SOUTH AFRICAN TVETs

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Section 1

# Introduction to the Study

## 1.1 Introduction and Problem Statement

South Africa currently has 50 registered Technical and Vocational Education and Training (TVET) colleges, with over 250 campuses spread nationwide. The number of learners enrolled in these colleges was estimated to be 452,277 in the 2021 academic year and increased to 518,584 students in 2023 (Department of Higher Education and Training (DHET). During the 2023 State of the Nation Address (SONA), President Cyril Ramaphosa noted that the number of artisan students in TVET increased from 17,000 to 30,000 in the 2023 academic year (Ramaphosa, 2023). This signals a substantial increase and uptake in the TVET sector, that could have the potential to address the phenomenon of NEET (Not in Education nor Education and Training) youth, which is currently estimated at 3.5 million (of those aged 15-24) (Stats SA, 2024), and the skill shortages in the trades. It is essential to ensure that investment in this sector matches the increased demand and enrolment in TVET education, while also considering the current constraints and emerging opportunities, with technology innovation (tech innovation), and entrepreneurship becoming drivers of modern economies. However, the lack of ecosystem data and data-mapping of tech innovation in the TVET sector makes it difficult to understand where the opportunities for enhancement of innovation lie. This hinders the growth potential of this sector to contribute to national development imperatives, and excludes TVET colleges from emerging technology and innovation entrepreneurial opportunities. Mapping the tech innovation entrepreneurship ecosystem in Technical and Vocational Education and Training (TVETs) is important for creating an enabling environment that will spur technology development, adoption and diffusion. South Africa's broad infrastructural challenges and investment needs, present an opportunity for the education landscape to design training programmes and interventions to meet the demand for new and relevant skills.

For example, the South African government invested R600 million to address the lack of technical skills required to maintain infrastructure, technical skills that exist in the TVET sector (Ramaphosa, 2023). Furthermore, the Just Energy Transition era, driven by the shift to renewable energy, has opened up a demand for new skills capable of being facilitated by the TVET sector. The importance of this sector is also evident in the government surpassing the placement of 10,000 TVET graduates in employment, with the President's commitment to increase this number to 20,000 in 2023. However, the funding to TVETs is expected to decrease by 10% in 2024 despite a slight (3-4%) increase in TVET enrolment (Nzimande, 2024). It is critical that TVET graduates are not only seen as employment seekers but are also equipped to take advantage of the emerging entrepreneurial opportunities in the innovation space, renewable energy sector (where there is a high demand for TVET graduates), and other in-demand trades, such as welding and boiler making. This presents an opportune moment for organisations in the entrepreneurial ecosystem landscape to support the development of innovation entrepreneurship in the TVET sector. Against the above backdrop, there is a need to undertake an ecosystem mapping of tech innovation and related entrepreneurship in the South African TVET sector. While there is abundant research on universities, there is a need for more up-to-date research on the trends, constraints, and opportunities in the TVET sector. This research should be considered in relation to technology innovation and the increasingly important role of research and development on national economies. The core focus of this ecosystem mapping exercise is on the existing and envisaged capabilities of the TVET sector and its potential to play a leading role in responding to the country's economic challenges through tech innovation and related entrepreneurial activities.

> ***To effectively deliver on this mandate, this research uses the holistic and evidence-informed entrepreneurial ecosystem framework to assess the TVET sector's contribution to the economy, particularly the knowledge economy.***

The entrepreneurial ecosystem framework identified ten elements as crucial to a healthy entrepreneurship ecosystem (infrastructure, formal institutions, access to finance, leadership, talent, network, intermediaries, entrepreneurial culture, demand, and knowledge). Should these ten elements be assessed as healthy, the ecosystem is in its best state for productive entrepreneurship i.e. tech businesses are in an optimal environment to start and grow. This research adopts and tailors these ten elements to the TVET sector by creating specific metrics for each element around tech innovation, these metrics will be used to create a reliable ecosystem mapping framework to meet the research goals. The metrics also consider innovation elements in TVETs by focusing on the state of support systems at TVETs, comprising innovation Hubs and Centres for Entrepreneurship and Rapid Incubation (CfERIs).

## 1.2 Brief Literature Review

South Africa's TVET sector has experienced rapid growth over the last decade due to increased demand for technical skills. In addition, the TVET sector plays a vital role in closing the gap between those unable to access universities and those who prefer trades that do not require a university education. To elucidate the importance of TVETs, a report by DHET (2019) showed that 600,000 students had graduated from TVET colleges in 2018, and approximately 70% of those who graduated were employed within the first six months. TVET colleges are essential for producing skilled artisans that address the high demand for artisans in critical sectors of the economy, such as manufacturing and construction. While addressing these vital skills is important, there has also been a gradual shift toward producing TVET graduates capable of utilising their skills to pursue entrepreneurial aspirations. This shift is in recognition of the country's high unemployment rate, the limited employment opportunities available in the formal sector and thus the need to enable more entrepreneurs to make their own income-earning opportunities. A recent report by DHET shows that only 6% (1.7 million people) of South Africans have a university degree and a 15% graduation rate (meaning only 15% of students graduate within the stipulated time), and 3.4% hold TVET qualifications, the lowest of all OECD countries (DHET, 2021). Despite the stigma associated with TVET qualifications, a survey conducted by the Small Enterprise Finance Agency (SEFA) revealed that 40% of new Small, Medium and Micro Enterprises (SMMEs) are started by TVET graduates (SEFA, 2018). This points to entrepreneurial intentions and opportunities in the TVET ecosystem that need to be unearthed and supported, particularly in relation to the high failure rate of SMMEs. The Global Entrepreneurship Monitor (GEM, 2022) observed that 50% of small businesses fail within the first three years, and this figure goes up as high as 80% in the first five years. Such failures explain the importance of interventions such as Entrepreneurship Development in Higher Education (EDHE), which is focused on increasing entrepreneurial capabilities and aspirations for students, academics and leaders within the education landscape (EDHE, 2023). However, EDHE is only currently operating in universities and released an ecosystem mapping of universities (excluding TVETs), which provides many opportunities for those interested in investing in entrepreneurship in TVET colleges. In a study on merging entrepreneurship education in engineering as a component for innovation, Charles and Gregory (2021: 1) posit that "students need to exit the TVET colleges as institutions of higher learning with relevant entrepreneurial skills to improve employability and growth of the economy". This is quite important for the South African context because of the country's high unemployment rate and limited income-earning opportunities, with the youth disproportionally affected. In Europe, the TVET sector is recognised as an essential policy lever for innovation competitiveness and contributing to the knowledge economy. However, a study on the technological skills offered by TVET colleges in South Africa revealed that students did not believe that the curriculum equips them with the necessary technological skills to be competitive in the fourth industrial revolution (4IR) (Denhere and Moloi, 2021a). These beliefs are driven by the available infrastructure in these TVETs and the level of education of TVET lecturers. Within the framework utilised in this study, innovation infrastructure, such as research labs and access to the internet are important infrastructure components to support tech innovation.

In a different study, Denhere and Moloi, (2021b) interviewed principals, deputy principals and ICT managers to understand the fourth industrial revolution readiness of TVETs. The study found that although efforts were made, TVETs "were not completely ready due to lack of or inadequate teaching and learning technologies, training for teaching staff on the use of available technology, poor connectivity, lack of computing equipment, lack of ICT infrastructure, lack of ICT strategies, and above all, a lack of policy directive" (Denhere and Moloi, 2021b). These findings reiterate the pressing challenges facing the TVET sector, such as infrastructure challenges and competency issues related to TVET lecturer development. In addition to this, little is known about the capabilities of all TVET colleges in the country, which makes it impossible to design suitable interventions. Furthermore, little is known about what innovation emerges from the TVET sector, particularly from students and the TVET support system. With increased focus on entrepreneurship in South Africa's education landscape, universities have often acted as the domain of all research, innovation and development. This posture is supported by the significant investment in research and development for universities, including the various subsidies available to universities and scientific councils. The government of South Africa spent R33.541 billion on research and development in 2020/21, translating to 0.6% of the country's GDP (HSRC, 2022). Of this, R13.7 billion was spent on higher education and R5.9 billion on science councils. The expenditure on research and development is "an aggregated measure of in-house R&D expenditure performed domestically in five sectors, namely government, science councils, higher education institutions, the business sector, and the not-for-profit sector" (HSRC, 2022). This is low in comparison to other countries as South Africa is ranked 61 out of 132 in the 2022 Global Innovation Index (World Intellectual Property Organisation, 2023). The manufacturing and financial sectors have the highest share of spending on research and development in South Africa (HSRC, 2022). It is important to note that the manufacturing sector strongly relates to skills produced in TVET colleges. Yet, the capabilities of TVETs to work with and contribute to such vital sectors of the economy still need to be explored. Furthermore, there is little to no mention of the TVET sector in the South African National Survey of Research and Experimental Development. This suggests a clear lack of studies on research and development (specifically innovation technology entrepreneurship) emerging from TVET colleges. Therefore, this study, to map the technology innovation entrepreneurship ecosystem and the TVET sector's contribution to the knowledge economy, is essential. An important component is how innovation is diffused to all levels of society to promote local innovation systems, particularly within the emerging entrepreneurial aspirations of TVET students.

## 1.3 Research Gap and Significance of this study

**This research is significant for the following reasons:**

- **Ecosystem mapping:** There is currently a lack of studies/ecosystem mapping of the TVET sector exploring the state of innovation in TVET colleges across the country. As such, this study is important because it seeks to advance our understanding of innovation within the TVET landscape in South Africa and offers insights into the country's TVETs through the entrepreneurial ecosystem framework. The ten-factor framework is important because it consists of generic questions about the TVET environment, as well as entrepreneurial questions about the TVET colleges.

  The combination of these elements, offers a rich background into the TVET sector and the entrepreneurial and innovation intentions of the students and the surrounding environment. While other studies do exist (the recent National Advisory Council on Innovation study), they are not grounded within the entrepreneurial ecosystem framework adopted in this study. The ten-factor framework introduces a new approach to understanding the tech innovation system within the TVET landscape.

- **Tech innovation and knowledge economy:** Abundant research exists on the role played by universities in the innovation space, yet little is known about innovations emerging from the TVET sector. As such, this study will focus on the technology innovation/new knowledge landscape within the TVET sector. The results from this study will showcase the importance of TVETs in the innovation space and contribute to the body of knowledge on technology adoption and diffusion in this education sector. In addition to this, the results will show the tech innovation and entrepreneurship profile of each TVET college in an index format.

- **Understanding innovation** in TVETs using the entrepreneurship ecosystem framework with specific reference to tech innovation will provide recommendations on how to improve innovation in each of the 50 TVETs to grow their contribution to the knowledge economy. This study will also help more skill- and trade-based businesses leverage this innovation and knowledgeand knowledge to become more sustainable and grow. This will help accelertate employment and economic growth in South Africa.

For policymakers and budget holders, this study is important because it creates the first ecosystem mapping of the TVET sector's tech innovation system in South Africa. The results from this study could be used to draft and implement evidence-based strategies and investments to improve the competitiveness of the TVET sector, while also ensuring support for emerging innovations.

The recommendations suggested in section six will also assist in overcoming the gaps in TVET support for innovative entrepreneurs. Furthermore, the study also presents successful case studies relating to activities on training youth for entrepreneurship and support for converting innovation emanating from the TVETs into business ventures.

## 1.4 Aim of this study

This study aimed to undertake an ecosystem mapping of the technology innovation and entrepreneurship ecosystem at TVETs, and the contribution of the TVET sector to the knowledge economy.

**The overall objectives were to:**

- Understand the TVET entrepreneurship ecosystem status under the ten conditions in all 50 TVETs that will guide the support and investment required in each TVET college to improve the environment for innovation to thrive.
- Explore the contribution of the TVET sector to the knowledge economy through technology entrepreneurship.
- Explore specific challenges facing the TVET sector's tech innovation and knowledge innovation space.
- Recommend strategies to support tech innovation and innovation entrepreneurship in the TVET sector.

## 1.5 Research Questions

The research question is as follows: What is the state of tech innovation entrepreneurship and the contribution of the TVET sector to the knowledge economy?

**The overall objectives are to understand:**

- How can the entrepreneurial ecosystem framework be utilised for an ecosystem mapping of the TVET sector (and possibly any learning institution) in relation to tech innovation entrepreneurship?
- What is the contribution of the TVET sector to the knowledge economy tech and innovation entrepreneurship?
- What specific challenges does the TVET sector's tech innovation and knowledge innovation space experience?
- What strategies can best support tech innovation entrepreneurship in the TVET sector?

## 1.6 Anticipated Outputs

Other than this report, the following outputs are anticipated:

**A case study** of how to apply this framework to a learning institution and a model of how others can do this in their context (i.e school or higher learning institution etc). This will also inform how the framework can be adopted and adapted to fit other sectors of the economy.

**Dialogue** to ensure the research is known by users in the TVETs. Dialogues will be held around the various topics so that research is converted into actionable insights to support entrepreneurship on the ground.

It is also envisaged that there will be a second phase of this study. The second phase will involve a survey designed to understand the technology entrepreneurial aspirations of TVET students and their emerging innovations. The survey will involve all TVET colleges and target those students who have started new businesses or those who wish to start new businesses in the tech space and other categories.

## 1.7 Conclusion

This section provided the backdrop for the study, and focused particularly on the contextual background and problem statement. Furthermore, the section highlighted the motivation for an innovation entrepreneurship ecosystem mapping of the TVET sector to support the development of improved institutional frameworks for TVET colleges in the 4IR.


## Section 2

# Literature on TVETs in South Africa

## 2.1 Introduction

South Africa faces many socio-economic challenges marked by the triple challenges of unemployment, poverty and inequality. The South African government has developed various strategic initiatives to address these challenges through education and development, primarily focused on universal access to education, specifically for the previously marginalised. Since democracy, there has been increased access to education through the increase of schools in previously disadvantaged areas, increased funding for all levels of education and government-led financial support for students to access tertiary education. In the context of this report, access to TVET education is an important milestone in the effort to address the high numbers of people who are considered NEET. With access to TVET education on the rise, it has become important to conduct a literature review of the design and the institutional architecture of the country's TVET ecosystem. International literature shows existing case studies of innovative approaches to TVET colleges and their role in national development. Benchmarking global literature with South Africa's TVET ecosystem is an important step to learning from key insights.

Section 2 of this report provides insight on the innovation entrepreneurship capabilities of South Africa's TVET colleges. To this end, a desktop review of existing research was undertaken. The first part focuses on South Africa's TVET ecosystem in the context of the country's national development imperatives. This includes the role of TVETs in reducing unemployment and other issues facing students and teachers. The second part reviews unemployment trends in South Africa and the skills demand in relation to the TVET sector. The third part zones in on the architecture of the country's National System of Innovation (NSI), its role in the country's development, and whether there is a role for TVET colleges. The final part of this section reviews literature on the role of TVET colleges in innovation, with a particular focus on the National Advisory Council of Innovation (NACI) report commissioned by the Department of Science and Innovation (DSI). This part explores some case studies of innovation in the TVET ecosystem and the roles of different stakeholders. Some potential lessons are noted for other TVET colleges and the role of the NIS in building TVET capabilities in South Africa.

## 2.2 South Africa's TVET System in National Development

With South Africa's high unemployment rate, the creation of job opportunities is a heavy burden for the state and the private sector. This predicament is caused by the sustained failure to create job opportunities that substantially out number jobs shed over the past decade. In South Africa's White Paper on Post School Education and Training (Republic of South Africa, 2013a: 13), the following important objective is stated:

> *"Government expects that TVET colleges will become the cornerstone of the country's skills development system. Headcount enrolments increased from:*
>
> ***345,566** in 2010*
>
> ***to an estimated 550,000** in 2013*
>
> ***enrolments are expected to increase to 1 million by 2015 and 2.5 million by 2030.***

Despite these ambitions, South Africa only managed to enrol 518,584 students in 2022 (DHET, 2023). The structure of South Africa's economy is exacerbated by the growing contribution of the financial sector, whereas labour-intensive industries such as manufacturing and agriculture continue to record negative employment growth. Stats SA (2024) observes that issues of unemployment disproportionately affect the youth and worsen with the focus on those considered NEET. This indictment on the NEET places a heavy burden on TVET to not only absorb these unemployed youth, but to also provide them with necessary skills to be employable in a competitive labour market. Emerging industries such as renewable energy (and other opportunities in the green economy) and others, provide a platform for TVET to be innovative in the delivery of their programmes and provide opportunities for industry partners to tap into this space.

This will require leadership with foresight and business acumen to meet the needs of the modern economy.

Most literature on TVETs focuses on the notion that ensuring youth accesses to TVET education will yield better socio-economic outcomes because of the increased chances that trained youth have to access the labour market. The system used by the South African government follows the Human Capital Theory that emphasises skills development to address labour market issues and address the high level of unemployment among the youth. This approach is criticised by Ngcwangu (2019) for focusing on productivity over developmentalism because it sees the TVET ecosystem as being responsible for creating labour and productivity. The developmentalist approach is different from the Human Capital Theory because it sees education as basic human right for people to determine their freedom and pursue alternative modes of development. In the context of this report, alternative development could be in the form of TVET graduates pursuing entrepreneurship instead of mainstream employment, and thereby contributing to the country's growth and development. This unique approach does not need to be decoupled from productivity, but both approaches need to be understood as complementary because TVET graduates could pursue one of the two streams and equally contribute to their needs.

An important consideration (one that is often not addressed) is the key reasons students enrol at TVET institutions. Literature tends to focus on negative factors, such as students were not academically strong or dropped out of schools.

Powell and MacGrath (2013) focus on the positive factors, and argue that learners enrol for rewarding reasons, such as needing practical skills to prepare for the workforce, seeking better and decent work, improving their personal, family and community contribution, and raising their status and self-esteem through fulfilling work with potential for growth. Most importantly, the findings of this study also show that leading reasons for learners enrolling at TVETs was because of the job opportunities they associate with TVET and that they enjoy working with their hands. These findings suggest that students see more value in enrolling in TVET institutions than remaining in high school. Such findings contribute to the positive outlook of TVET and need to be shared with wider audiences to improve the perception of TVET institutions.

**“Learner/student attrition in TVET colleges is an important component that causes challenges in the TVET ecosystem. In a research study on the driving factors behind student attrition in KwaZulu-Natal TVET colleges, Zulu and Mutereko (2020) found that high student attrition is not only an issue in select programmes but happens across all programmes. Their findings also revealed that high student attrition is attributed to dissatisfaction with the programmes, inadequate work placement and induction incompetencies that do not prepare students for the TVET ecosystem (Zulu and Mutereko, 2020).”**

These particular problems with the quality of TVET education, undermine the country's NDP vision of enrolling over 2.5 million students in TVET by 2030, particularly if many of these students do not graduate. Importantly, these shortcomings also impact the country's ability to arrest the high unemployment rate because of the failure to channel out a pipeline of highly-skilled workers.

There is burgeoning research on whether educational institutions are providing the necessary foundational skills required by employers. The NACI report (2021) argues that TVETs have an essential role in South Africa meeting the NDP goals through the provision of mid-level technical skills required to drive an efficient economy.

**In his 2023 SONA address, the President identified TVET skills as critical to address the country's fundamental challenges.**

This creates an impression that TVET colleges are developing skills that might not be meeting demand, and suggests that there is a skills mismatch. Some authors have suggested that South Africa is not producing sufficiently skilled TVET graduates. A further and fundamental problem is the lack of comprehensive studies on TVET lecturer qualifications and their implications on producing a pipeline of talent capable of addressing the country's skills shortage and need. This problem not only persists in the TVET landscape but is also prevalent in basic education (mainly primary and high school).

Another challenge facing South Africa's TVET sector is that while students often go through work-integrated learning, lecturers are not expected to go through the same process, particularly the industry-learning experience. Van der Bijl (2021) asserts "While South Africa has a well-developed history of teacher education policy and work placement in schools, it does not have a convention of vocational teacher education policy, or of industry placements for vocational teachers". Literature shows that lecturer industry placement would not only enhance their industry knowledge and skills, but could create better lecturers (Van de Bijl and Taylor, 2016). Such an experience could also provide lecturers with industry networks that could later partner with TVET colleges in the delivery of their programmes and work placements. In addition to this, industry experience could also provide motivation for both lecturers and students, particularly the role that could be played by role models in building aspirations and mindsets. In the innovation space, workplace placement opportunities could increase lecturer's innovation knowledge and motivation to become an innovator. Increased knowledge and motivation among lecturers would increase student awareness and motivation within the innovation space. With improved learning in the policy space, the Policy on Professional Qualifications for Lecturers in Technical and Vocational Education and Training (Republic of South Africa, 2013b) cements the need for TVET lecturers to undergo industry placement.

