Going beyond the Infrastructure Funding Gap:

A South African Perspective

Technical and Vocational Education and Training (TVET) Sector Report

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Purpose and scope

This report assesses the infrastructure needs in public Technical and Vocational Education and Training (TVET) colleges, in the context of South Africa's commitment to achieving the Sustainable Development Goals (SDGs) by 2030. It is one of four sectoral reports that utilise World Bank's "Beyond the Gap" methodology and is the product of a partnership between the Department of Higher Education and Training (DHET), the Development Bank of Southern Africa (DBSA) and the World Bank. The TVET sector was chosen because of its direct and significant role in achieving SDG 4 (quality education; specifically, SDG targets 4.3, 4.4, and 4.5 which relate to TVET), and its enabling role in achieving several others, such as SDG 8 (decent work and economic growth) and SDG 10 (reduced inequalities).

The report aims to inform policy choices and investment decisions related to TVET infrastructure, by quantifying the infrastructure funding needs for the public TVET system for a variety of scenarios to 2030 arising from infrastructure backlogs in existing TVET colleges and from the infrastructure needs arising from the anticipated expansion of the public TVET system that South Africa is targeting by 2030. The primary audience for the report is policymakers in the TVET system.

Methodology

The methodology used for this study is based on the World Bank report titled Beyond the Gap (Rozenberg & Fay, 2019), which emphasizes the need to analyse policy choices for addressing infrastructure deficits away from only spending more, to spending better, i.e., on the right objectives. It provides a systematic approach to estimating the infrastructure funding needed, and analysing the resulting policy choices, to close service gaps. The framework used in Beyond the Gap is summarized in Figure ES.1.

Figure ES.1: Beyond the Gap analytical framework (Source: Rozenberg & Fay, 2019)

The report analyses TVET infrastructure funding needs as one component of the overall cost of meeting South Africa's TVET objectives. This overall cost is estimated using a financial simulation model that encompasses the five steps described in Beyond the Gap and analyses three expansion scenarios. The first is the 'BAS Scenario' (or baseline scenario), which maintains the status quo of TVET performance in terms of access as well key quality inputs like the ratio of instructors to trainees. The second is the Post-Secondary Education and Training White Paper scenario ('PSET White Paper scenario') (DHET, 2014), which is aligned to the DHET's interpretation of the National Development Plan (NDP) as described in the PSET White Paper and sets an ambitious goal for the expansion of TVET, where the current access rates are expected to triple. The third and final scenario is the 'NDP scenario,' which is aligned to the NDP 2030 goal of having at least 1.25 million Full-time Equivalent (FTE, i.e., the standardised number of students when part-time students' actual course loads are standardised against the normal course load of full-time students) trainees in TVET by 2030. Table ES.1 highlights the various parameters driving expansion in the three different scenarios. The report uses the targets from the PSET White Paper and NDP as the relevant operational targets derived from South Africa's TVET-related SDG commitments (Targets 4.3, 4.4, and 4.5) because no specific targets related to these SDGs have been set.

Table ES.1: Overview of the expansion scenarios analysed using the financial simulation model

Focus area	BAS Scenario: Maintaining status quo	PSET White Paper Scenario: Ambitious expansion	NDP Scenario: Moderate expansion with efficiency
Population growth	Modest (1.3%)	Modest (1.3%)	Modest (1.3%)
Trainee participation	Baseline participation rate in TVET per 100 000 population	Triple participation rate in TVET per 100 000 population	Double participation rate in TVET per 100 000 population
Training modalities/ pathways	No students in distance education	Distance education begins in 2024, 50% of trainees in distance education by 2030	Distance education begins in 2024, 30% of trainees in distance education by 2030
Supply of instructors/ teachers	Baseline student teacher ratio sustained across all programs	Improved student teacher ratio across all programs	Improved student teacher ratio across all programs

Focus area	BAS Scenario: Maintaining status quo	PSET White Paper Scenario: Ambitious expansion	NDP Scenario: Moderate expansion with efficiency
Support staff	Teacher to non-teacher ratio fixed to the baseline	Teacher to non-teacher ratio fixed to the baseline	Improved efficiency in the teacher-to-non-teacher ratio per the 2016 staffing norms
Housing	No additional student is housed in TVET institutions	20% of additional students housed in TVET institutions	10% of additional students housed in TVET institutions
Welfare support	59.6% of trainees receiving welfare support from National Student Financial Aid Scheme (NSFAS[1])	59.6% of trainees receiving welfare support from NSFAS	All trainees receive welfare support from NSFAS

Source: Authors' compilation based on discussions with DHET

The report uses administrative data on enrolment, student housing, instructors, and support staff provided by the DHET. Both DHET-provided data and data from the National Treasury are used to estimate current funding levels, including funding provided through the NSFAS. The unit cost of constructing new TVET infrastructure is derived from the completion costs of recent DHET-financed infrastructure projects and data obtained from field visits conducted by the report team. Finally, the cost of meeting infrastructure backlogs in existing TVET campuses is calculated using data on infrastructure conditions provided by the DHET and estimates of the cost of upgrading existing campuses based on the team's field visits. Some of the limitations of this study include the lack of complete enrolment in 2020 for some of the TVET programs due to the COVID-19 related disruptions, but which has been estimated using the 2019 TVET census results; and fewer field visits to TVET institutions than preferred, aimed at understanding the

[1] NSFAS is the National Student Financial Aid Scheme established in 1999 and implemented by the South African government through its Department of Higher Education and Training (DHET). The scheme provides financial support to students from poor and working-class families thereby promoting access to, and success in, higher and further education and training

overall status of infrastructure in TVET institutions, which may have slightly skewed the results presented in this report.

Results

The cost of upgrading existing facilities and expanding the TVET system would be ZAR 211.6 billion under the baseline scenario, ZAR 754.7 billion under the ambitious PSET White Paper scenario, and ZAR 426.8 billion under the NDP scenario, all between 2022 and 2030, and these costs cover recurrent[2] and capital funding needs. Recurrent costs would account for between 79-89 percent of the total costs in respective scenarios (see Table ES2). The infrastructure upgrading and expansion would cost between ZAR 22.4 billion in the baseline scenario and ZAR 157.3 billion in the PSET White Paper scenario, with expansion taking the larger part (ranging from 72 percent in the baseline and more than 90 percent in the non-baseline scenarios).

Table ES.2: Total Funding needs for expansion and upgrade of TVET system, 2022-2030

In Million ZAR	BAS Scenario	PSET White Paper Scenario	NDP Scenario
Total projected costs	**211 599**	**754 698**	**426 753**
Recurrent	189 234	597 407	336 364
Capital	22 364	157 291	90 389
Expansion	16 160	151 087	84 185
Upgrade	6 204	6 204	6 204
% of costs that are recurrent	89.4%	79.2%	78.8%

Source: Authors' computations based on administrative data, simulation model results, and discussions with DHET

When annualized, the costs of expanding and upgrading the TVET system range between ZAR 22.6 billion in the baseline scenario to ZAR 78.8 billion in the PSET White Paper scenario, annually for the nine years (see Table ES.3). The moderated NDP scenario would cost ZAR 45.7 billion annually. Compared to the baseline scenario, expansion in the PSET White Paper scenario will cost three and seven times higher in recurrent and capital costs respectively (this is inclusive of upgrading and expansion). The NDP scenario, which also targets an improvement in system efficiency, would cost two and four times higher in recurrent and capital costs respectively, compared to the baseline scenario.