It is also noted that "TVET lecturers have commonly been sourced from industry or on graduation and, as a result, a significant number of those employed in TVET colleges do not have a professional teaching qualification, a qualification related to their field of expertise or industry experience" (Van de Bijl and Taylor, 2021: 17). The lack of strict requirements on TVET lecturers therefore places a burden on underqualified lecturers to perform work without any prior experience or specialisation in some of the fields they are hired in. This predicament reduces TVET capacity to deliver students capable of impacting industrial development.

## 2.3 The State of Innovation in South Africa's TVET Colleges

NACI was requested by the Minister of Higher Education, Science and Innovation to assess the state of innovation in TVET colleges across the country. Data was collected using a survey (with a 72% response rate) of interviews with TVET principals and other selected participants (NACI, 2021). The survey revealed that "product innovation in the colleges is rare, with more cases of process innovation (in-college functional innovation)". In this case, product innovation refers to innovation produced within TVET colleges, whereas process innovation refers to innovating the various steps of creating innovation. From these findings, it can be argued that there are bottlenecks in process innovation if it does not channel out product innovation from students, or from the college as a whole. Literature identifies the lack of technology infrastructure, particularly ICT-related infrastructure as the leading barrier to the production of innovation. This reflects a support challenge in that technology infrastructure is expensive and often requires intervention from the state.

> "One of the most important findings in the NACI report is that there are few innovation leaders in TVET colleges."

This is seen as an opportune moment for the birth of more innovation leaders from using bottom-up approach (NACI, 2021). An important component not covered in the NACI report is on the key factors that cause a dearth in innovation leaders among TVET colleges. Some assumptions can be made based on existing desktop research. The NACI report found that external stakeholders were willing to partner with colleges in spearheading innovation. However, such noble intentions were undermined by the diminishing trust underpinned by capacity constraints and the commitment of TVETs to work with such stakeholders (NACI, 2021). In the case of the Malta College of Arts, Science and Technology (MCAST), it was the close relationship between the TVET college and the industry and the practical experiences of working with industry leaders, that birthed new innovation leaders (UNESCO, 2021b).

**Most TVET institutions also cite the lack of recognition from industry as a key barrier to innovation development and improving innovation capacity. There are gaps in the current leadership structures in that it limits the engagement between TVET colleges and innovators (NACI, 2021).**

A leading insight into innovation barriers from the NACI report is the governance process that "constrains innovation" (NACI, 2021: 6). NACI (2021) recommended the review and reconfiguration of existing policies governing TVETs to enable innovation and all the accompanying elements that give birth to innovation. In this case, a bottom-up approach is suggested to replace the existing top-down approach that stifles the emergence of innovation because of the underpinning bottlenecks. This suggests the need for governance systems that promote collaboration between the industry and the TVET ecosystem to tap into the pockets of innovation playing out in certain TVET colleges. In this case, industry leaders should not look at capacity constraints as stumbling blocks, but rather collaborate with TVET colleges to improve innovation capabilities and co-create groundbreaking innovation. The willingness of TVET lecturers and students to work on innovation suggests the need to create TVET structures of innovation that are underpinned by strong relationships between government, TVET colleges and the industry which can tap into the innovation opportunities in existence.

The broad literature underscores the importance of TVET colleges in the innovation system, while also acknowledging the scarcity of innovation capacity and industrial links to strengthen the envisaged role for TVET in the innovation space (NACI, 2021). Although the National System Innovation (NSI), South Africa's framework for guiding technology innovation policy and collaboration, echoes the importance of TVET in the innovation system, it is unlikely to find TVET playing a central role in the country's NSI (NACI, 2021). As such, it was recommended that TVETs be explicitly and implicitly added as important players in South Africa's innovation system. Extending the NSI to include the role of TVET could provide space to build the innovation capacity of these TVETs, while also promoting information sharing between TVET institutions and universities. The case study of Rift Valley Technical Training Institute (RVTTI) model (in Section 3) could be modelled to create an environment for TVET institutions to demonstrate their innovation capabilities within their ecosystem before they play an essential role in the country's NSI. As demonstrated in the RVTTI, it was the innovation awards (and the various innovations produced) that led to RVTTI being recognised as an important player in Kenya's innovation system. NACI (2021: 7) argues for the autonomy of TVETs to experiment on innovations and ensure such experiences are shared and communicated with other TVET colleges.

## 2.4 Summary of the NACI Report on TVET Innovation Capabilities

**A summary of the NACI report findings is as follows:**

**lecturers understanding of innovation:** lecturers generally defined innovation as underpinned by novelty, use of technology and new approaches to doing things, whereas some focused on online teaching, and 20% of the participants linked it to labour market innovation (NACI, 2021). In this context, the lecturers' understanding of innovation is limited to the theoretical component of teaching and learning.

**On innovation activities:** TVET principles predominately cited investment in equipment and capital resources (91.4%) and Continuous Professional Development (CPD) (91.4%) as innovation activities. Other innovation activities that scored high are participation in skills competitions (60%), marketing and promotion activities (54.3%) and 45.7% in development of incubators for TVET students. A concern is that only 11.4% cited patents and trademarks.

**Elements in specific innovations:** Most of the colleges (68.8%) sought to provide skills for the labour market, 62.9% provided staff with Continuous Professional Development (CPD), 60% established partnerships for business education, 57.1% focused on learning pathways, and 54.3% focused on skills competition. There was a lesser focus on the introduction to entrepreneurial competencies, with 48.6% working with SMMEs and 40% fostering the mobility of learners. Other business-related elements such as incubators for TVET learners scored lower (37.1%) (NACI, 2021).

**Barrier to TVET innovation:** The top list of barriers cited include the lack of resources (83%), lack of incentives (72%), resistance to change (65%), a lack of staff (64%) and stringent policy environment (56%). Other barriers included the non-commitment of stakeholders to collaborate, lack of shared vision and inability to respond to labour market and the lack of time (NACI, 2021).

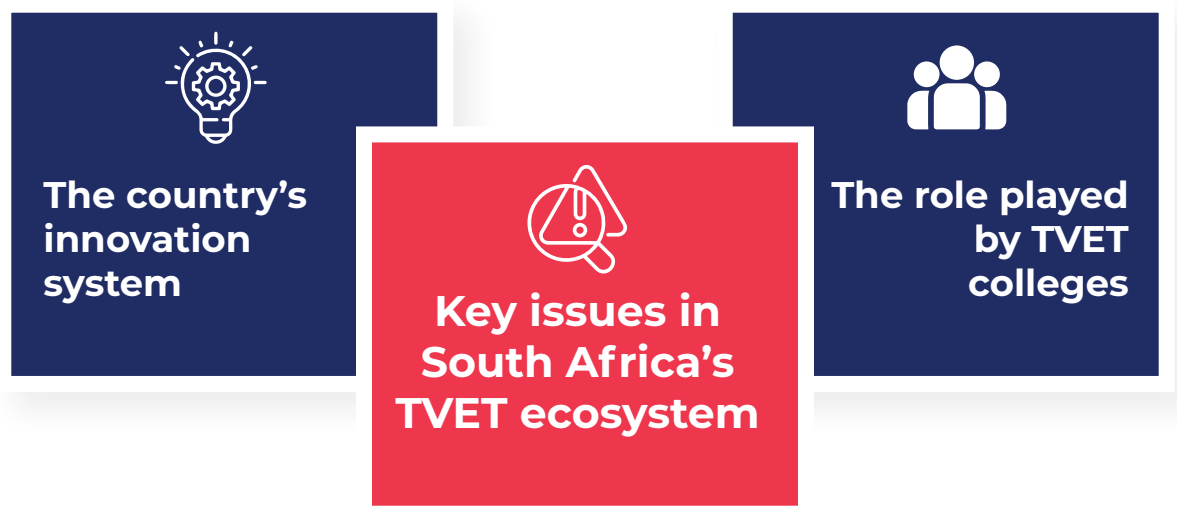
**On innovations introduced:** One product was created (a new app for the college and online teaching), five colleges cited the intention to partner with entities to deploy new innovations aligned to the colleges' vision, seven colleges introduced innovative online platforms, whereas five colleges focused on infrastructure and equipment. Some survivalist innovations focused on a guesthouse and the other on linking with a local retail store to supply agricultural goods. Some also focused on the sets of partnerships they planned to embark on (NACI, 2021).

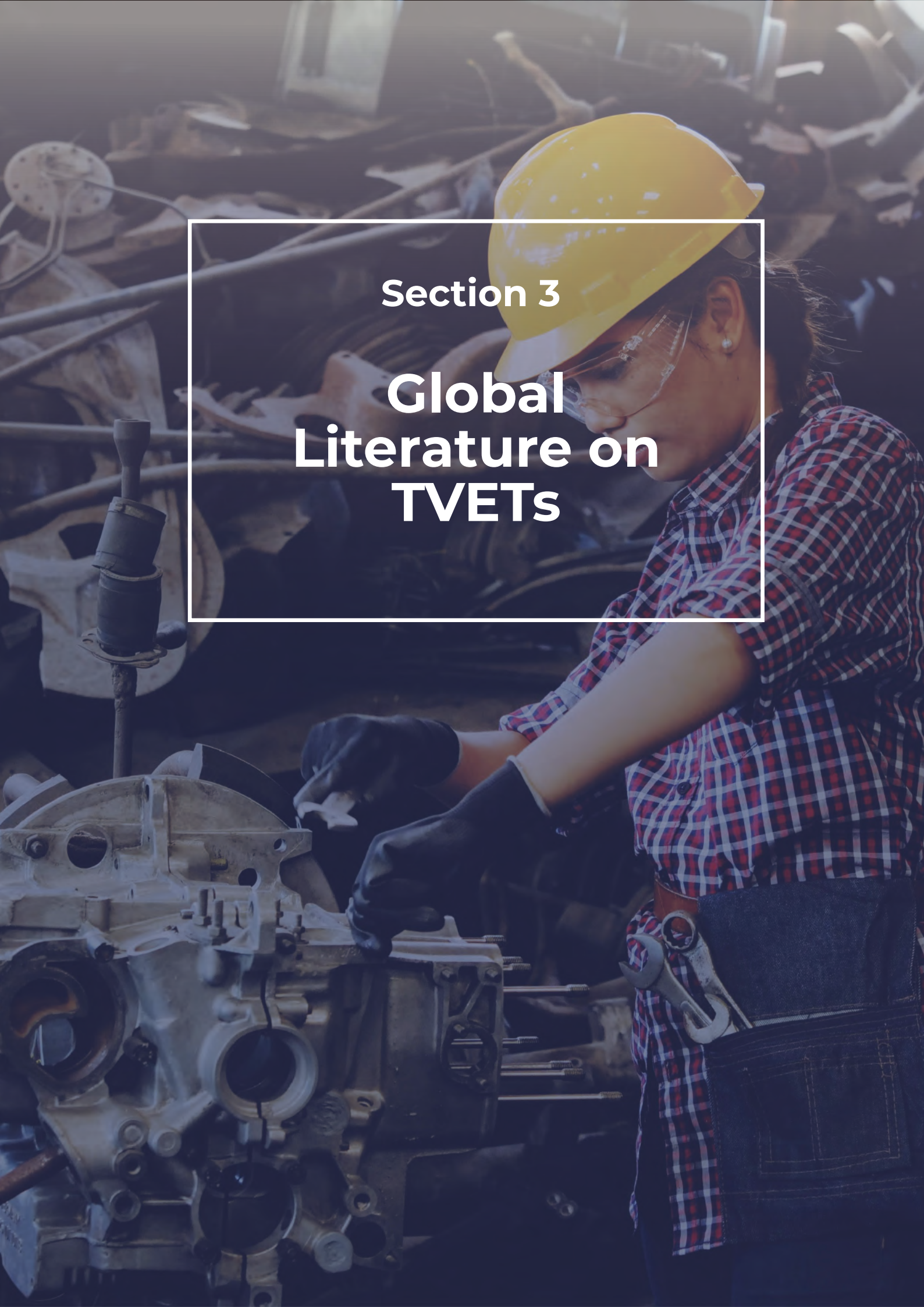
**Partnerships:** SETAs and the National Skills Fund were the main partners in innovation (reported by 88.6% of colleges). Partnerships with businesses followed with 65.7%, college trainers made up 54.3%, international organisations were 37.1%, chambers of commerce and industry were 31.4% and incubators, clusters and industrial parks made up 31.4%. This suggests low levels of incubation partnerships that are essential for the success of innovation.

**Thematic analysis of barriers:** Resources, infrastructure and incentives were cited as common challenges. TVETs' relationships with (DHET) was cited as being blocked by red-tape, and faces issues on curriculum development.

## 2.5 Conclusion

This section focused on exploring key issues in South Africa's TVET ecosystem to determine the country's innovation system in relation to the role played by TVET colleges.





Section 3

# Global Literature on TVETs

## 3.1 Introduction

TVET institutions are gaining prominence in the educational sector for delivering work-learning exposure for different kinds of skills needed by various industries. In almost all cases, such skills cannot be provided by traditional universities because of the theory-based learning approach and the lack of focus on technical skills. In certain instances, TVET colleges provide unique opportunities for students to study the more practical side of courses such as electrical and mechanical engineering skills traditionally offered in universities. Through this approach, the decentralisation of skills from universities to accessible institutions such as TVETs contributes to building a pipeline of skills for the industry. With the ever-changing labour and market demands, TVET institutions are increasingly called to play a leading role in the transition to the digital and green economy sought by the world. While this is the case, it is imperative to consider whether TVET have the necessary tools and support to play a key role in innovation systems traditionally led by universities. Furthermore, ensuring that TVET students become entrepreneurial by developing their innovations and commercialising them has become increasingly recognised. Such entrepreneurship education in TVET can assist with the high level of unemployment and underemployment of graduates from all educational spheres in the globe.

This section gives a historical overview of the evolution of TVET institutions globally, with a particular focus on why TVET institutions were introduced and the role they play in society and the economy. The first part of this section is dedicated to understanding TVET institutions in the global education landscape and the skills provided. The second part explores the role played by TVET institutions in addressing high levels of unemployment amongst the youth and the use of data from organisations, such as the ILO, to make informed decisions. The third part moves on to explore TVETs in the innovation space within the context of the 4IR. This is based on UNESCO's recognition that TVET institutions need to be central to innovation and the digitisation of skills to meet the just transition to the green economy. The fourth part presents instances where TVET colleges demonstrated student-led innovation based on the case studies of MCAST and RVTTI. These case studies shed light on what some TVET institutions consider effective approaches to creating entrepreneurial TVET campuses driven by student innovations. The last part of this section looks at the key lessons for other countries from these case studies and considers implications for building innovative TVET institutions.

## 3.2 Understanding TVETs in the Global Education Landscape

The TVET system has a long history in the development space. In tracing its history, Allais and Wedekind (2020: 323) indicate that "decades after World War II, TVET and skills development were part of the orthodoxy of human capital development approaches that were championed by the World Bank and other international agencies". This emphasis can be linked to the need to reconstruct Europe from ashes after World War II, with primary skills needed for the reconstruction of Europe firmly grounded in TVET institutions. Some authors show how, in the 1990s, the global focus on education shifted from TVET to basic education because of factors related to the perceived rates of return, and other donor priorities (Wolf, 2004). This transition resulted in TVET receiving lesser focus and can explain the disparities in funding between basic education, TVET and higher education (Zeelen, 2015). However, there has been a global resurgence of focus on TVET because of the growing labour mismatch and the need to improve local skills for employment benefits (Allais and Wedekind, 2020). This resurgence is also caused by the ever-changing labour demands brought by industrial revolutions and the need for practical skills over theory. As the world faces constant social, economic and environmental challenges that shape the direction of labour markets, so do the skills demands that inform global productivity. Hassan et al. (2021) observed that the ongoing industrial reconfigurations and changing knowledge economies established the demand for a digitally skilled workforce to contribute to innovation and development. In this context, many educational institutions are required to change and be adaptive to global trends.

This includes the growing role played by TVET institutions in the production of skills to meet modern societal and industrial needs. The TVET system is considered "a value-added portion of a general education that integrates technology, sciences, practical skills, attitudes, understanding, and information relating to employment in different economic and social sectors" (UNESCO, 2021a). As evidenced by this passage, the infusion of technology and practical skills reflects the growing need to create a society capable of utilising technological advancement to address technical challenges.

In countries like Indonesia, Philippines, and Malaysia, TVET is recognised as educational institutions with the mandate of reducing unemployment through spurring economic development. Similar imperatives were noted as TVETs were used by developed nations to improve their competitive edge in order to grow their economy through industrialisation (UNESCO, 2021a). The TVET sector is seen as an educational intersection between the skills demanded by the labour market and what educational institutions provide for young people to enter the labour market (UNESCO, 2021b). It is further established to be the social contract that binds those who did not finish high school and those who are likely to fall into the category of not being employed, or in education or training. The integration provided by the TVET education system is therefore pinned on addressing the growing rate of unemployment and destituteness among young people across the globe. As such, it is argued that TVETs should be agile and adaptive to the skills needed to make a positive contribution to society (UNESCO, 2021b). The main difference between TVET colleges and mainstream university education is that TVETs provide the broader focus on providing skills-oriented education aimed at right-skilling the youth for the workforce. Despite this clear difference, Ismail & Hassan (2013) point to the stigma associated with TVETs being created to cater for those who dropped out of secondary school for various reasons, including the ability to make it through the 'normal' educational pathway because of being less academically competent. This has resulted in TVET education being disregarded in many developing and developed countries. Such stigmas resulted in many governments working on addressing the stigma attached to TVET education because of the increasing demand for skills offered in TVETs and the need to address youth unemployment and those living in poverty.

**In Malaysia, Yusoff, Harun and Munzir (2020) note that the Prime Minister led a campaign to destigmatise TVET education and re-orient it as an educational pathway that responds to skills in critical demand.**

This approach involves the internationalisation framework underpinned by close cooperation with some Malaysian universities. Singapore adopted an innovative approach by ensuring TVET campuses have world class infrastructure and innovative pedagogies to attract emerging talent. A positive outlook sees TVET as addressing the gap between the school curriculum and the labour demand skills (Allais and Wedekind, 2020). The TVET system is considered the main provider of technical intermediary skills that respond to a country's labour market demand and ideally placed to bridge the socio-economic gaps caused by modern economies (NACI, 2021). Hence the evolution of skills is sacrosanct to the relevancy of TVET institutions in the high-paced and competitive industrial world. As the world moves to a greener economy, it becomes important for TVET institutions to reconfigure their curriculum to meet modern demands. A study with seven industrial players in the TVET space highlighted the need to infuse green technology in the TVET curriculum to ensure graduates do not miss out on such opportunities (Kalippan and Hamid, 2021). However, this sudden change needs a proper framing of the debate on transitions that happen in economies and their sustainability in curriculum development. This echoes a question on whether TVET institutions should be responsive or play a leading role in determining societal changes. Such a role could be instrumental in shaping the future of TVET institutions and their place in national development.

While much of the literature on TVET historically focused on the provision of skills to meet labour demand, there is more and more literature focused on entrepreneurship education in TVET because of growing global youth unemployment. The dominant position in this literature, is that TVET students should not only be trained to fill vacancies in the industry but should be trained and enabled to become entrepreneurs.

I new UNESCO Strategy for TVET underscores the need for national TVET systems to not only offer skills, but also entrepreneurship and job opportunities (UNESCO, 2021b). In a case study on entrepreneurship education in Ghana's TVET, Padi, Dzisi and Eshun (2022) find that while an entrepreneurship course sparks entrepreneurial intentions, social support systems enhance the potential of entrepreneurial mindset and aspirations for TVET students. In another study, Ibrahim et al. (2022: 342) found six themes on entrepreneurial research in TVET: "the need to revise current TVET educational approaches and strategies, entrepreneur intentions, the need for substantial networking with industry players, promote self-employment, foster self-efficacy and entrepreneurship motivations.". These themes are consistent with the required structures to create effective entrepreneurial support programmes in TVET.