[2] Recurrent costs include salaries for teachers and non-teaching staff; non-salary operational costs (goods and services, utilities etc.); and support to students through the NSFAS

Table ES.3: Average annual costs for the upgrade and expansion of the TVET system, by scenario

	BAS Scenario	PSET White Paper Scenario	NDP Scenario
Recurrent costs (in Million ZAR)	**20 112**	**61 293**	**35 621**
Expenditure at central level	914	914	914
Expenditure for in-person education	19 199	56 207	33 868
Expenditure on distance education	-	4 172	839
Recurrent costs as % of GDP	0.34%	1.04%	0.61%
Capital costs (in Million ZAR)	**2 485**	**17,477**	**10,043**
Upgrading	**689**	**689**	**689**
Expansion	**1 796**	**16,787**	**9,354**
Maintenance of facilities	500	500	500
Construction of new campuses	1 296	9 182	6 057
Housing for additional students	-	4 662	1 571
Upgrade of existing housing facilities	-	2 187	969
Distance education infrastructure	-	257	257
Capital costs as % of GDP	**0.04%**	**0.30%**	**0.17%**
Annual funding needs (Million ZAR)	**22,597**	**78,769**	**45,664**
Annual funding needs as % of GDP	**0.38%**	**1.34%**	**0.78%**

Source: Authors' computations based on administrative data, simulation model results, and discussions with DHET

The total costs presented in Table ES.2 are compared to the resources projected to be available for TVET in the coming years to arrive at an estimated funding gap for meeting South Africa's TVET objectives. The funding gap in the three scenarios is projected on the assumption that public expenditure on TVET will remain the same as in the baseline year i.e., 0.35 percent of the GDP in the case of recurrent expenditure and 0.01 percent in the case of capital. The projected resources are subjected to the three different GDP growth profiles i.e., an annual growth of 2.21 percent on the GDP under the first socioeconomic projection scenario, 1.98 percent under the second and 1.78 percent under the third scenario. These assumptions would result in ZAR 188.9 billion potentially being available for spending on TVET over the 9-year period, under the first socioeconomic projection, dropping to ZAR 186.3 billion under the second growth scenario and ZAR 184.1 billion under the third growth option. The funding gap would range from ZAR 22.7 – 27.5

billion under the baseline scenario; ZAR 565.8 – 570.6 billion under the PSET White Paper scenario; and ZAR 237.9 – 242.7 billion under the NDP scenario (see Table ES.4).

Table ES.4: Funding gap for expansion by scenario, 2022-30

In Million ZAR	BAS Scenario	PSET White Paper Scenario	NDP Scenario
Total projected costs	**211,599**	**754,698**	**426,753**
Recurrent	189,234	597,407	336,364
Capital	22,364	157,291	90,389
Expansion	16,160	151,087	84,185
Upgrade	6,204	6,204	6,204
Total Projected resources			
Under GDP Growth Scenario 1	188,877	188,877	188,877
Under GDP Growth Scenario 2	186,284	186,284	186,284
Under GDP Growth Scenario 3	184,057	184,057	184,057
Funding gap			
Under GDP Growth Scenario 1	(22,721)	(565,821)	(237,875)
Under GDP Growth Scenario 2	(25,315)	(568,414)	(240,469)
Under GDP Growth Scenario 3	(27,541)	(570,641)	(242,695)

Source: Authors' computations based on administrative data, simulation model results, and discussions with DHET

Annual estimates show that the funding gap would range from ZAR 1.6 – 2.1 billion under the baseline scenario, translated to an average of 0.03 percent of the GDP; ZAR 57.8 – 58.3 billion annually under the PSET White Paper scenario, translated to an average a percentage point of the GDP; and ZAR 24.6 – 25.2 billion under the NDP scenario, translated to an average 0.43 percent of the GDP (see Table ES.5).