## 3.3 TVETs in Addressing Youth Unemployment

UNESCO's Strategy for TVET 2016-2021 echoed the need to ensure all member states have TVET systems capable of equipping the youth and adults with the necessary skills to be employed in decent jobs, become entrepreneurs and play a leading role in the realisation of Agenda 2030 – the Sustainable Development Goals (UNESCO, 2016). Some progress was made prior to the COVID-19 pandemic that had a severely negative impact on the global economy. The ILO observed that the youth, the disabled and women were disproportionally affected by the impact of the pandemic that resulted in millions falling into poverty. This period also saw a significant rise in digitisation in the education system, with many TVET colleges forced to transition to online learning. Some TVET colleges were not prepared for this transition due to socio-economic disparities within countries. It still however presented an opportunity for many TVETs to embrace the digital space, and also a unique opportunity for those with entrepreneurial mindsets. UNESCO's 2022-2029 strategy titled *"Transforming Technical and Vocational Training for Successful and Just Transitions"* shows that more than 267 million youth are NEET (UNESCO, 2022). The strategy echoes fundamental principles of the youth leading the digital revolution that promotes skills development capable of empowering the youth to be at the forefront of productive employment and decent work long sought by organisations such as the International Labour Organization (ILO). Another fundamental facet is the current need to facilitate a just transition to inclusive, digital and green societies and economies (UNESCO, 2022). This transition also presents new opportunities within emerging industries such as renewable energy, and prompts TVET institutions to consider offering these technical skills to meet the growing demands. It is only through such an approach that TVET can make meaningful contribution to growing the economy and creating the required skills pool and a pipeline of talent capable of addressing challenges facing the youth. Recognising the need to create a better future for all aligned to the 2030 Sustainable Development Goals (SDGs), UNESCO has committed to supporting the TVET revolution. **Commitments include three identified priorities:**

1. Developing skills for all individuals to learn, work and live,
2. Developing skills for inclusive and sustainable economies, and
3. Developing skills for inclusive and peaceful societies (UNESCO, 2022).

**These three principles can also be linked to the SDGs:**

The first principle is underpinned by SDG 4 (ensuring quality education and lifelong learning).

The second principle is linked to SDG 8 (promoting decent work and economic growth), and SDG 11 (making cities inclusive).

The third principle reflects SDG 16 (promoting peaceful and inclusive society).

The three principles are interconnected in that they prioritise inclusivity, and skills development is at the heart of the end-goals. Given that much of the global education funds tend to flow to universities as centres of innovation and development, it becomes important to also prioritise the streaming of funds to the TVET ecosystem in the bid to address the high level of youth unemployment across the globe.

Chacaltana, Barcucci and Moreno (2024) reviewed historical data from the YouthPOL database from 1997 to 2017 focusing on youth labour market challenges. As per figure, the data shows the concentration of policies in respective countries and regions.

**Figure: Main employment challenges related to youth that the policy or law addresses, by region (percentage of YouthPOL document)**


***Source: ILO YouthPOL database (2017)***

As per above figure, most of the policies speak to the relevance and quality of technical and vocational skills throughout all regions. In this segment, Arab States (86%), Africa (75%), and Asia (72%) have policies above the global average of 61%. America (57%) and Europe (51%) scored below the global average (61%). The potential reason for Europe scoring the least is the high level of employment among the youth and that the European TVET system has worked better and is probably the most advanced. Other core areas such as social inclusion, matching labour demand and supply, school-to-work transition and financial capital scored below 50%. Interestingly, despite financial capital being instrumental to the creation of new entrepreneurs, it scored lower.

Developing nations are widely affected by mass underemployment, with the youth being disproportionally affected by this setback. Entrepreneurship has been identified as the leading solution to this problem, with a growing trend of TVET colleges being recognised as instrumental players in building entrepreneurial capabilities. In a study focusing on how TVET can be harnessed for entrepreneurship to address unemployment in Zambia, Mubanga et al. (2019) argue that unemployment reflects the underutilisation of human resources, and these problems can be addressed by enabling the entrepreneurial spirit of TVET students. For the authors, this could be harnessed by strengthening entrepreneurship education. In another study conducted in South Asia, Sudan (2021) observes the need to reorient and align TVET programs with demand skills valued by the labour market as a strategy for addressing high levels of youth unemployment.

**The common framing from both these studies is the recognition of the critical role the TVET system plays in addressing unemployment.**

## 3.4 TVETs and Innovation in the 4IR Era

The age of 4IR has been premised by many academics to bring an industrial revolution that ushers the world into digitisation of societal functions. This era also ushers in new skills and competencies that require agility in all educational phases. Abdullah et al. (2020) posit that the 4IR exposed pre-existing technological gaps between the industry and academia, with TVET being on the backfoot of the automotive engineering industry. Mainstream universities are better prepared because of their traditional role in innovation, whereas TVET are underprepared because they have been neglected in the innovation space. In the bid to address this predicament, Abdullah (2020: 51) created an automotive virtual laboratory through cloud OpenStack which "enables industries to share competency and occupational materials for maintenance and repair of light vehicle or automotive engines in the form of 3D view web, video, audio-visual that can be accessed by students, lecturers in enriching aspects of repair and maintenance skills". The innovativeness of this approach is the timeliness of working with industry to provide insight on the required skills and trends in the automotive industry. Such an approach enhances the proximity of TVET to industry and ensures a match in skills supplied versus labour demand. Embedding TVET within technological advancement requires the alignment of the TVET curriculum with skills needed in the future to ensure the agility of workers in taking advantage of available digital technologies. Some of these skills include big data and analytics, robotics, sophisticated manufacturing, cloud computing and many more skills identified in the future of work (Mohammad, Low and Rahman, 2019). In adding the element of gaining knowledge and project-based training, it is essential to ensure learning includes problem solving, creativity and emphasises the development of competencies (Abudullah et al., 2020). This ambitious approach to TVET education is undermined by the lack of technological infrastructure and facilities and limits the creativity of students (Mustapha et al., 2019). In Nepal, a study on e-learning initiatives at TVET colleges showed that despite the advantages of e-learning, the lack of infrastructure and training support for TVET lecturers remained a barrier (Pangeni and Karki, 2021). These challenges are underpinned by limited investment in the research and development carried out by (and on) TVET colleges because they are not considered traditional innovation and development structures.

**This echoes the need to ensure TVETs are given the right mandate to contribute to research and development which would facilitate the appropriate investment in infrastructure to enable them to make a meaningful contribution to innovation and national economies.**

The issue of infrastructure underpins many important factors in the success of the TVET system. Given that there are various types of infrastructure required for the success of TVET, it becomes important to define the kind of infrastructure needed to support innovation. Hu Tan and Seet (2020: 111) make a distinction between two kinds of infrastructure; "the design of the TVET campuses and the setup of training facilities within these campuses".

In the Fourth Industrial Revolution (4IR), both these facets are important and need to align to maximise the skills offered by TVET. While the traditional focus has been on the design and existence of TVET structure, innovation-led development has brought emphasis on facilities within these campuses. Facilities such as internet services, computers, software programmes and many others are key to enabling innovation. Hu Tan and Seet (2020) argue that Singapore has the leading and idolised TVET because of the country's ability to invest in infrastructure development and pedagogy innovation. Human capital plays a leading role in the innovation process as it is underpinned by critical skills that can be imparted from one person to the next. Clifton (2020) highlights Fourth Education (education in 4IR) as being instrumental in training students to be producers of innovation, rather than being consumers of innovation. Using the case study of Malaysia's system of Learning Organisation in six TVET colleges, Clifton (2020) finds that Innovative Work Behaviour positively influences the innovation of teachers and notes the need to enhance learning organisations within TVETs "to form an innovative culture, encourage the generation of new knowledge, diffuse and transform the knowledge for the application to the improvement of the organization's activities, thus enhancing the innovation capability" (Clifton, 2020: 64). Such emphasis is based on the recognition that the competencies and skills of TVET lecturers affect the readiness and employability of students. Additionally, such competencies also frame whether learners will have aspirations to be innovators. This is notable in a study that finds that "ICT technologies and application dispersion into TVET training cycle system components/functional areas is very low" (Hassan et al., 2021). An important consideration is how TVET colleges are planning to streamline their mandates with the UNESCO's 2022-2029 strategy. A study by Pavlova and Askerud (2023) on innovation and the transition to the green economy in Euro-Asia noted the distinct skills required for innovation and the green economy. A further study by Pavlova (2019) showed that the new environmental industries emerging in response to the need to fast-track and mitigate climate change has resulted in a demand for new skills. These new skills are in the domain of the TVET ecosystem and require strategic responses capable of developing innovative programmes to access them. The case studies of Hong Kong, China, India, and Malaysia, according to Pavlova (2019), show that integrating a green future into the curriculum in China and Hong Kong needs to be applied from a lifelong learning acquisition approach by focusing on all levels of education to inculcate a mind shift from early childhood. On the other hand, Malaysia and India have done a great job in merging policy, education and industry in their approaches to the new skills required (Pavlova, 2019).

## 3.5 Case Studies of TVETs and Innovation from Students

While TVETs are responsible for providing the necessary infrastructure to enable innovation, students have the agency to create innovations from TVET-enabled infrastructure. In section 3.4, the focus was on the TVET institutions and innovation in the 4IR era. It is also important to focus on students as the unit of analysis in the innovation system. In a study on the effect of entrepreneurship education on student innovation capabilities in Kenya's TVET sector, Mbore (2021) finds that although students were interested in becoming tech entrepreneurs, the absence of a conducive learning environment because of the lack of facilities to enable innovation from students, prevents them from doing so. This is a general predicament in many developing nations - where there are limited budgets to procure technology infrastructure for the education sector, particularly in basic education and TVETs. These challenges limit the innovative edge of students, and this is explained by the residual contribution of innovation to development. This challenge has led to UNESCO emphasising innovation-enabled TVET colleges as the future of inclusive economies and economic development. The ILO underscores that affording and deploying digital technologies will result in new opportunities (Grech and Camilleri, 2020).While the case study in Kenya reflects challenges in making innovation and entrepreneurship work, there are case studies that present models of making entrepreneurship education and innovation work in some countries. It therefore becomes important to reflect on case studies that demonstrate some unique approaches to enabling innovation and entrepreneurship education in TVET. In the context of this report, the case studies are relevant to showing innovation led by students and supported by the TVET, thereby showing the role of leadership in creating an enabling environment to spur innovation.

**Some of the case studies are as follows:**

## 3.5.1 The Case of Malta College of Arts, Science and Technology (MCAST), Paola, Malta

UNESCO provides a comprehensive case study of making entrepreneurship and innovation work through the case study of MCAST. In 2011, in response to the socio-economic challenge of businesses needing to create more employment opportunities, Malta established an entrepreneurship and entrepreneurial learning programme to support successful business creation that can staff more than fifty people (UNESCO, 2020). The Matla case is based on four dimensions:

Figure 3.1: Dimensions of Analysis (MCAST)


Source: UNESCO (2020)

As per figure, MCAST focused on collaboration with businesses, embedding students in the building of products and services with the business sector, a strong curriculum focusing on entrepreneurship, and the creation of a culture centred on entrepreneurship and innovation throughout the different curriculum offered (UNESCO, 2020). Firstly, MCAST's curriculum utilised innovation teaching and learning approaches by using simulation-training centres to enable students' real life industrial experience through all faculty educational pathways. The teaching and learning also involves learners working together in executing business ideas and plans, while teachers are empowered through teacher training programmes and getting practical experience in leading entrepreneurial projects. For MCAST, entrepreneurship education is not just for students, but for teachers as well, thereby creating a healthy entrepreneurial culture (UNESCO, 2020). MCAST's entrepreneurial strategy is hailed for its innovative approach in spurring entrepreneurial intentions in a collaborative manner.

According to UNESCO (2020: 49) "One example is the new Entrepreneurship Centre on campus – a top-down initiative that created space for teachers and learners to experiment with new methods". Such an approach is important because it enables space for teachers and learners to put their ideas to test in an entrepreneurial environment, thereby providing space for learning and innovating. This approach is enhanced by the close relationship between the TVET and the industry, with incubators and mentors, including the use of MCAST's incubator programmes to test ideas. Lastly, the industry plays a critical role in exposing teachers and learners to the latest trends in the industry and in informing the design of the curriculum to meet industry needs (UNESCO, 2020). Such opportunities allow TVET students to access mentors and industry leaders capable of facilitating the capital and innovation-thinking needed to make businesses succeed. This case study demonstrates the strong relation between innovation and pedagogy and its impact in creating the next generation of capable entrepreneurs.

## 3.5.2 The Case of Rift Valley Technical Training Institute (RVTTI), Eldoret, Kenya

Kenya is one of the most innovative and entrepreneurial African economies. This is not only demonstrated through the country's dynamic fin-tech industry, but also through the filtering of innovation to local structures in the informal economy. The Kenyan case study demonstrates the evolution of how demonstrating technical innovation resulted in tapping into the entrepreneurial aspirations of Kenyan students. According to UNESCO (2020: 51), "RVTTI is recognized as a relevant player in the national innovation system and is seen as a centre of quality management among TVET institutions". This is based on the role played by the TVET in increasing the innovation capability of students, while also increasing their competencies to enter the labour market as innovators and entrepreneurs. **RVRTI recognised that the lack of funding for innovation stifles the growth of local innovations, and this led to the introduction of the Innovation Awards in 2015. The awards focused on harnessing innovations that can be commercialised and lead to employment creation.** Years later, the Innovation Awards are recognised as the leading avenue for showcasing TVET innovations (UNSECO, 2020). It is such results that lead to TVET systems being recognised as integral players in national innovation systems. However, only a few countries have reached this feat. F

UNESCO (2020) identifies four critical factors to the success of RVTTI. First, it is the ability to introduce innovation into an ecosystem that previously did not cater for TVET innovations as per figure 3.2.

Figure 3.2: Dimensions of Analysis (RVTTI)


Source: UNESCO (2020)

Second, it was the ability of the TVET to establish incubation and mentoring platforms for students. Thirdly, RVTTI set a milestone by becoming the centre of innovation by embedding innovations within societal needs. Lastly, the ability of the leadership to align all priorities in an innovation-led approach ushered a new wave of thinking about innovation in the TVET system. RVTTI's approach not only focuses on Kenya's 2030 strategy "on digitalization, greening and entrepreneurship" (UNESCO, 2020: 52), but aligns well with UNSECO's 2022-2029 strategy on Transforming Technical and Vocational Training for Successful and Just Transitions. UNSECO (2020) observes that the innovation awards also provided teachers and students with the motivation to be competitive, thereby instilling a culture of entrepreneurship and innovation. RVTTI's success is also echoed in its ability to link innovation with research and development. However, a fundamental problem is that only a few TVET colleges have research and development offices, let alone the capacity to run them effectively.

## 3.6 Lessons for Other Countries

It is important to reflect on key lessons for building effective structures for dynamic and innovative TVET institutions. The literature has shown that TVET colleges across the globe are critical for producing skills for the current and future workforce. While some are capable of producing such skills, there are concerns that the lack of infrastructure and funding to support TVETs limit the emergence of innovation. In most cases, funding for infrastructure needs to target the building of modern TVET institutions capable of housing the latest technologies to attract students and other stakeholders that play an important role in skills development and product creation. The case of Singapore is unique because it focused on ensuring TVET infrastructure is equivalent to university infrastructure and pedagogies promote innovation (Allais and Wedekind, 2020). Such an approach creates a conducive environment for students to see TVET institutions as appropriate mechanisms for venture building and wealth creation. In comparison, some cases of Malaysian TVET institutions show that infrastructure (particularly ICT infrastructure) deficits undermine the creation of TVET-led innovation. Such challenges limit the contribution of TVET systems to national innovation systems. The case of MCAST is important in demonstrating the importance of an entrepreneurial TVET embedded in resolving societal challenges. In this case study, MCAST resolved to increase the creation of businesses capable of employing more than 50 people to bolster mass employment in Malta. Building the entrepreneurial TVET approach in collaboration with existing businesses and industry, facilitated many avenues for students to increase their entrepreneurial awareness, mindset and intentions. The availability of incubator spaces, mentors and role models in one ecosystem created a healthy entrepreneurial environment to birth innovation. As shown in the case study, the use of simulation-training centres strengthened product development for students and the market (UNESCO, 2020). A key takeaway from this case study is that entrepreneurial training and practice should not only be limited to students, but teachers should play a key role as well. In the case of MCAST, such an approach allowed teachers to experiment with entrepreneurial ideas in collaboration with students, thereby providing a space to learn and improve. Literature on entrepreneurship education shows that teachers without entrepreneurial intentions do not produce entrepreneurial and innovation-driven students. The case of RVTTI demonstrates key lessons in building a pipeline of innovators based on the first step taken by the TVET college. To recap, RVTTI introduced a programme focusing on improving the innovation capabilities of students and this was stimulated through the innovation awards (UNESCO, 2020). Students were provided with platforms to demonstrate their innovations, and the leading innovations were selected for funding and product development. This approach resulted in more students innovating and getting support from the incubation processes created by RVTTI. Based on this innovative idea, RVTTI managed to improve the TVET ecosystem within Kenya's innovation system.

> "The key lesson is that strategic support for innovative ideas and an entrepreneurial-driven TVET is likely to create more impact if it is supported from the top. Secondly, the ability to link TVET with national development imperatives has the potential to unlock support and recognition from relevant structures."

## 3.7 Conclusion

TVET education is an essential component to building a pipeline of skills capable of supporting national economies and alleviating the burden of importing skills. This literature review explored the role of TVET in modern societies and economies, with a particular focus on the innovation component of TVET systems. The literature shows that while some TVET institutions are innovative and capable of building innovations, the lack of infrastructure support undermines this sector's role in innovation, research and development. Evidence from countries such as Malaysia, Kenya, Nigeria and many more shows that the entrepreneurial focus of TVETs is not receiving sufficient attention from leaders in the education landscape. However, the cases of Singapore, Malta and Kenyahave successful case studies of innovation in TVET institutions.

# Section 4

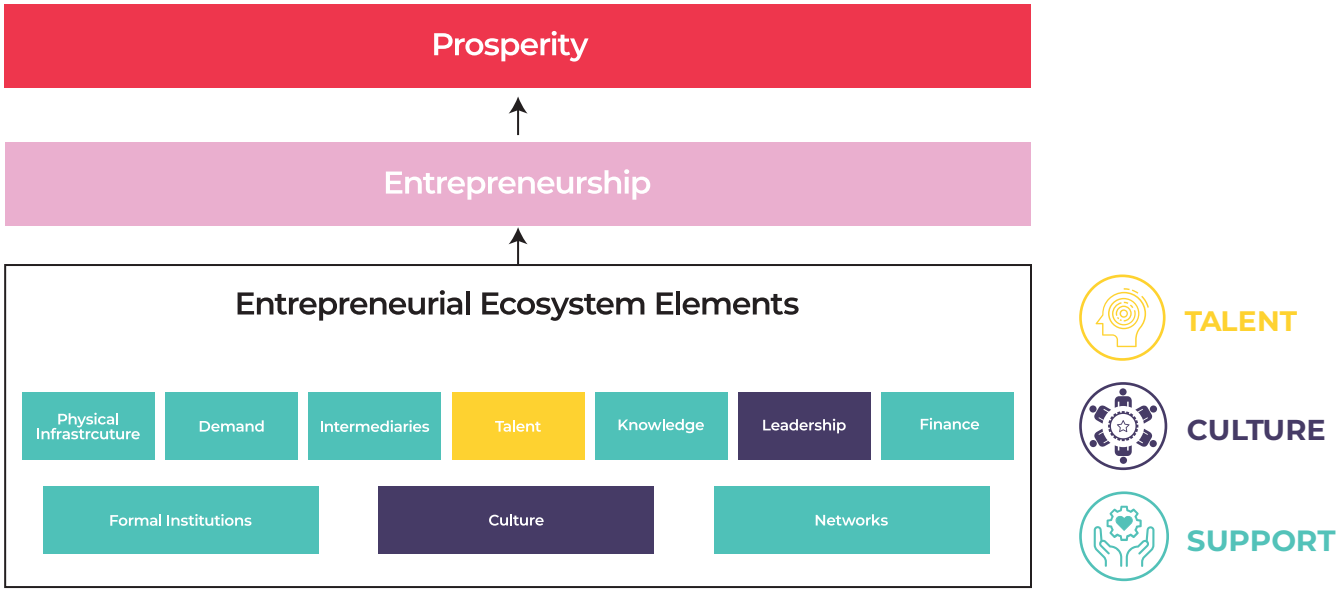
# Methodology

## 4.1 Methodological Approach

There is a growing body of literature focused on explaining entrepreneurship from an ecosystem perspective. Spigel (2017) observed that entrepreneurial ecosystems emerged to explain the abundant growth of entrepreneurship activities in a particular region. For others, the entrepreneurial ecosystem is informed by the notion that everything occurs within an ecosystem informed by several variables that influence the health or strength of that system. Cavallo, Gezzi and Balocco (2019) underscore that the entrepreneurship ecosystem provides a systematic view of entrepreneurship embedded in a complex system that brings together several factors that inform entrepreneurship. This observation is consistent with business ecosystems interpreted as "an interdependent network of self-interested actors jointly creating value" (Bogers, Sims and West 2019). Adopting a systems view of the entrepreneurial ecosystem is important because it moves away from the notion that people are born entrepreneurs, to a context where ones surrounding informs entrepreneurship.

Within the ecosystem approach, ten elements are identified by Stam (2015) as enablers for entrepreneurship. These include physical infrastructure, finance, institutions, culture, knowledge, networks, demand, intermediaries, demand, leadership, and talent, as depicted in Figure 4.1.

Figure 4.1: Entrepreneurial Ecosystem Framework




Source: Modified from Stam (2015)

Essentially, these identified elements determine whether a region's entrepreneurial initiatives will prosper, or be stifled based on the condition of these elements. While the entrepreneurial ecosystem framework is mainly applied across Europe, this paper considers the framework in the context of a developing country through the case study of mapping innovation entrepreneurship in South African TVET colleges. The methodology for this study included a survey questionnaire designed for all TVET campuses in the country. Given that this study is an ecosystem mapping of the entire TVET sector, it was important to include all colleges. South Africa has 50 TVET colleges, with many having different campuses that are unique in terms of geography, demographic backgrounds, campus specialisation and varying institutional capacities. Therefore, to create representation and a true reflection of each TVET, the study aimed to enrol all 50 TVET colleges. However, only 34, 68%, responded. The ecosystem approach adopted in this study is deemed suitable because it uses a multidimensional overview by focusing on ten specific elements. The entrepreneurial ecosystem elements and attributes are considered key for producing an environment capable of spurring entrepreneurial investment, innovation, firm competitiveness and economic developmental outcomes. This approach is therefore important because it takes into consideration the environment for innovation and the enabling factors.

## 4.2 Survey Questionnaire

The survey questionnaire was developed using the ten conditions of the entrepreneurial ecosystem, as shown in Figure 4.1. The operationalisation of these elements is also included in Table 4.2, where the questions to be asked for each element are also included. The survey was digitised and administered online to all TVET campuses in the country.

TVET principals and other relevant authorities were key participants in the study. These individuals important key because they have the institutional knowledge of their TVET colleges. Existing work in the TVET colleges through Allan Gray Makers increased buy-in and improved survey completeness.

The data was collected from 34 out of the 50 TVET colleges in South Africa, a 68% response rate. The remaining TVET colleges will still have the opportunity to complete the survey, the results will be updated on the anticipated dashboard.

## 4.3 Data Analysis

Data analysis will be conducted through Microsoft Excel as the statistical software for managing and analysing the data collected. The data has been handled and interpreted by experienced data scientists and all protocols are followed to ensure data is handled in a manner that follows research ethics guidelines.

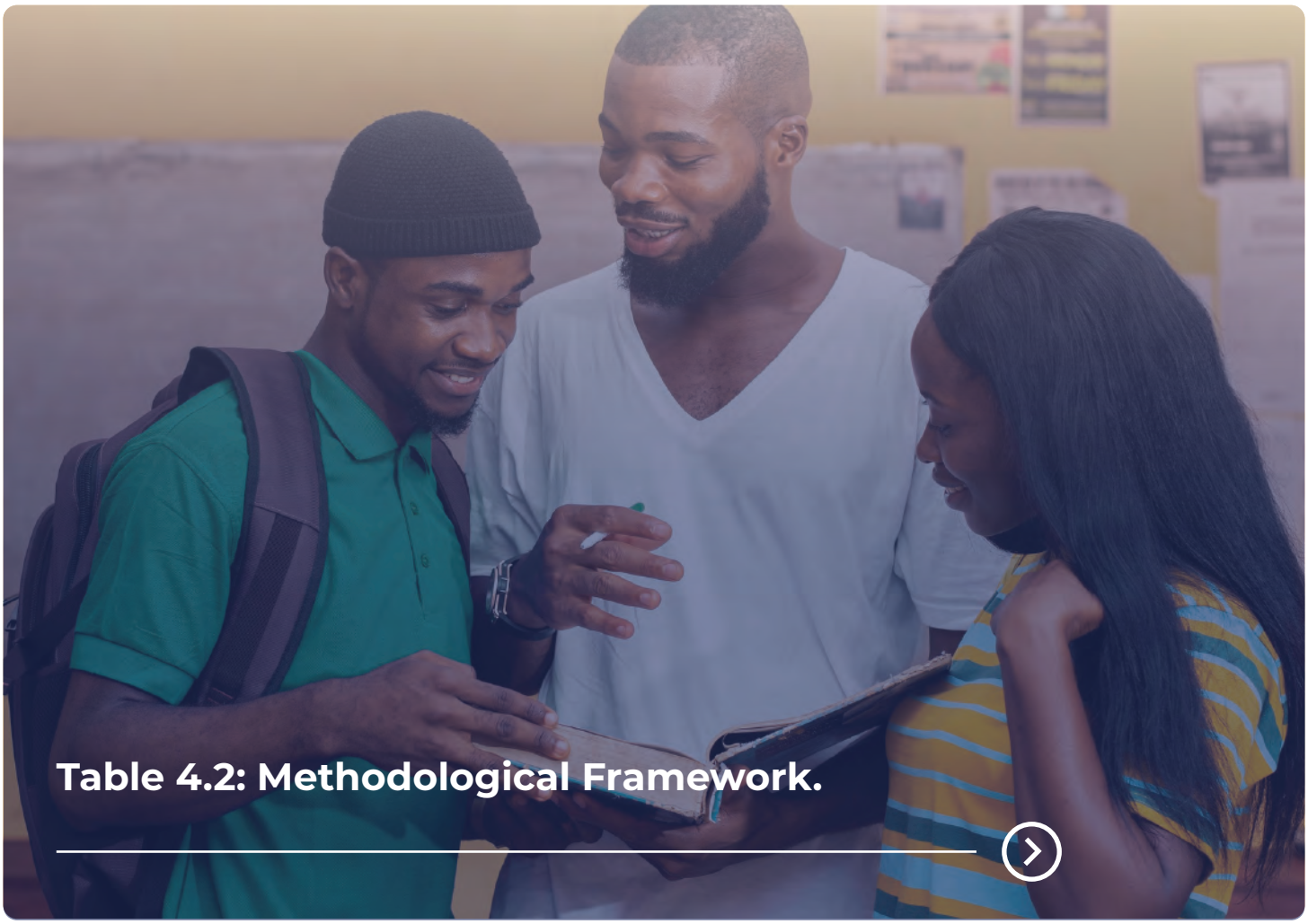


**Table 4.2: Methodological Framework.**

| Elements | Empirical Indicators | Elements/Empirical Indicators (specific to tech entrepreneurship innovation) |
|---|---|---|
| **Physical infrastructure** | Incubator spaces, available labs, internet access, maker spaces (fab labs). | What type of tech innovation infrastructure exists? Is it functional and do students have access to it? How often is it currently used? How do we increase utilisation? |
| **Finance** | Finance received and attracted by the TVET for entrepreneurship or innovation, funding received from DHET, Funding received for entrepreneurship programmes, students funded by incubators, funding from networks, entrepreneurship funding received by students | Are you receiving funding for tech innovation and tech innovation training and development? % funding for entrepreneurship support and development, % funding for entrepreneurship within the knowledge economy vs trades, % finance to invest in small businesses emerging from TVETs.Types of sources of funding – e.g. government, private sector? Stages of finance provided – startup, ideation, growth, etc. Incentives to attract funding. |
| **Formal Institutions** | Relationship with government agencies (local, regional, provincial and national), existence of entrepreneurship policies. | Who are your key government supporters for tech innovation? And innovation within the knowledge economy? |
| **Culture** | Number of students with entrepreneurial aspirations and mindset, number of students with businesses, number of new innovation-led ventures, number of students participating in pitching competitions. | |
| **Talent** | Number of TVETs in region, enrollment targets, graduation throughput, % of graduates employed, lecturers' level of qualifications, existence of a minimum requirement policy, number of lecturers with entrepreneurship experience, gender split | What % of students are actively involved in tech innovations? What % are referred for tech innovation support? What is the student's level of awareness of tech innovation? Workplace learning? % of youth interested in Entrepreneurship within the innovation sector, within the knowledge economy innovation sector, and other (such as trade etc.) |
| **Leadership** | Permanent/acting principal, entrepreneurship role models working with the college, presence of Deputy Principal for Innovation and Development, permanent or acting executives. | What is the lecturer's level of awareness of tech innovations? Work integrated learning. What training and development interventions are available for lecturers? Who provides the training and development services and support? Is training accredited? % lecturers receiving training in entrepreneurship and innovation, and at what rate.<br><br>Level of support for the TVET from entrepreneur and innovation support hubs? How often are these facilities and services utilized to supplement offering from the TVET in the entrepreneur innovation sector. |
| **Networks** | Relationships/partnerships with businesses, relationships with chambers of commerce, relationships with ecosystem players. | Who are the network and industry partners for tech innovation? What support is provided by them?<br><br>Innovation entrepreneurship support versus location and resources of the TVET. |
| **Intermediary Services** | % graduates/students with businesses incubated, relationship with innovation support organizations, Number of incubators where TVET is located, market share of incubated businesses, etc.<br>% graduates in innovation entrepreneurship programmes. %graduates in entrepreneurship (knowledge economy)<br>% graduates in trade and other types of entrepreneurships. | Who are the key intermediary support partners? What is the nature of the support (financial / non-financial)<br>Is there a CfERI? [About CfERI tech innovation outputs; governance] |
| **Demand** | Demand for enrolment/space in the TVET, skills in demand, products produced by students/graduates, value chains, etc. | What is the main course enrolment (by 1st year intake)?<br><br>Incentives to commercialise innovations, incentives to attract potential firms/government to aid commercialization at TVETs. |
| **Knowledge** | % of budget spent on Research and Development, innovation emerging from the TVET, relationship between TVET and industry, %budget spent on commercialisation of innovations, number of prototypes created by students, prototypes patented<br><br>Publications (popular or academic) produced on the topic of innovation and entrepreneurship. | Who are the key industry partners and what is the nature of their support (financial / non-financial)? |

Source: AGGP_SA

The next chapter focuses on the data analysis and provides trends that emerged from the results of this study.

## Section 5

# Data Analysis

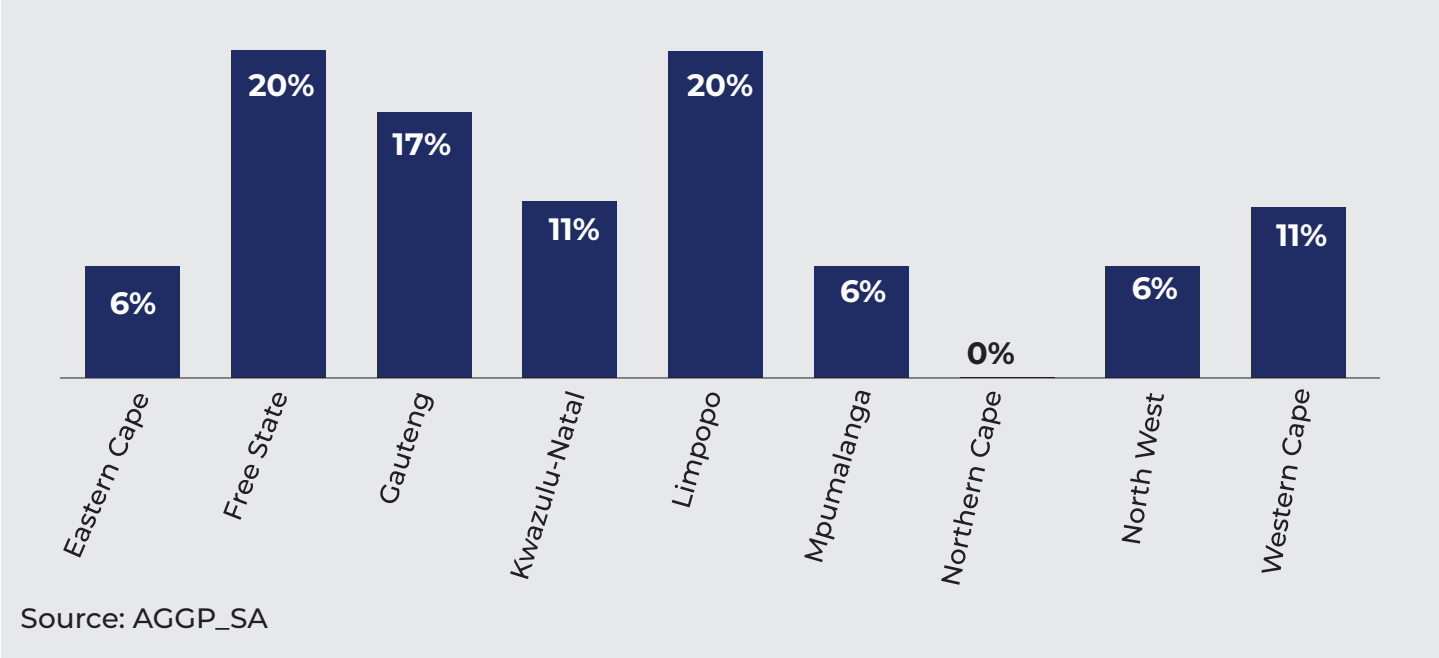
## 5.1 Introduction

This section presents an analysis of the data collected from TVET principals and lecturers across the country. The data is organised based on the entrepreneurship ecosystem methodological framework. A descriptive analysis of the data is undertaken to showcase the respondents' views and dominant trends. The analysis is first presented from the demographic background of the TVET colleges, mainly focusing on where most TVET colleges are located. Thereafter, the data is divided by ten conditions.

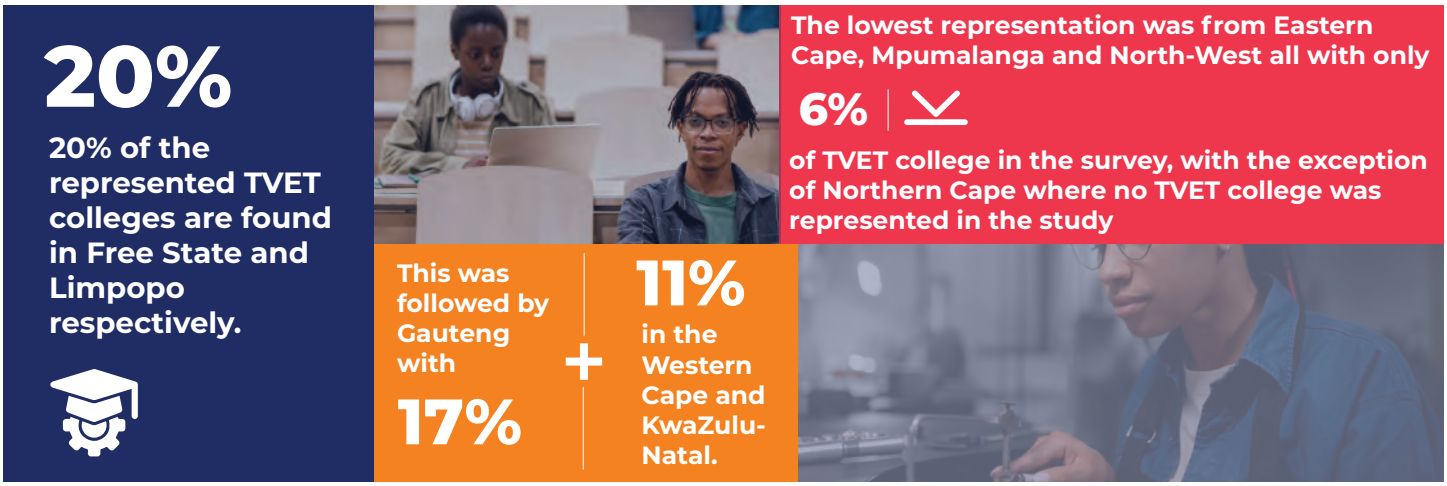
## 5.2 Data Analysis

South African TVET colleges and campuses are spread throughout the country, in urban areas, small towns and rural areas. This was important to ensure inclusivity of the various geographical locations. Figure 5.1 shows the provincial distribution of TVET colleges that participated in this study.

Figure 5.1: Provincial Location of TVET colleges Participating in the Study




Source: AGGP_SA




The low rate in North West reflects the fact that the province only has two TVET colleges. The high rate of response from Limpopo and Gauteng is to be expected as there are many TVET colleges in these provinces. The Free State only has four TVET colleges, yet had a high participation rate.

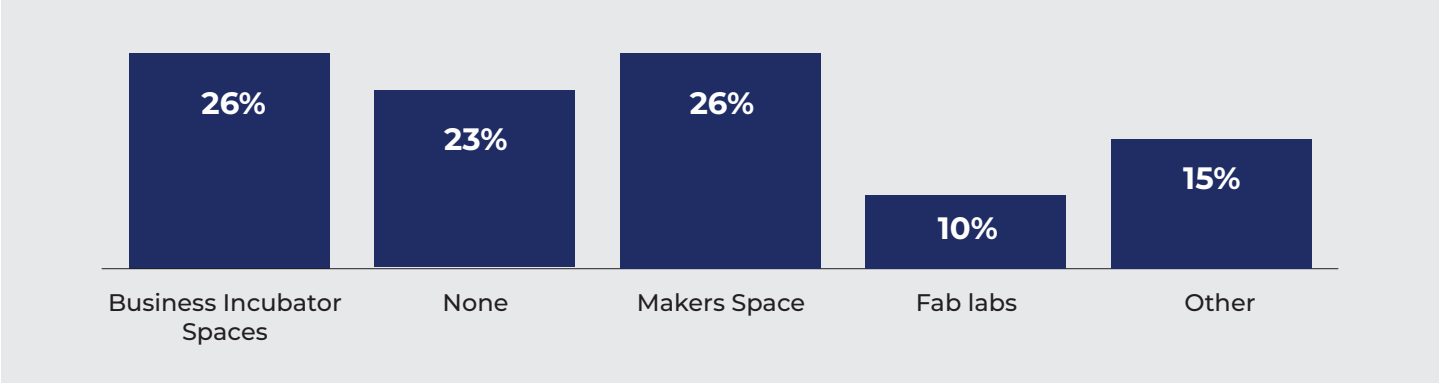
## 5.3 Data Presentation: Ten Factor Framework

**5.3.1 Physical infrastructure: There is insufficient and ineffective access and use of physical infrastructure to support innovation with 75-90% of TVETs having no access to Maker Spaces, Fab Labs or Incubators and a 45% usage rate of existing equipment.**

Physical infrastructure in the innovation space plays a critical role in providing access to inputs for innovation to be housed and emerge. For the purpose of this study, physical infrastructure refers to all hard innovation input components, such as incubator spaces, existence of fab labs, etc. These are important innovation inputs with a direct impact on the quality of innovations produced. Incubating spaces and their infrastructure are important for the testing of ideas, information sharing and improving products. Most of the TVET respondents (59%) indicated that their colleges do not have incubator spaces, whereas 41% of the participants indicated that their colleges did have incubator spaces. Of the total TVET colleges with incubator spaces, 36% are in the Free State, 21% are in the Western Cape and 14% are in Gauteng and North-West, respectively. 7% of these colleges were found in Limpopo and Mpumalanga, respectively.