Table ES.5: Annual funding gap for expansion and upgrading of TVET, by scenario

In Million ZAR (2022-2030)	BAS Scenario	PSET White Paper	NDP Scenario
Projected annual costs	**22 597**	**80 826**	**47 720**
Recurrent	20 112	61 293	35 621
Capital	2 485	19 533	12 100
Expansion	1 796	18 844	11 410
Upgrade	689	689	689
Projected annual resources			
Under Scenario 1 GDP projections	20 986	20 986	20 986
Under Scenario 2 GDP projections	20 698	20 698	20 698
Under Scenario 3 GDP projections	20 451	20 451	20 451
Projected annual funding gap			
Under Scenario 1 GDP projections	(1 611)	(57 783)	(24 678)
Under Scenario 2 GDP projections	(1 899)	(58 071)	(24 966)
Under Scenario 3 GDP projections	(2 146)	(58 319)	(25 213)
Gap as % of GDP under scenario 1 projections	-0.03%	-0.98%	-0.42%
Gap as % of GDP under scenario 2 projections	-0.03%	-1.00%	-0.43%
Gap as % of GDP under scenario 3 projections	-0.04%	-1.02%	-0.44%

Source: Authors' computations based on the NDP, simulation model results, and data on TVET expenditure obtained from the National Treasury

Conclusion

Current levels of TVET funding are insufficient for South Africa to meet its TVET-related SDG commitments, with even the more modest TVET-expansion targets described in the NDP, costing two and five times higher than the estimated cost for the baseline (business as usual) scenario. Compared to projected funding available over the 9-year period from 2022-2030, this results in an estimated funding gap of ZAR 237.9 billion, which is 126 percent of the resources that are likely to be available from the first option of

the socioeconomic projection (See Figure ES.2). The funding gap for the more ambitious targets described in the PSET White Paper scenario is substantially larger at nearly ZAR 566 billion, translating to 300 percent of the resources likely to be available. These gaps assume that the funding levels in 2020 remain constant. An important contributor to the funding gap is the cost of TVET infrastructure. Funding this expenditure, even in part, will require more funding for TVET and better utilization of resources that will be directed to the sector. Figure ES.2 presents a summary of the average cost of expanding and upgrading the TVET system per scenario.

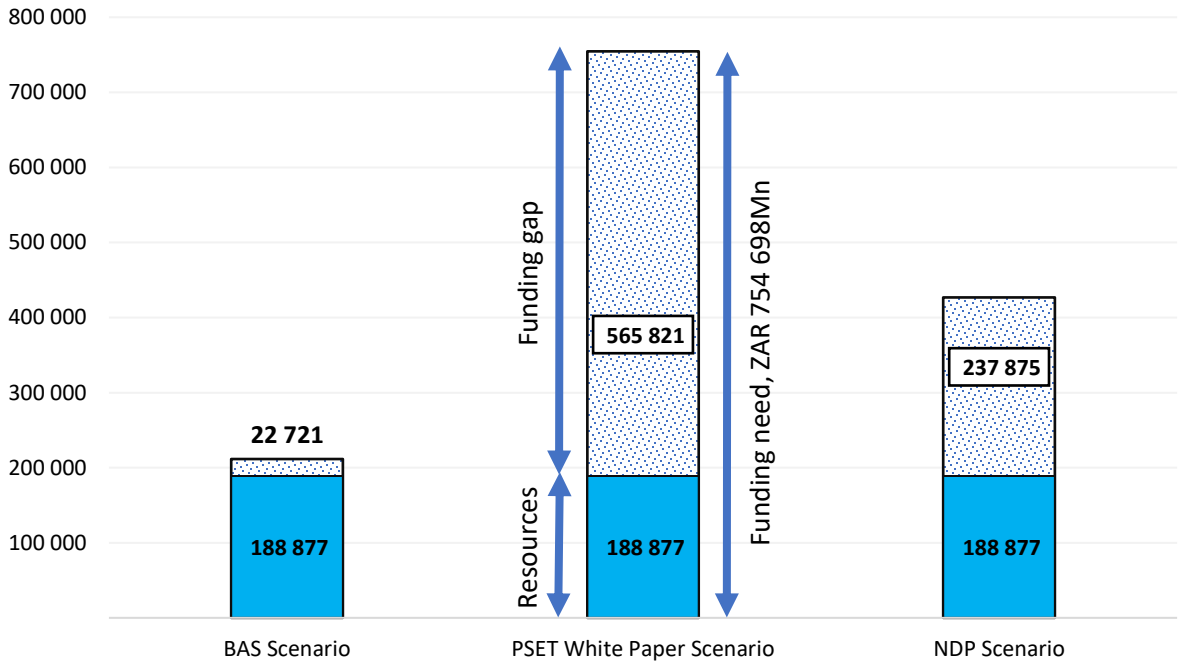


Figure ES.2: Estimated annual funding gap for TVET expansion, by scenario (ZAR Million)