The infrastructure component had an additional question on the kind of innovation infrastructure present in TVET colleges as outlined in Figure 5.2.

Figure 5.2: Types of innovation infrastructure in TVET colleges



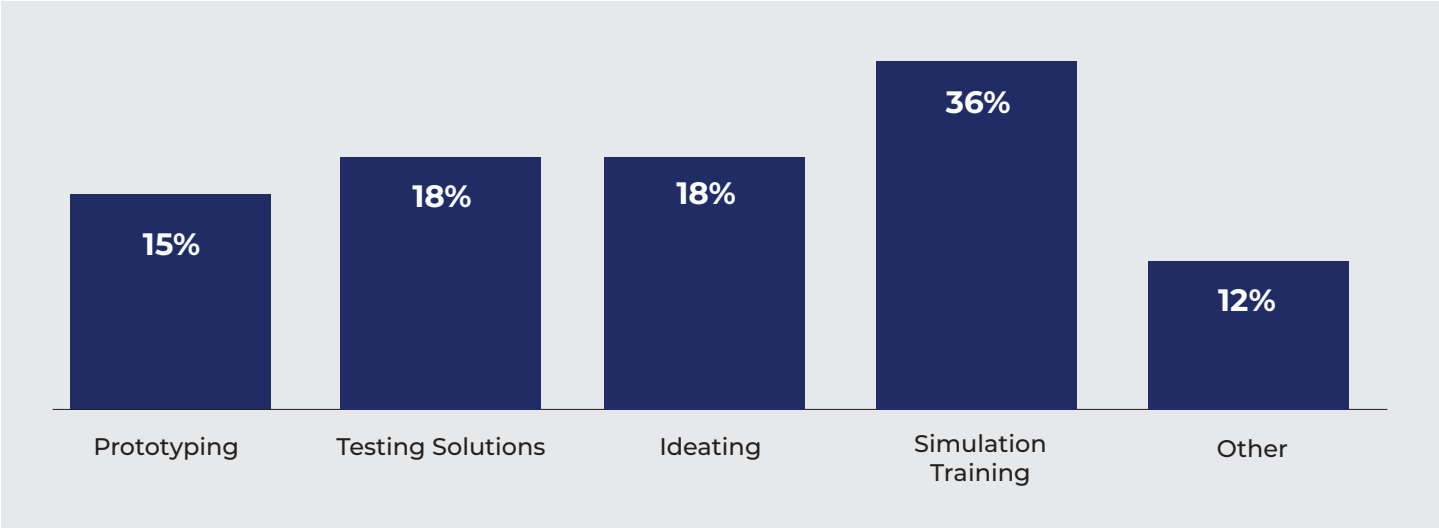

**Source:** AGGP_SA

As per figure 5.2, 26% of TVETs have Business Incubator spaces and another 26% have Makers Spaces, and only 10% have Fab Labs. Overall, 15% of TVETs indicated that they have other types of innovation infrastructure. The majority of the TVETs that selected 'other' mentioned the use of hotel schools and farms. On the utilization of this infrastructure, 55% of participants indicated that it is currently not in use, whereas 45% indicated that it is used.

A provincial breakdown of these statistics shows that Free State had the largest share of TVETs with incubator spaces (7%) and Makers Spaces (7%), followed by Gauteng and the Western Cape both at 4%. No colleges from KwaZulu-Natal and North West reported having incubator spaces.

A critical element was the purpose of the existing innovation infrastructure. Figure 5.3 shows that the infrastructure was mainly used for simulation-training (36%) with few listing innovation and entrepreneurship linked activities such as ideation, prototyping and testing of solutions.

Figure 5.3: Primary use of innovation infrastructure




Source: AGGP_SA

Only 18% of the participants indicated that the infrastructure is mostly used for testing solutions, followed by 18% for ideating and 15% for prototyping, with an additional 12% using it for other purposes. While the infrastructure exists, it was important to consider whether students are equipped to use the infrastructure. Many of the TVETs (38%) indicated that the students were not trained to use the infrastructure, and 31% indicated that students were only partially trained. Only a third indicated that students were trained to use the infrastructure.

This is an underutilisation of what infrastructure exists and also presents an opportunity to train more students to increase the usage of existing infrastructure. Provincially, Limpopo (11%) and Free State (17%) hosted most TVET colleges that use the infrastructure for simulation training, with KwaZulu-Natal (8%), Eastern Cape (8%) and the Western Cape (4%) dominating the non-use of infrastructure. Free State and Gauteng were the two provinces that had the highest share of using the infrastructure for ideating.

Internet access plays an important role in determining the levels of innovations produced because of the ease of access to information. For this study, the data showed that all campuses and colleges provide internet access for their students.

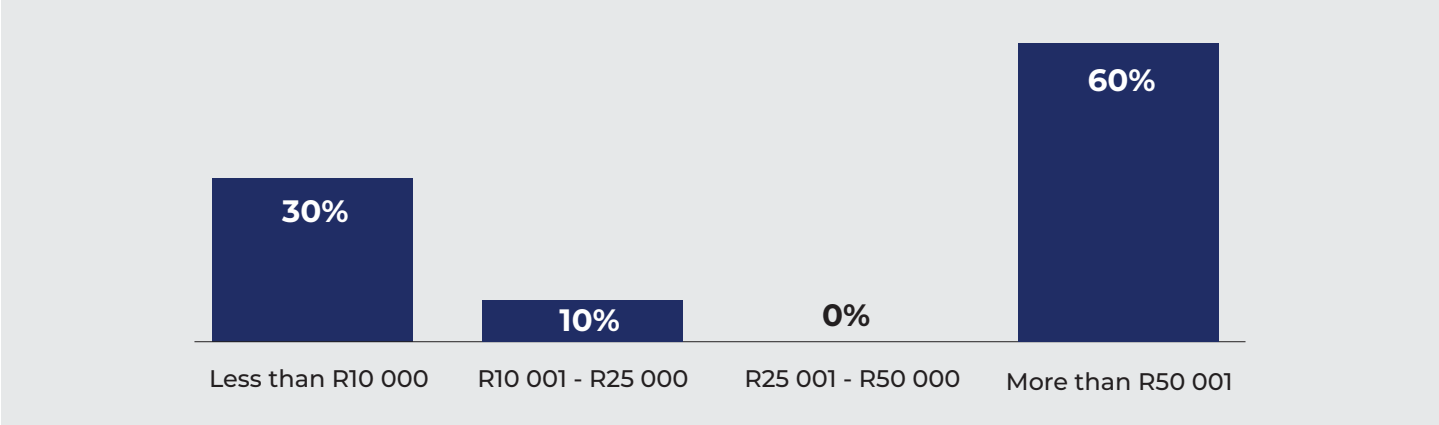
### 5.3.2 Access to finance: There is little financing for TVETs to invest in innovation with almost half of TVETs receiving less than R10 000 annually for innovation and 44% of TVETs spending less than 5% of budget on innovation.

Access to finance plays a prominent role in supporting innovative and entrepreneurial aspirations. For the South African context, access to finance is important because ventures are unable to take off without any financial support from the state and other private funders.

The access to finance component therefore sought to understand funding avenues for the TVET ecosystem and its entrepreneurs. The data analysis revealed that 61% of the surveyed TVET colleges do not receive funding for innovation. Only 39% indicated that they do receive some kind of funding - the extent and sufficiency of this funding is presented in figure 5.4.

Respondents were also questioned about the value of financial support they receive annually for innovation support. Figure 5.4 shows the various value benchmarks received by TVET colleges.

Figure 5.4: Value of financial support received annually for innovation.

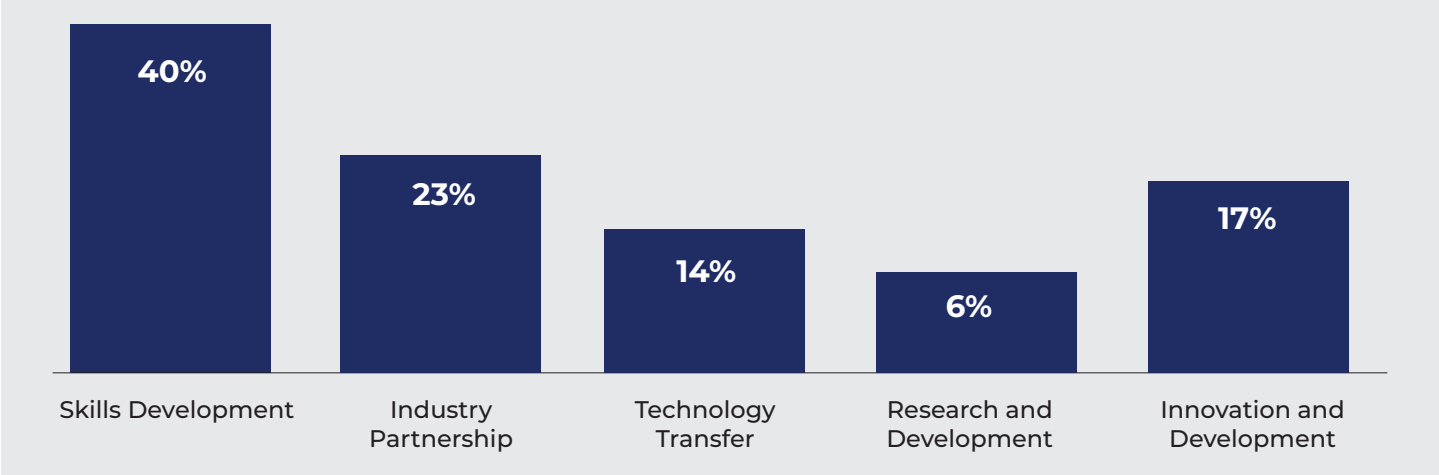



Source: AGGP_SA

In response to this question, 30% of the respondents indicated that their TVET colleges received less than R10,000 annually for innovation, followed by 60% that received more than R50,001 annually, with 10% recieving R10 001 - R25 000. This is evidence of the lack of funding support to encourage innovation. It was important to establish the source of the funding received by TVET colleges. The government was the largest funder of TVET colleges (65%), followed by the private sector (23%), and other sources making up 12% (NGOs and other funders) of the funding stream. This phenomenon was prevalent in all provinces, thereby showing the strong reliance of TVETs on state support.

Most of the TVET colleges provided some form of innovation training support (70%), with the remaining 30% not providing any support. Figure 5.5 shows the different kinds of innovation training and support provided by TVET colleges.

Figure 5.5: Types of innovation training and support provided by TVET colleges.




Source: AGGP_SA

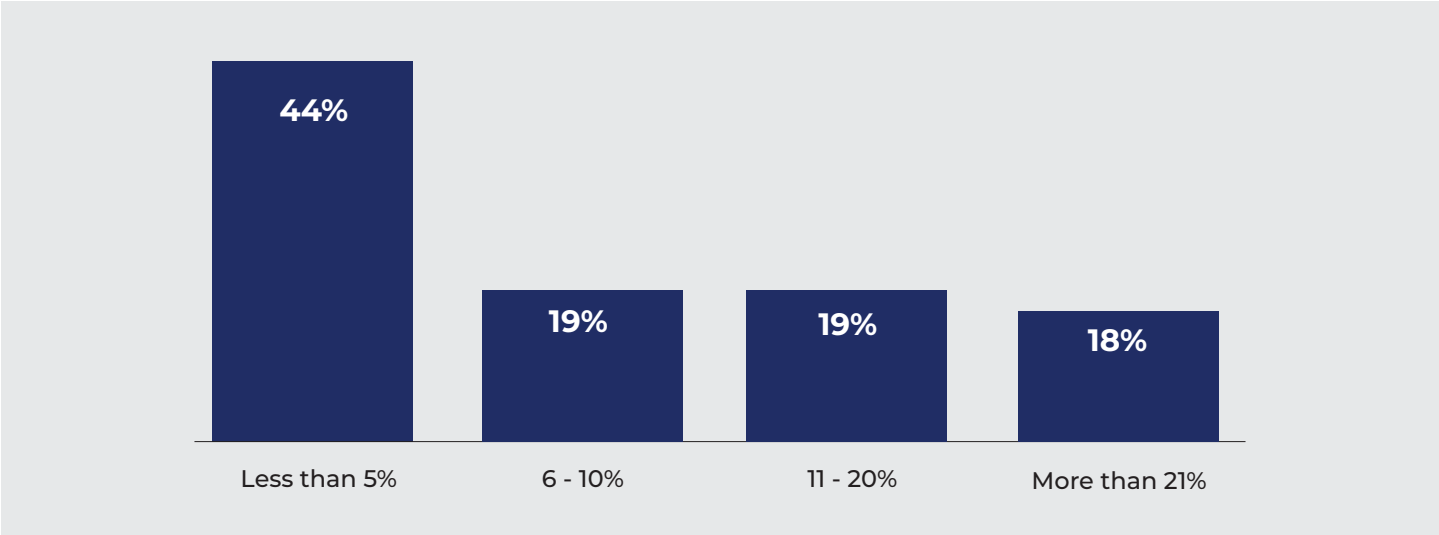
The above figure illustrates that 40% of TVET colleges provided skills development as the leading form of training, followed by 23% that also provided industry partnerships. Widespread evidence shows that industry partnership is critical to enhancing entrepreneurship education within TVET colleges.

Innovation development (17%) and technology transfer (14%) were the third and fourth-most common training provided to TVET students, respectively. Research and development (6%) was the training type least offered.

A provincial breakdown shows that Limpopo and Free State dominated the provision of skills development, although all provinces had a smaller share of intensive involvement or training in research and development. The low rate of research and development must be understood in relation to the fact that universities are the drivers in this space. This gap must be addressed, as innovation cannot take off without a strong research and development element.

The research went as far as trying to understand how the TVET budget was distributed and if the innovation element was accounted for in the budgeting process. Figure 5.6 shows what TVET colleges spend on innovation.

Figure 5.6: Percentage of budget spent on innovation.



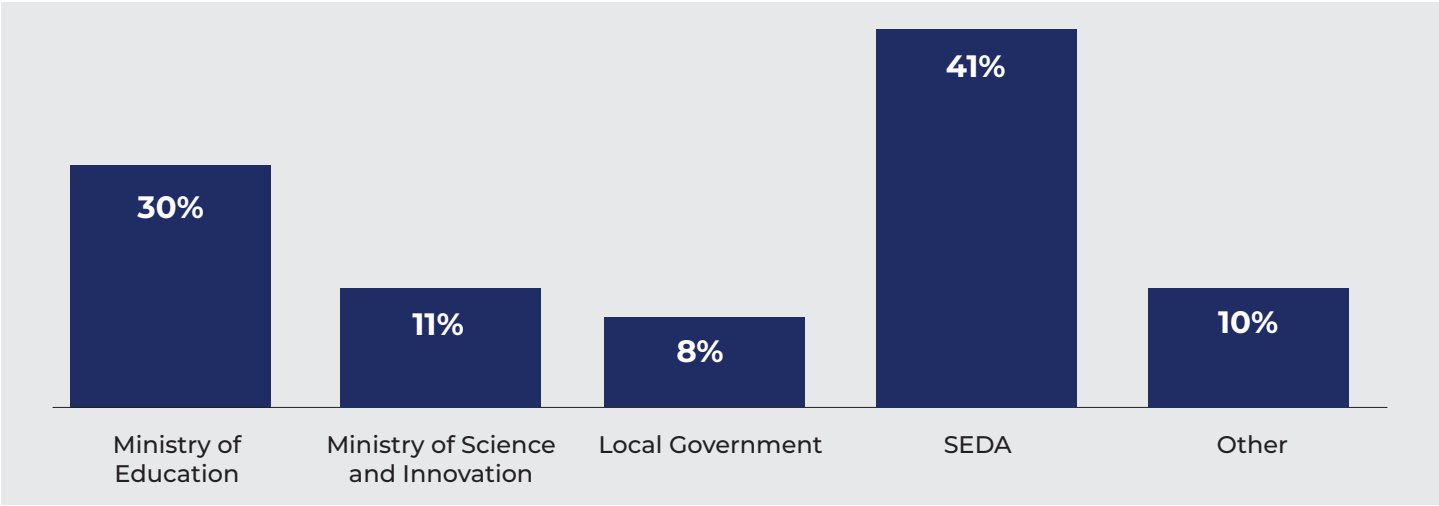

Source: AGGP_SA

The above figure shows that most TVETs (44%) spend less than 5% of its budget on innovation. This is consistent with the national picture as the government spends less than 1% on research and development in South Africa (DSI, 2022). In addition to this, 19% of TVET colleges spend 11-20% of their budget on innovation, and another 18% spend more than 21% of their budget innovation. Furthermore, 19% of the TVET colleges spent more than 6-10% % of their budget on innovation. In this category, a provincial focus shows that Free State (10%) and Limpopo (3%) were the only provinces that spent a higher share of their budget on some form of research and development.

**5.3.3 Institutions: Institutions providing the most support through funding (79%) and entrepreneurship training (59%) are DHET and SEDA, but 24% said no innovation support is provided.**

Institutions play a significant role in building structures to support innovation and development. Institutions such as the Human Sciences Research Council (HSRC) and the Council for Scientific and Industrial Research (CSIR) advance the country's innovation landscape. TVETs were also asked for a list of their stakeholders as per figure below.

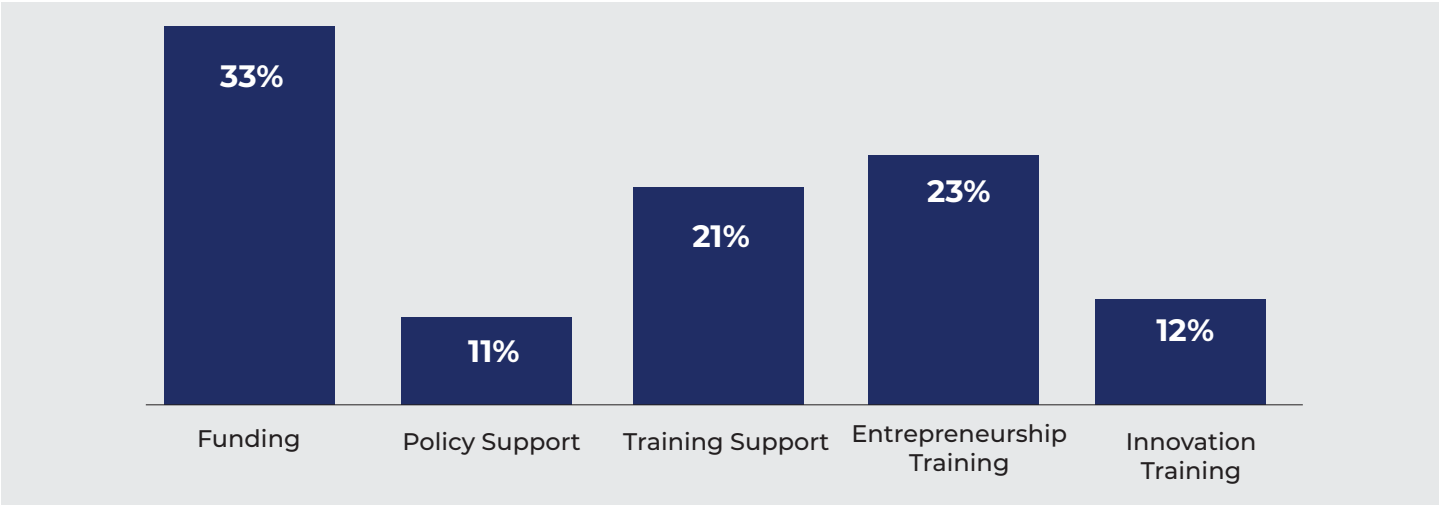
Figure 5.7: Key government stakeholders (On the next page)




Source: AGGP_SA

The respondents (30%) cited the DHET as one the leading stakeholders. This could be largely driven by the fact that TVET institutions report to DHET and are guided by DHET policies. Seda was cited by most of the respondents (41%) as the second biggest stakeholder, and 8% cited local government as another important stakeholder. The DSI was cited by 11% as a key stakeholder and 10% selected 'other'. In all the provinces, the DHET and Small Enterprise Development Agency (Seda) were cited as the key government stakeholders. This was expected because TVETs are public institutions. Sector Education and Training Authority (SETAs) and Allan Gray Makers were cited as the main stakeholders for those who selected the 'other" option. It was important to consider the kind of support provided by the list of government stakeholders that work intimately with TVET. Figure 5.8 shows the support provided by these stakeholders.

Figure 5.8: Support provided by government stakeholders.

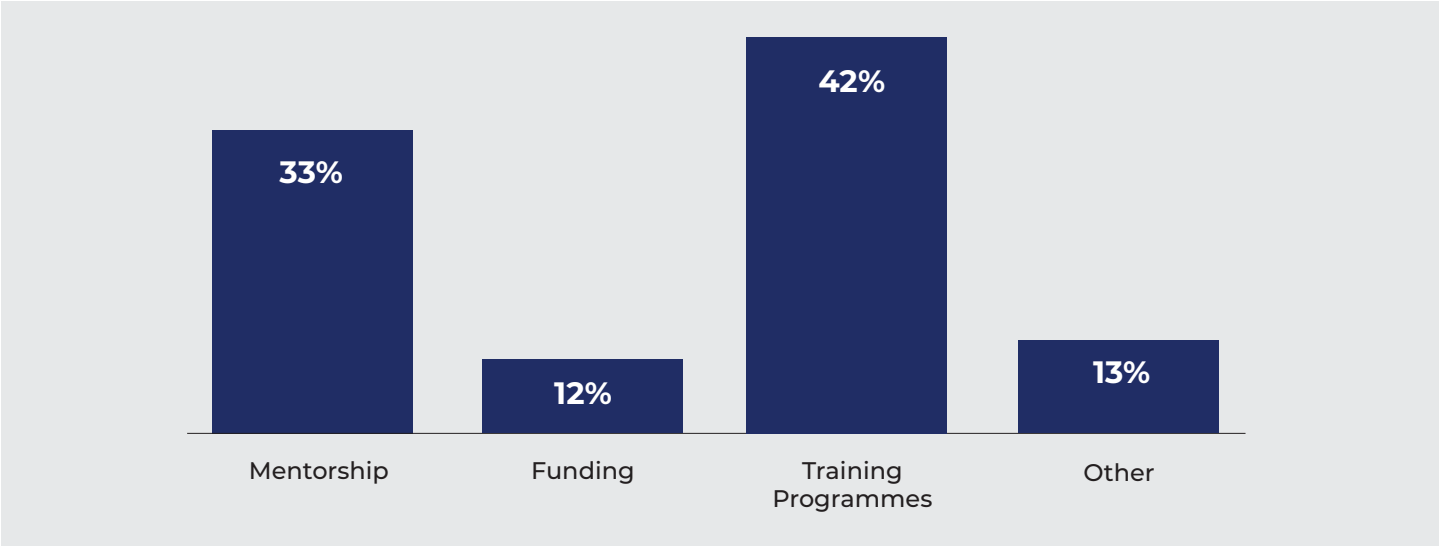



Source: AGGP_SA

Funding was the most support provided by the government (33%), followed by entrepreneurship training (23%), training support (21%), policy support (11%), innovation support (12%). In relation to innovation support, those that supported TVETS were found to provide funding (48%), infrastructure (26%), policy support (11%) and 11% said no innovation support was provided by these institutions. Within these categories, different provinces cited similar trends, i.e that funding and training support were mainly provided to TVETs by the public institutions that are custodians of the education space.

Innovation is mainly spearheaded by private companies under the pursuit of entrepreneurial profits and competitiveness in the market space. In the context of this study, we also had to consider the main private sector partners working with TVETs. Tech companies (27%), followed by philanthropies (38%), and financial institutions (15%) were cited as the most dominant private partners. Furthermore, 12% of the TVET worked with 'other'. Figure 5.9 shows the list of innovation support provided by these private sector partners.

Figure 5.9: Support provided by private sector partners.

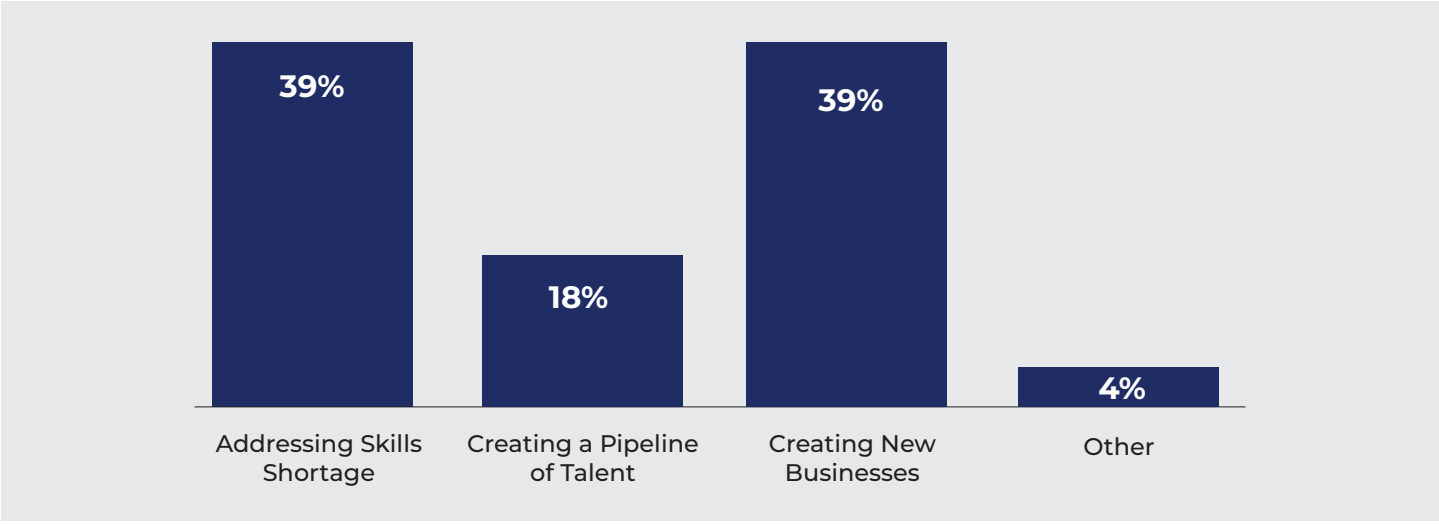



Source: AGGP_SA

Training programmes were most cited as the kind of innovation support received from the private sector (42%), followed by mentorship (33%). These two categories were mainly provided in the Free State province (over 10%), followed by the Gauteng province. Funding was the least support provided by the private sector (10%). Limpopo was the province with the largest funding support from a provincial perspective. It is also worth noting that 13% of the participants cited 'other' types of innovation support without being specific.

Funders often contribute to institutional support to meet a particular goal. In the survey, various goals were outlined by respondents as per figure 5.10.

Figure 5.10: Partners' interests in supporting TVET.




Source: AGGP_SA

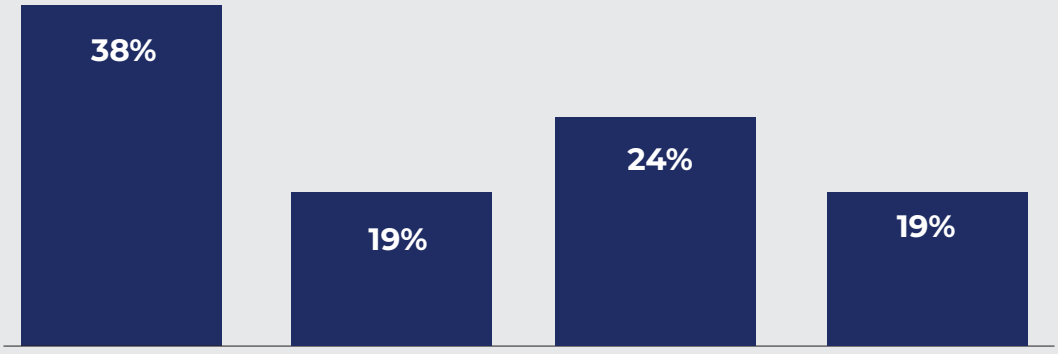
Most of the private sector partners (39%) worked with TVET colleges to address skills shortages (likely the shortages that they are themselves experiencing in their businesses). Furthermore, 39% work with TVETs to stimulate the creation of new businesses (this is likely to be philanthropy work). Furthermore, 18% of the participants cited the creation of a pipeline of talent as the essential reason behind the private sector support, whereas only 4% cited 'other'. Addressing skills shortage and creating new businesses were also dominant responses throughout all the provinces, with Gauteng leading all other provinces in this component.

**5.3.4 Entrepreneurship Culture: Awareness and exposure to Entrepreneurship among TVET students is low: 62% of TVETs say less than 10% of students enter entrepreneurship competitions, almost half (38%) of TVETs have only produced 1-5 businesses in the last 5 years.**

Entrepreneurship culture shapes how people perceive entrepreneurship as a career and is strengthened when there is a high tolerance for failure and many entrepreneurial role models emerging from the TVET space. Within the TVET landscape, entrepreneurship culture is important as it encompasses the learners' growth mindset and ability to identify opportunities, and determines whether they are entrepreneurially inclined.

Exposure to innovation through teaching plays an important role in whether students take interest and see themselves as innovators or not. For this study, only 35% of those surveyed responded that innovation is taught in their colleges, with the remaining 65% indicating that it is not taught. Free State and Limpopo had the highest representation of TVETs that teach innovation (25% and 17% respectively), with the other provinces scoring below 10% (8.33% to be specific for each remaining province. Figure 5.11 shows the number of businesses that emerged from TVET institutions in the last five years.

Figure 5:11: Number of businesses that emerged from TVET institutions in the last five years.



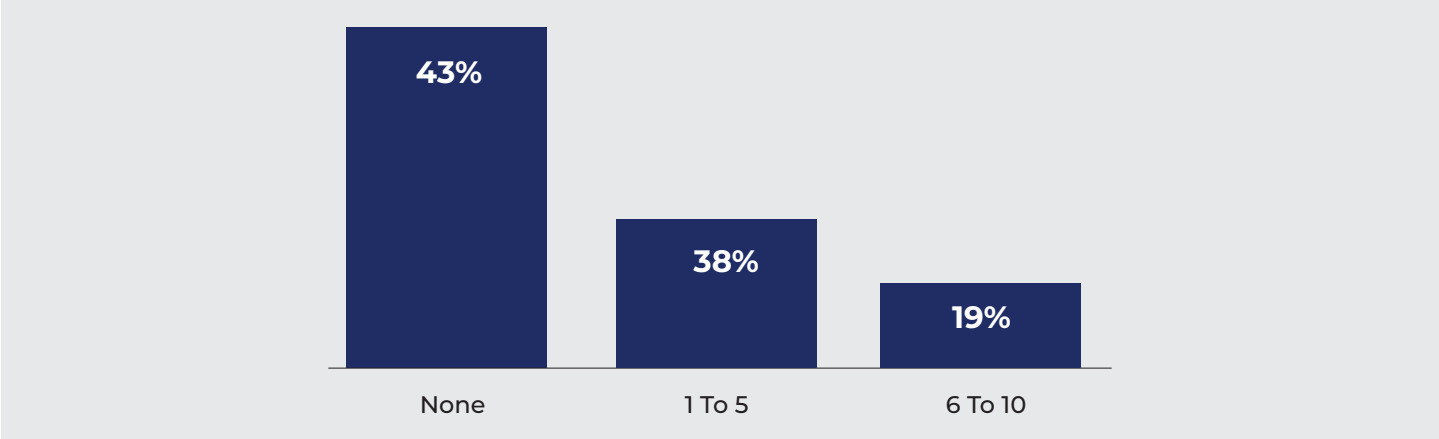

Source: AGGP_SA

One proxy to measure entrepreneurship culture is the number of businesses that are emerging from TVET institutions. The results indicated that this is low. The above figure shows that 38% of the surveyed TVET institutions only produced between one and five businesses in the last five years, with 24% producing more than 11 businesses. Only 19% produced six to ten businesses, whereas another 19% produced more than 20 businesses.

These results are highlighted by the fact that 52% of the respondents reported that less than 10% of their students have participated in entrepreneurship competitions, and no colleges indicated that 50% or more of their students have taken part in such competitions. From a provincial focus, Limpopo produced more businesses in the 'one to five' business category, followed by Free State in the 'more than 11' businesses and 'more than 20' businesses category.

Innovation outputs require necessary innovation inputs to ensure a conducive environment for emerging innovators. In this study, only 9% of the TVET institutions had an IP commercialisation office. Consideration was given to the number of innovations produced in a college as per figure 5.12.

Figure 5.12: Number of innovations produced in TVETs in the last five years.




Source: AGGP_SA

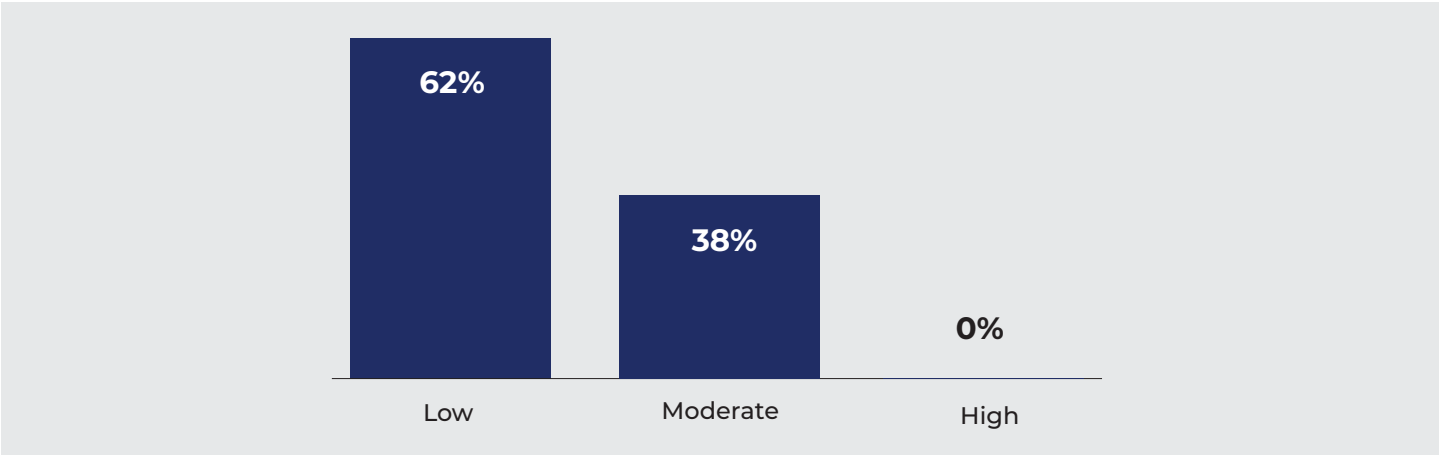
As per figure 5.12, it is clear that an overwhelming majority of TVET (43%) did not produce any innovations in the last five years. Only 38% of TVETs produced one to five innovations and 19% produced six to ten innovations. In addition, none of the TVETs were noted to have produced more than ten innovations. From a provincial focus, Free State, Mpumalanga and the Western Cape had the largest share of TVETs that produced one to five innovations, followed by Free State and Limpopo for TVETs that produced six to ten innovations.

### 5.3.5 Talent: Innovation interest among TVET students was high (67%), yet levels of innovation awareness was low.

Talent refers to the human capital found in a particular environment and whether there are sufficient skills to create a labour pool and the next pipeline of entrepreneurs. The quality of TVET education plays an important role in determining the attraction of TVET graduates to the labour market.

From the data collected, the analysis showed that 62% of TVETs perceived a low awareness of innovation amongst students. Figure 5.13 shows the results for students' awareness of innovation.

Figure 5.13: Students' awareness levels of innovation.

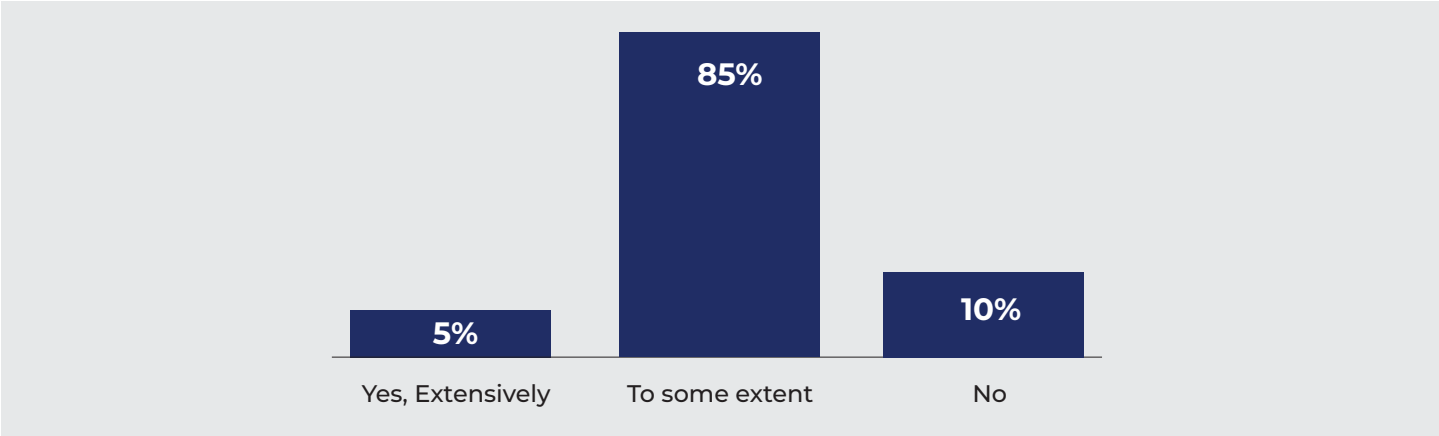



Source: AGGP_SA

The research showed that despite a perceived high interest in innovation from students, there is little awareness of innovation at TVETs. Only 38% of the TVETs cited a moderate awareness in innovation amongst students, with no college reporting a high awareness. However, it is also interesting to note that 67% of the students were perceived to show some interest in innovation, followed by 28% that showed partial interest. Only 5% of colleges indicated that students show no interest in innovation. A provincial focus shows that entrepreneurial innovation awareness was high in Free State, Gauteng and the Western Cape, and low in provinces such as Limpopo.

Another question for entrepreneurial talent considered whether students use any innovative infrastructure on campus. Figure 5.14 shows whether students use supporting software solutions.

Figure 5.14: Students knowledge of supporting software solutions.




Source: AGGP_SA

Most of the participants (85%) indicated that students use supporting software to some extent. Only 5% of colleges believe that their students have extensive knowledge of supportive software systems. In addition, only 10% indicated that students do not have any knowledge of using supporting software solutions. Limpopo, Free State and Gauteng showed the highest percentages of those who were equipped to use supporting software solutions to some extent.

On the other hand, Eastern Cape, Gauteng and the Western Cape recorded the highest number of TVETS that were using supporting software. The graduation throughput rate in TVET colleges is a significant underlier of some of the challenges faced within South African learning institutions. Most respondents (50%) cited the TVET graduation throughput rate as moderate, with 15% citing it as low. Only 35% TVETs cited it as high.