Source: Authors' computations based on the NDP, simulation model results, and data on TVET expenditure obtained from the National Treasury; Notes: This figure shows the funding needs, resources and funding gap based on the baseline macroeconomic projection scenario only

The development of TVET infrastructure must be accompanied by several other policy and institutional reforms for South Africa to meet its TVET goals. Infrastructure is one of several mutually reinforcing constraints to the expansion of quality TVET services. Reforms in financing, infrastructure, instructor qualifications and competencies, management capacity, internal efficiency, and curriculum and training must be implemented simultaneously, and in a calibrated manner, to resolve these constraints.

Recommendations

(A) Improve the internal efficiency of the TVET system

Expenditure on TVET is highly inefficient. On-time graduation rates as low as 10 percent mean that a large share of resources is lost to dropout and repetition. Improving internal efficiency requires a combination of financial support to students, improving the quality of instruction, and providing better opportunities for students to complete practical training requirements. A part of the resources unlocked by improving efficiency must be directed towards capital expenditure, which is currently less than 4 percent of expenditure at the college level. More flexible fee regulation, linked to the quality of services provided, can also unlock additional funds for capital expenditure while incentivizing quality improvements.

(B) Diversify sources of funding and training models

Colleges must leverage their infrastructure, equipment, and expertise to generate additional revenue by directly providing services to industry. Private TVET colleges can also play an important role in supplementing public investment in TVET. Private colleges currently account for about a quarter of TVET enrolments but are increasingly losing access to public finances and face an unfavourable regulatory environment, with SETA resources being channelled away from the private sector and a quality assurance regime that imposes barriers to entry. Creating a more favourable environment for the growth of private colleges is critical because public investment alone is inadequate to achieve South Africa's TVET targets. Alternate modes of training, such as workplace-based training (WBL), can also be used to leverage the capacities and resources of firms, while imparting labour market-relevant skills that ease education to work transitions and help micro and small enterprises to secure skilled labour.

Finally, emerging business models, particularly venture capital, have been an important source of funding for the adoption of education technology in TVET globally. A conducive policy and regulatory environment, supplemented by targeted financial incentives, can help South Africa attract these investments.

(C) Develop macro-level space norms and strengthen DHET capacity to implement these norms and strengthen TVET staff capacity to deal with infrastructure issues

The planned expansion of TVET infrastructure requires new macro-level space norms (i.e., norms that establish broad ranges for the space required based on student headcount) that will allow the DHET to forecast infrastructure funding needs, given trends in enrolment. Existing norms also need to be revised to improve the utilization of space and better account for the different needs of each trade. This requires strengthening the DHET's capacity to develop and implement infrastructure norms, including investments in information systems for TVET infrastructure. In addition, future capacity building efforts should focus on the capacity of TVET staff to deal with issues regarding building and maintenance.

(D) Leverage technology to reduce demands on space and equipment

The TVET system must also adopt new technologies, such as virtual and augmented reality enabled training, which have successfully reduced demands on space and equipment in other TVET systems, thereby reducing infrastructure funding needs.

Planning and policy processes for TVET infrastructure need to account for the role of technology. Technology will enable new models of TVET delivery, which will change how TVET colleges are designed and constructed, potentially improving the efficiency of TVET. For South Africa to benefit from education technology, it must invest in digital infrastructure and digital skills for students, teachers, and administrators. As a result, investment needs for digital infrastructure will grow relative to physical infrastructure.