**5.3.6 Leadership: Leadership in TVETs is insufficient to support innovation with many TVETs lacking principals, 91% of lecturers are partially or not at all equipped and ready to teach innovation at TVETs and 38% of TVETs did not have an entrepreneurial role model working with the college.**

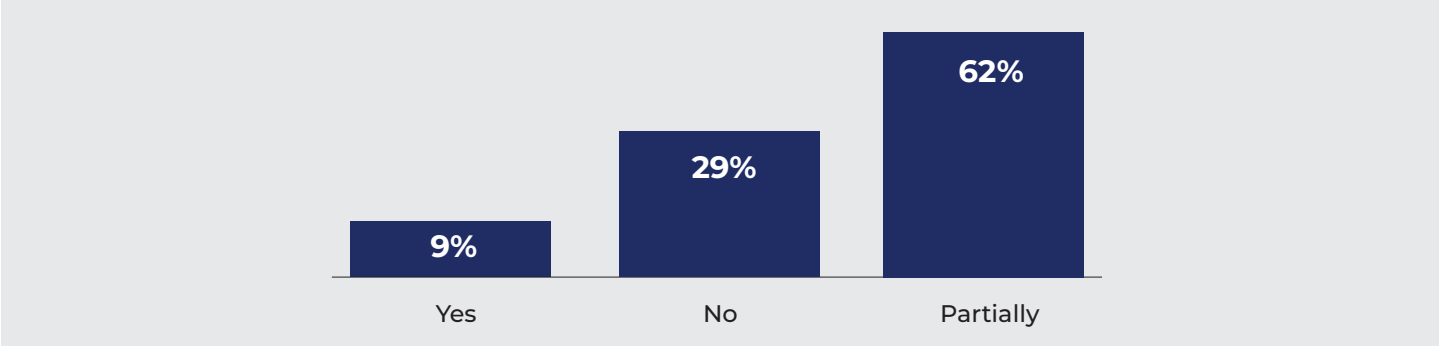
Leadership, within private and public domains, plays an important role in influencing entrepreneurial culture and the emergence of innovations likely to emerge based on the institutional direction provided by leaders. Entrepreneurial role models, particularly those in the innovation space, therefore, play a significant role in influencing how students perceive their entrepreneurial aspirations in relation to their lived realities.

In this section we look at lecturers, principals and entrepreneurial role models and their capability and extent of leadership to encourage innovation. TVET lecturers play an important leadership role in equipping students with the necessary skills and attributes.

Figure 5.15 shows perceptions on whether TVET lecturers are equipped to teach innovation.

> In the innovation landscape, TVET lecturers are instrumental in equipping students with skills of the future.

Figure 5.15: Lecturer's readiness to teach innovation.

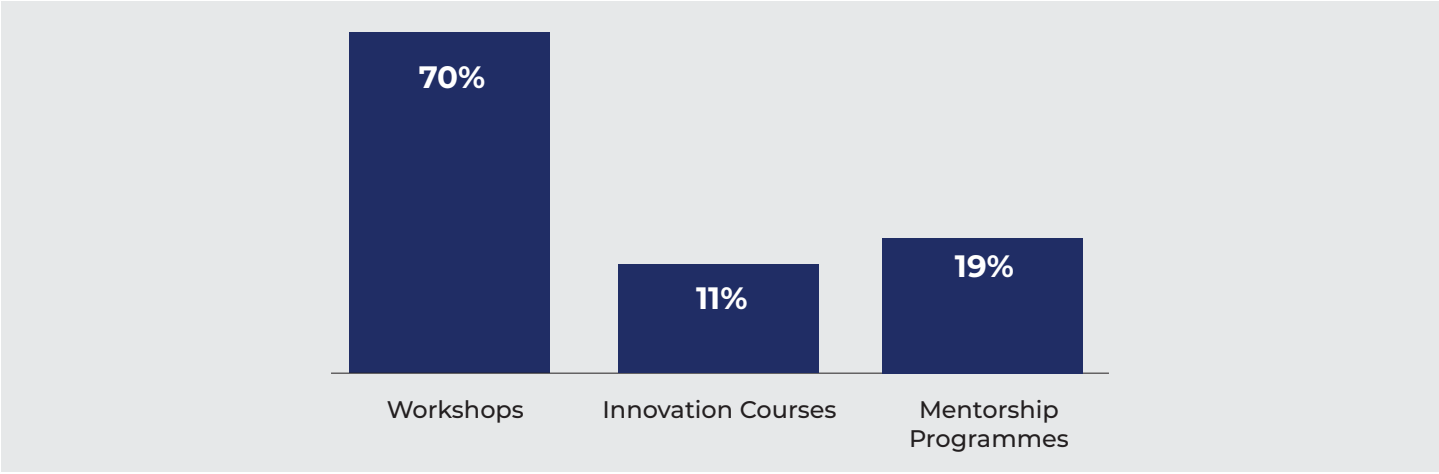



Source: AGGP_SA

The research shows that there is room for improvement in terms of lecturers being equipped and ready to teach innovation at TVETs. Most of the respondents (62%) think lecturers are partially equipped to teach innovation, and a further 29% believed they are not equipped at all. Only 9% believe they are firmly equipped. Limpopo, KwaZulu-Natal and Free State had the highest share of TVET lecturers partially equipped to teach entrepreneurship, with Gauteng TVETs boasting the highest number of lecturers unequipped to teach entrepreneurship. The study also found that 48% of the respondents also highlighted that lecturers do not have innovation industry experience. In addition, only 9% believe lecturers have the necessary industry experience, and 43% think they have partial industry experience to teach innovation at TVET colleges.

Given the low state of entrepreneurs capable of teaching innovation in TVET, it is important to ensure measures are in place to address this shortfall. As such, the study also considered training and development interventions introduced to address this problem as evident in figure 5.16.

Figure 5.16: Innovation interventions availed for lecturers and leadership.




Source: AGGP_SA

Based on the responses, 70% of the interventions to right-skill lecturers and TVET leadership to teach innovation are mainly through training workshops. The figure also shows that innovation courses (11%) and mentorship programmes (19%) were important interventions introduced to capacitate lecturers and leaders.

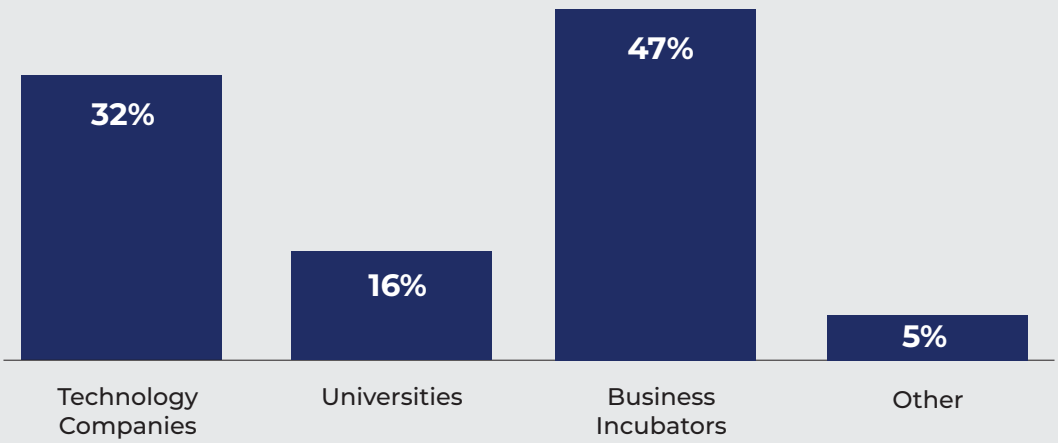
Entrepreneurial role models play an important role in motivating others to be entrepreneurs. In the case of this study, it is positive that more than half of the TVET colleges (62%) had an entrepreneurial role model working with the college, indicating that there is room for improvement. Furthermore, there was a lack of TVET principals in many TVET colleges, which ultimately undermines the role played by leadership in improving innovation systems.

**Networks: 47% of TVETS say business incubators (essential for connecting entrepreneurs with a variety of networks such as funding, mentorship and market access) are the main industry partners, and 43%of the TVETs have some form of a relationship with their local chamber of commerce.**

Networks provide opportunities for emerging innovators to learn from other established pioneers in the field of innovation, and also provide TVET structures with partnership opportunities to enhance delivery of their mandate. In the context of this study, networks included the relationship that TVET colleges have with local ecosystem players.

One of the most pressing question was about the main industry partners for TVET colleges in their pursuit of enhanced innovation training. Figure 5.17 shows the list of key industry partners for TVETs.

Figure: 5.17: Industry partners




Source: AGGP_SA

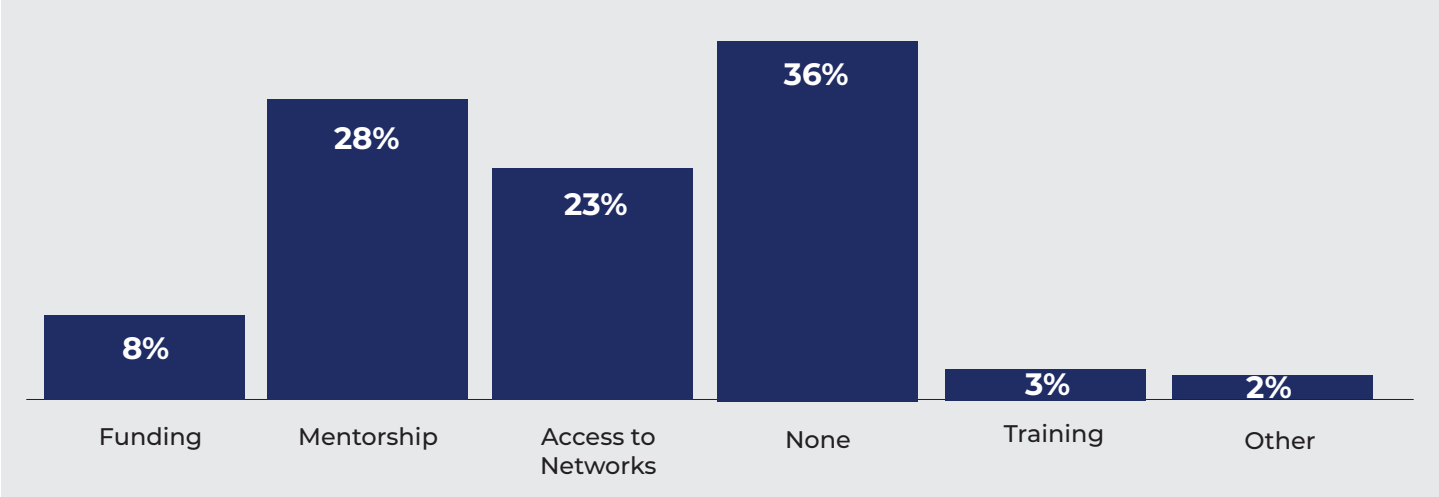
Business incubators (47%) were cited as foremost partners for TVET colleges, followed by technology companies (32%). Provinces such as Gauteng, KwaZulu-Natal and Limpopo reported the highest number of TVET colleges that were partnering with tech companies. Business incubators are essential for connecting entrepreneurs with funding, mentorship and market access networks. This sequence aligns with tech innovations needing to be incubated before being introduced to the market. Universities (16%) also formed the basis of important stakeholders because they are in the space of providing education, albeit at a higher level than TVET. It was mainly TVETs in KwaZulu-Natal and Eastern Cape that had close partnerships with the industry. 'Other' (5%), cited as important stakeholders for TVET colleges, included the likes of SEDA and other entities. Within the same segment, a high proportion of the TVET colleges (43%) have a relationship with their local chamber of commerce, with 33% of these reporting having a relationship 'to some extent'.

Some TVET colleges are found within the same geographical locations and therefore form a relationship between themselves. In considering whether TVET colleges form any partnerships between themselves, 62% of the participants positively cited the existence of partnerships between TVETs, compared to 38% without any form of partnership or collaboration.

**5.3.8 Intermediaries: There is very little incubation support in TVETs with most (59%) of the colleges that took part in this study not having any CfERIs on their campuses and 63% of TVETs with no student entrepreneurs undergoing incubation, and little data on the effectiveness of the incubation support in sustaining a business over the long term.**

Intermediary structures, such as incubators and other support interventions designed to enhance the lifespan of innovations are important for building resilience in local ecosystems. The research shows that there is very little incubation support in TVETs with most of the colleges (59%%) that took part in this study not having any CfERIs on their campuses. Figure 5.18 shows the list of support provided by CfERIs for colleges where they exist.

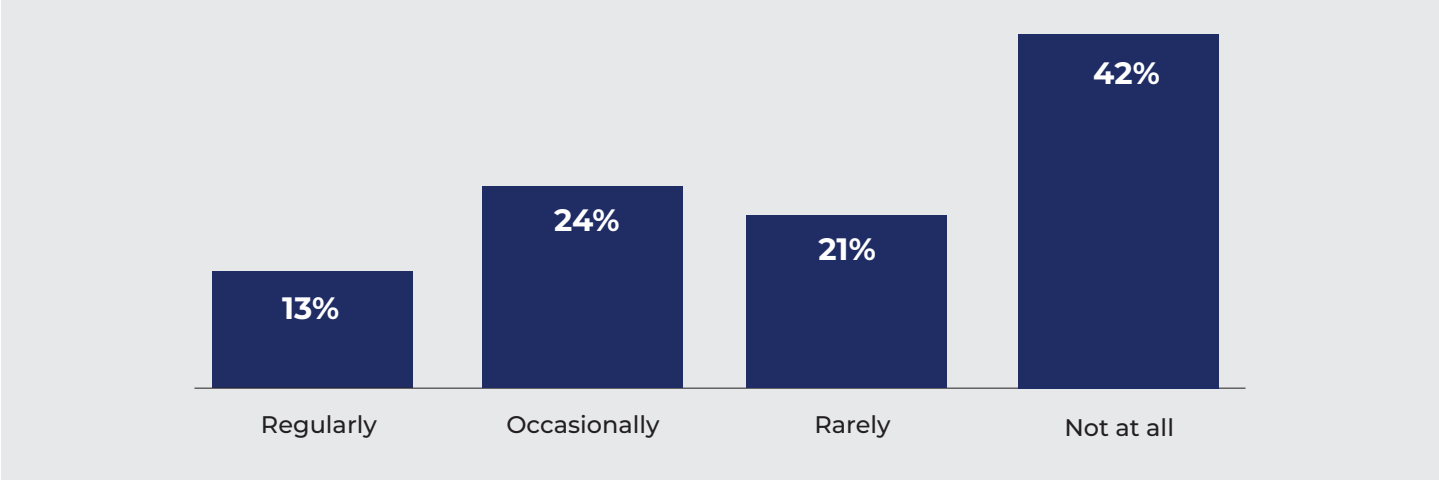
Figure 5.18: Support provided by CfERI in TVET colleges.




Source: AGGP_SA

Most of the CfERIs (36%) did not provide any type of support. Other TVETs listed support mechanisms were noted as follows: mentorship (28%), access to networks (23%), and funding (8%). It was also a concern to note that 63% of TVETs did not have any student entrepreneurs undergoing incubation. In this case, only 31% of the TVETs had a student undergoing incubation outside the TVET space, and 6% underwent other incubation processes. Entrepreneurship monitoring does not only end at the incubation phase, but needs to be extended to the post-incubation phase. Figure 5.19 shows the extent to which colleges monitor their entrepreneurs post incubation or qualification.

Figure 5.19: Monitoring of entrepreneurs post qualification or incubation




Source: AGGP_SA

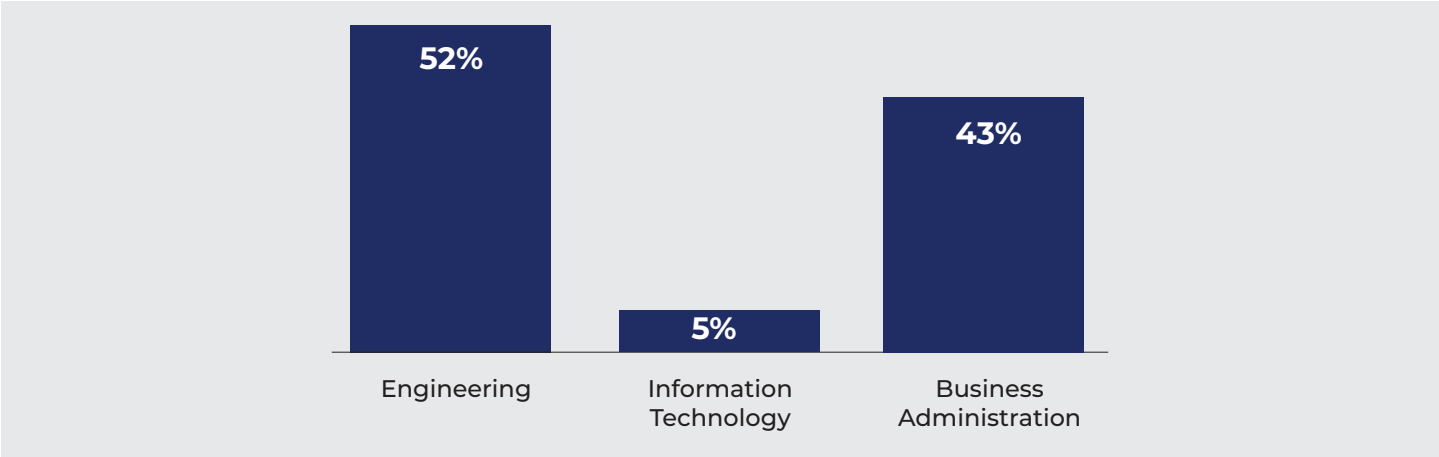
The data showed that there is very little monitoring of entrepreneurs and their growth post qualification or incubation. 24% of entrepreneurs post qualification and incubation were monitored occasionally, 21% were rarely monitored and 42% were not monitored at all. Only 13% of the post-qualifications were regularly monitored. This may mean that even where there is support, there is little data on the effectiveness of the qualification and incubation support in sustaining a business over the long term. Most of the support was available in the Free State and Gauteng.

**5.3.9 Demand: Qualifications that are foundational to innovation such as STEM and those that meet actual demand in the marketplace should be prioritised and this requires stronger relationships with industry partners to identify opportunities.**

Demand is the ability of the business and innovation to meet a need, thereby accessing customers and being commercially viable. It is an important element in the entrepreneurial ecosystem because it provides space for opportunities to be recognised, and for innovators to identify the gaps they fill in the market. For this study, demand considered various factors. These included in-demand qualifications as the assumption is that if the skill is in demand, the business that is derived from the skill will have a market.

TVET colleges offer various types of qualifications that lead to different career paths for students. Figure 5.20 shows in-demand qualifications.

Figure 5.20: In-demand qualifications.




Source: AGGP_SA

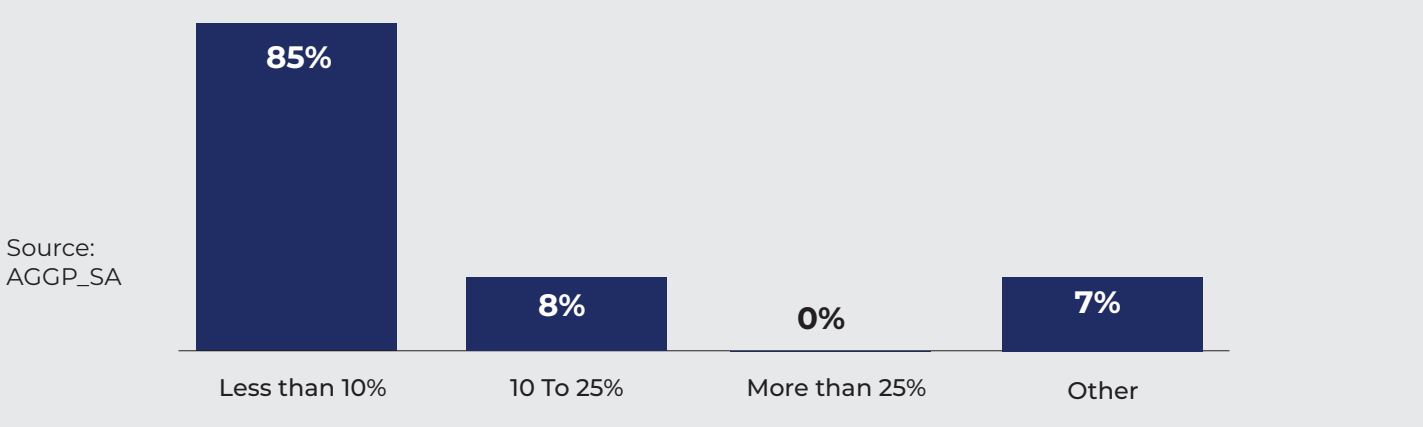
Engineering (52%) and Business Administration (43%) were the mainstream qualifications in most TVET colleges. Information technology, which is one of the major inputs to innovation, was only mentioned by 5% of the TVET colleges as an in-demand qualification. On a positive note, it was established that 81% of the colleges planned on introducing innovation studies in their curriculum, compared to the 19% that did not.

**5.3.10 Research and development (new knowledge): Spending on research and development is insufficient to encourage innovation with most (85%) TVET colleges spending less than 10% of their budget on research and development with the majority (88%) of TVETs only having one patented innovation (the rest having two to five patents) and only 6% of colleges commercialising some of these innovations.**

Scientific studies show that research and development is the backbone of innovation.

This study also considered the share of TVET college budget that is spent on research and development. While acknowledging that TVET institutions are not centres of research and development, some level is required to enhance innovation structures. Figure 5.21 shows the percentage spent on research and development.

Figure 5.21: Share of budget spent on research and development.

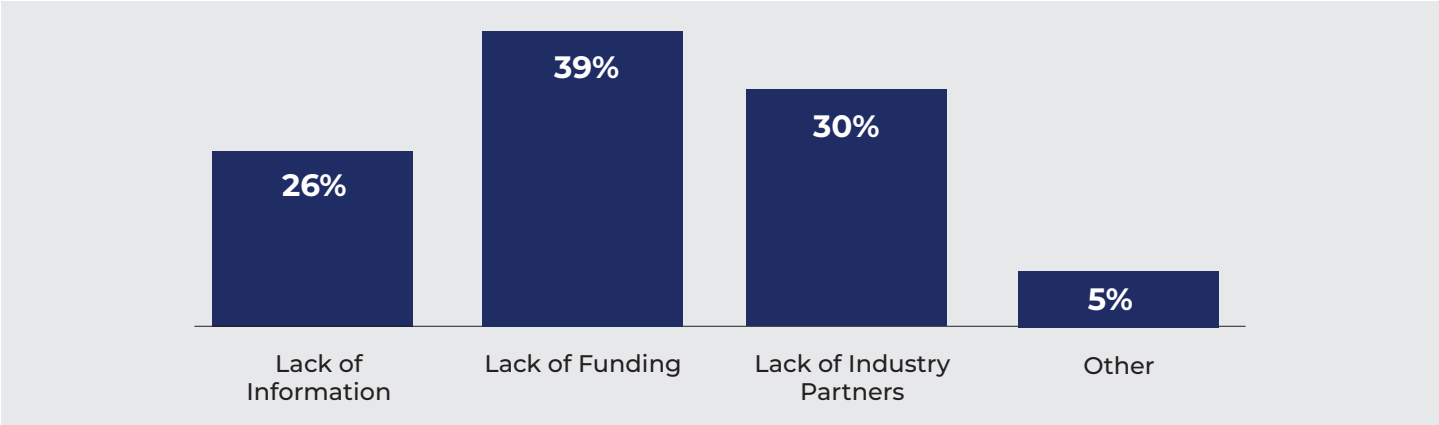


Most TVET colleges (85%) spent less than 10% of their budget on research and development, followed by 8% that spent 10-25% of their budget, and no college that spent 26% and more. A provincial overview shows that Limpopo, Free State and North West were the only provinces that spent 10-25% of its budget on research and development. Most provinces spent less than 10% of their budget on research and development. Based on the low investment, it is not surprising that only 6% of colleges had commercialised some innovations emerging from their structures. 88% of the colleges had at least one patented innovation, and only 12% had patented two to five innovations – very slow statistics.

## 5.4 Challenges to Commercialising Innovation

The research also considered barriers that inhibit TVET entrepreneurs from commercialising their products and services in the market. Figure 5.22 shows leading reasons that act as barriers to commercialisation.

Figure 5.22: Barriers to commercialization.

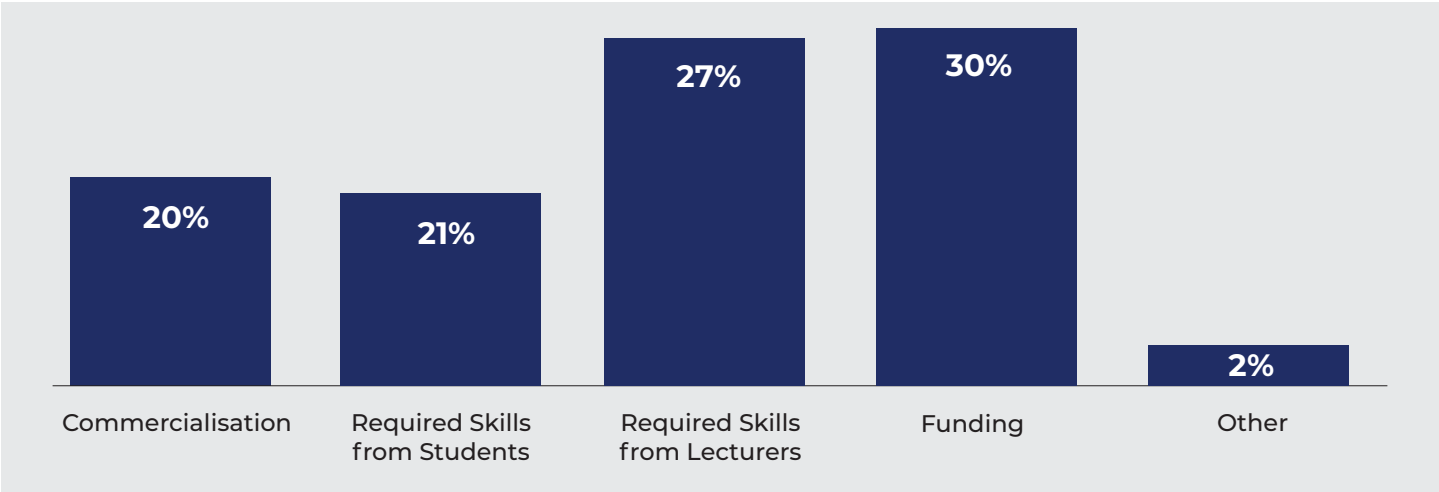



Source: AGGP_SA

The lack of funding (39%), lack of industry partners (30%) and a lack of information (26%) were cited as the most significant problems facing the commercialisation of innovation products within the TVET ecosystem. These significant challenges could also be interrelated. For example, the lack of funding may also be caused by the lack of market information and inability to partner with industrial players with established connections.

Barriers not only exist in innovation, but also exist in relation to the entire innovation process. Figure 5.23 shows barriers to pursuing innovation.

Figure 5.23: Barriers to colleges pursuing innovation.




Source: AGGP_SA

Once again, the funding issue was raised by 30% of the participants as a significant barrier to pursuing innovation. The lack of required skills from lecturers (27%) was also cited as an important barrier, followed by the lack of required skills from students (21%). In this context, if the lecturers are not fully equipped to teach innovation, it is impossible to expect learners to possess innovation skills and attributes. Commercialisation (20%) is also cited as another barrier inhibiting innovation within the TVET space.

A qualitative component also considered what could be done to improve TVET's pursuit of innovation. Most of the themes that emerged focused on training and development:

> "More training and development" – P2

> "Training and workshops for both teachers and students" – P9

> "Additional training, legal training to pursue innovation" -P6

> "Training and development for staff, students and managers; funding for infrastructure" - P11

**Some other participants cited the need for entrepreneurship hubs within TVET colleges as a strategy to enhance training and support.**

> "The creation of an entrepreneurship hub or an incubation centre" – P10

**Other participants also focused on the need to work with innovation centres and partnership with private entities in this space.**

> "Have partners to support the innovation to the student and also the lecturers" – P21

> "Calling for partnerships with organisations that are in the innovation space" – P12

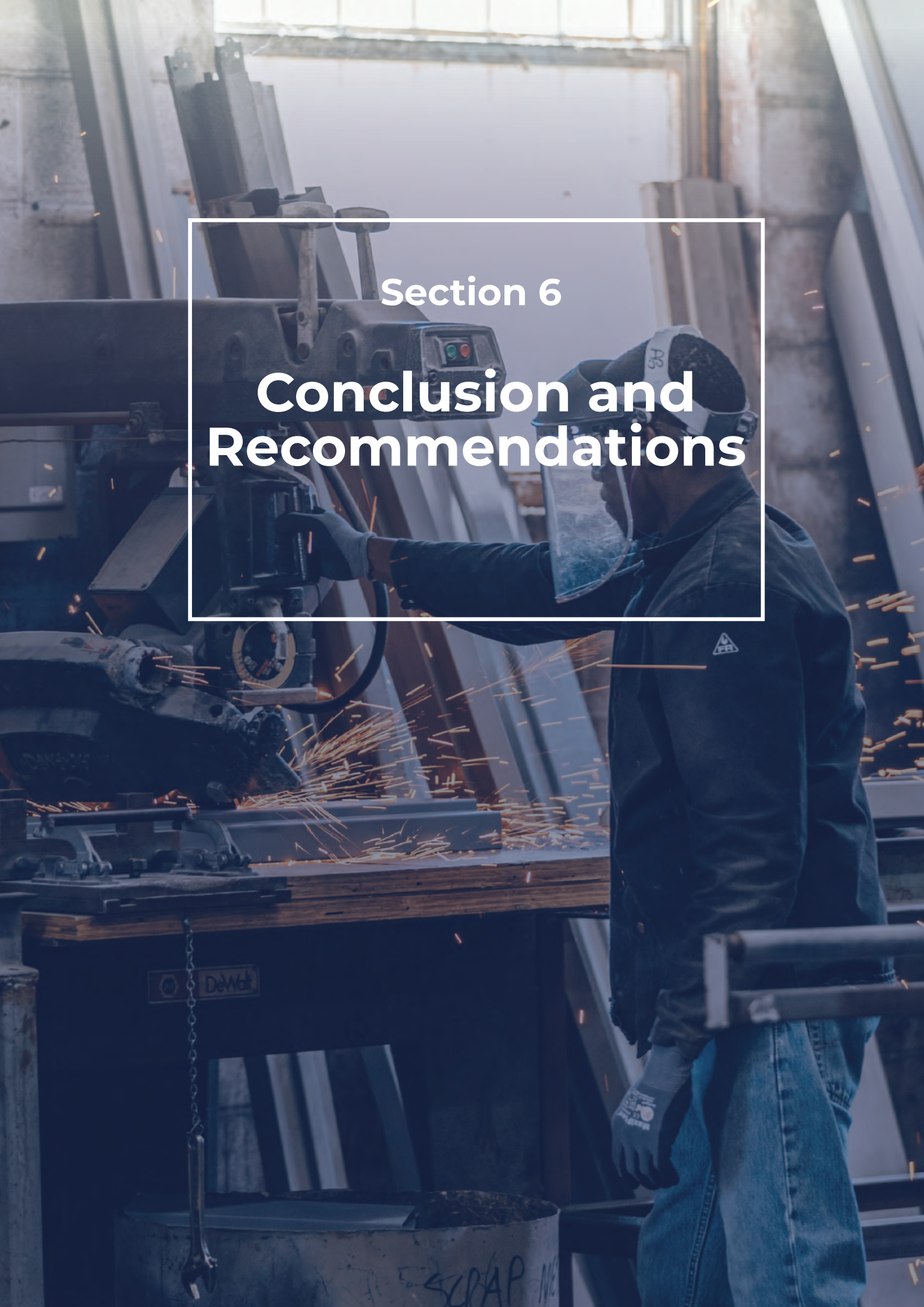
> "Colleges need to follow the innovation route" – P18

**Other participants cited the need for TVET colleges to be agile in their approach to adapt in the innovation driven economy.**

> "The college must be able to respond to the skills needs of all sectors of society, including businesses, industry and the government" – P20

## 5.5 Conclusion

This section has reflected on the emerging trends within the state of innovation and entrepreneurship in the TVET ecosystem. The analysis reveals interesting trends regarding the low rate of investment in innovation within the TVET ecosystem and the overall lack of industry partnerships to strengthen the ability of TVET to contribute to the innovation entrepreneurship ecosystem.




Section 6

# Conclusion and Recommendations

## 6.1 Conclusion

South Africa's research and development spend continues to be less than 1% of the country's GDP. This is despite evidence that countries that spend more on research and development experience unprecedented economic growth. Increasing the country's investment into research and development could have a net effect on South African patents and improve the country's competitiveness. However, it becomes important to also strengthen the TVET research programme as a measure to improve new technologies emerging from this sector and ensure competitive exposure for the TVET innovation system. This study was conducted as an ecosystem mapping of the TVET innovation landscape to ascertain the innovation capabilities of South Africa's TVET ecosystem. As it stands, only universities serves as prominent innovation structures in South Africa, with TVET colleges playing a lesser role in this space. This is largely due to some of the core challenges raised in this report, particularly the issue of required capabilities not existing within South African TVET institutions. For example, there is a scarcity of lecturers with necessary industry experience to impart critical future skills to the current crop of TVET students.

## 6.2 Recommendations

Based on this study's overall findings, the following recommendations are made to improve the institutional coherence and projections of the current TVET ecosystem towards making a significant contribution to the country's innovation system.

**Physical infrastructure: There is insufficient access to and ineffective use of physical infrastructure to support innovation with 75-90% of TVETs having no access to Maker Spaces, Fab Labs or Incubators and a 45% usage rate of existing equipment.**

- TVET colleges should be resourced with the latest innovations and simulation machines to improve innovation and learning outcomes.
- TVETs should understand the reasons why their existing innovation infrastructure has such a low usage rate (45%), and ensure that this typically costly investment is put to better use. Reasons for this low usage rate could be that the equipment is incorrect, it is poorly maintained, or there is not enough entrepreneurial talent to use it. One validated reason is that there is insufficient training on how to use the available equipment, and so a key recommendation is to train students on how to use the equipment to ensure better innovation outcomes.
- TVET students should be both encouraged and enabled to use innovation infrastructure, specifically for entrepreneurial and innovation activities such as ideation, prototyping and solution testing as currently, the equipment is seldom used for this.
- There is a need to partner with industry to help TVET lecturers understand which technologies are relevant, and to teach and manage new technologies introduced to the TVET ecosystem.
- TVET colleges should continue providing free and consistently accessible Wi-Fi to all students.

**Access to finance: There is little financing for TVETs to invest in innovation with almost half of TVETs receiving less than R10 000 annually for innovation and 63% of TVETs spending less than 5% of budget on innovation.**

- More funding should be dedicated toward the transition to soft skills (adaptability in tech) and innovation in TVET colleges.
- TVET colleges should have an innovation investment, fundraising and implementation strategy.
- TVET colleges need to fundraise and form better partnerships with industry to finance learning labs (information exchange platforms) within TVET spaces.
- It would be useful to conduct further research and explore whether there is correlation/causation between more investment in innovation in local TVETs and better innovation outcomes over the short and long term.
- It would be useful to conduct further research to gain an understanding of the various funding mechanisms available for TVET entrepreneurship and innovation, and to quantify the current extent of funding, the investment required and the associated funding gap.

**Institutions:** Institutions providing the most support are DHET and Seda. Of the 76% that did receive support, 79% received funding and 59% received entrepreneurship training . However, 24% of colleges reported that they did not receive any innovation support.

- Improved synergies need to exist between TVET colleges and public, private and civil institutions.
- The lack of close relationships between TVET colleges and DSI was noted. This needs to be further explored and strengthened as a potential measure to bolster the capacity of TVET to lead innovations.
- There is a need to establish a central centre of excellence for TVET innovations to be showcased at a national and international scale.
- There is a need for TVETs to prioritise more accurately meeting the demand for skills in the private sector which would enhance collaboration between TVETs and the private sector. This, in turn, might encourage the private sector to be more invested in TVETs, thereby improving relationships and contact with lecturers and students. This is essential for understanding existing challenges in the various industries, and sparking innovation to address these challenges.

**Entrepreneurial culture:** Awareness and exposure to Entrepreneurship among TVET students is low. 62% of TVETs say less than 10% of students enter entrepreneurship competitions, and more than half of TVETs have only produced one to five businesses in the last five years.

- Entrepreneurship education and training should be infused with innovation to increase the entrepreneurial awareness of students within the innovation industry.
- Lecturer-industry placement should be prioritised as per DHET policy.
- There is a need to develop a model for student-industry placement within the small business space to improve students' ability to recognise opportunity.
- Safe spaces to fail such as competitions and practical training, where students are exposed to and can experiment with entrepreneurship and innovation, learn and move forwards, are important to prioritise.
- There is a need to bring innovative entrepreneurs that are TVET graduates closer to students to inspire, mentor, and encourage students to take action.

**Talent:** TVET graduation throughput rates are moderate, with 25% citing it as low. Only one in four TVETs cited it as high.

- The phasing in of the high school exit certificates to TVETs, needs more awareness to attract additional talent to the TVET ecosystem.
- TVET lecturers need to be better trained to improve the overall institutional capability of TVET to deliver on their mandate of imparting quality skills and education to the youth.
- Training lecturers on how to have and impart an entrepreneurial mindset and infuse entrepreneurship education into the curriculum could improve student entrepreneurial mindsets and competency, laying the foundation for innovative thinking.

**Leadership:** Leadership in TVETs is insufficient to support innovation with many TVETs lacking principals. 88% of lecturers are partially or not at all equipped to teach innovation at TVETs, and 47% of TVET colleges did not have an entrepreneurial role model working with them.

- The full extent of the leadership instability in TVETs needs to be further researched and addressed. This study found anecdotally that many TVET colleges do not have full time TVET principals to consistently guide and lead the TVETs not only in innovation, but in all aspects.
- Quality innovation and entrepreneurship training should be provided to TVET management and lecturers.
- There needs to be stronger linkages, in the TVET ecosystem, between entrepreneurial role models and students in the innovation space.

**Networks:** 34% of TVETs say business incubators, essential for connecting entrepreneurs with a variety of networks such as funding, mentorship and market access, are the main industry partners and a high proportion of the TVETs (73%) have some form of a relationship with their local chamber of commerce.

- Existing relationships between incubators and chambers of commerce should be nurtured and invested in, and better networking structures should be created between TVETs and their localities, particularly local business to improve societal impact.
- Local industries and TVETs need to champion projects in the innovation space within their jurisdiction to improve collaboration and learnings.
- More TVETs should seek to form relationships between each other to improve cross-institution learnings and collaboration. This should be incentivised and funded.

**Intermediaries:** There is very little incubation support in TVETs with most of the colleges that took part in this study (62%) not having any CfERIs on their campuses. Furthermore, 63% of TVETs have no student entrepreneurs undergoing incubation, and there is little data on the effectiveness of the incubation support in sustaining a business over the long term.

- Access to incubation support for all students should be invested in.
- Students should be encouraged to use the incubation support and mechanisms to facilitate access to such support should be established.
- Existing incubators at TVETs should be trained in the use of effective incubation methods to ensure better business outcomes.
- Consistent data should be collected and shared between incubators at TVETs to understand and share effective (and ineffective) support both during and post incubation.
- Provincial TVET incubation structures need to be introduced to incubate leading projects in particular provinces. This will lead to enhanced support and promote competition within and outside provinces.
- It is imperative to link centres of excellence (within TVET structures) to industry expertise that will improve the efficiency of local incubation structures.
- TVET leaders need to consider partnerships with local chambers of commerce to enhance relevance of innovations and incubation support.
- There is a need to introduce innovation competitions for TVET colleges per province to strengthen the talent pipeline for incubation.

**Demand:** Qualifications that are foundational to innovation such as STEM and those that meet actual demand in the marketplace should be prioritised. This requires stronger relationships with industry partners to identify opportunities.

- Most of the offerings in TVETs are in business management. There is a need to strengthen and attract more individuals with STEM to ensure more innovations emerge.
- TVET students must be aware of in-demand innovations and opportunities through the strengthening of industry partnerships, partnerships with chambers of commerce, and the creation of innovation centres within TVET structures.
- Industry leaders should not look at capacity constraints as a stumbling block but work with TVET to improve innovation capabilities and maximise on this relationship to co-create groundbreaking innovation.

**Research and development (new knowledge):** Spending on research and development is insufficient to encourage innovation with most TVET colleges (70%) spending less than 10% of their budget on research and development with the majority (88%) of TVETs only having one patented innovation (the rest having two to five patents) and only 6% of colleges commercialising some of these innovations.

- Methods of improving funding, prioritisation of outcomes of Research and Development in TVET colleges must be explored to ensure TVET ecosystems positively contribute to the country's innovation system.
- Research should be treated as an integral component of TVET to enhance learning and the production of innovative products.
- There is a need to incentivise colleges to invest in and patent innovation. It is critical that there is investment and training of colleges to commercialise innovative products coming from TVETs to unlock the benefits of the innovation in the marketplace.

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