Alongside, the effective use of technology requires an enabling governance and regulatory environment which incorporates technology in the vision for the TVET sector, encourages the growth of technology-enabled solutions, promotes good decision-making on the choice of education technologies deployed, and effectively assures the quality of providers and programs that leverage technology-enabled training. The changes that technology will bring, such as the proliferation of providers and programs, will also require the DHET's capacity for system management to evolve. At the institutional level, TVET colleges will require strengthened capacity to manage digital infrastructure and devices.

Acronyms and abbreviations

AGPIA	Adjusted Gender Parity Index
AICTE	All-India Council for Technical Education
ASM	Assignable Square Meters
BCU	Base Cost Unit
BER	Bureau of Economic Research
CESM	Classification of Education Subject Matter
CET	Community Education and Training
CIEG	Capital Infrastructure Efficiency Grant
CoS	Centres of Specialisation
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of Southern Africa
DHET	Department of Higher Education and Training
FTE	Full-Time Equivalent
GDP	Gross Domestic Product
GER	Gross Enrolment Ratio
GFA	Gross Floor Area
HR	Human Resources
ILO	International Labour Organization
IT	Information Technology
LMIP	Labour Market Intelligence Partnership
MIF	Macro-Infrastructure Framework
NATED	National Accredited Technical Education Diploma
NC(V)	National Certificate (Vocational)
NDP	National Development Plan
NEET	Not in Employment, Education, or Training
NQF	National Qualifications Framework
NSA	National Skills Authority
NSDS	National Sustainable Skills Development Strategy
NSF	National Skills Fund
NSFAS	National Student Financial Aid Scheme

NSP	National Skills Passport
OECD	Organisation for Economic Co-operation and Development
P&Gs	Preliminaries and General
PLP	Pre-vocational learning programs
PSET	Post-School Education and Training
QCTO	Quality Council for Trades and Occupations
SAQA	South African Qualifications Authority
SDGs	Sustainable Development Goals
SENATI	Servicio Nacional de Adiestramiento en Trabajo Industrial
SETAs	Sector Education and Training Authorities
TEFMA	Tertiary Education Facilities Management Association
TVET	Technical and Vocational Education and Training
UFA	Usable Floor Area
WBL	Workplace-based learning

1 Introduction

1.1 Background and project objectives

South Africa is deeply committed to the SDGs. The country's ambition to achieve a prosperous society, based on inclusive growth and sustainable development, is closely aligned to the SDGs, the Paris Climate Agreement, and the African Union's Agenda 2063 ("The Africa We Want"). This ambition is embodied in its NDP: Vision 2030 (National Planning Commission, 2013), which is South Africa's blueprint for economic growth and development. While South Africa has made notable progress towards the SDGs, much ground remains to be covered. South Africa's 2019 voluntary national review of the SDGs indicates progress in some areas, including food security (SDG 2), health (SDG 3), education (SDG 4), water (SDG 6), and electricity (SDG 7) (Department of Planning, Monitoring and Evaluation (DPME), 2019), but suggests that the country has fallen behind on the SDGs overall. According to the Global SDG Index, which tracks countries' performances on the SDGs, South Africa is 61.5 percent of the way to the best possible outcome (Sachs et al., 2019). Of the 161 countries included in the index, it ranks 113th (in the bottom one-third).

Investments in infrastructure can accelerate progress towards the SDGs. Infrastructure deficits inhibit the delivery of critical services such as health, sanitation, and education, which in turn threaten the outcomes the SDGs aim to achieve. The World Bank report titled Beyond the Gap (Rozenberg & Fay, 2019) shifted the focus of the debate on addressing infrastructure deficits away from simply spending more, to spending better, i.e., on the right objectives. It provides a systematic approach to estimating the infrastructure funding needed to close service gaps. This report assesses infrastructure needs in the TVET sector, given South Africa's TVET objectives for 2030. It is one of four sectoral reports that draw on the approach taken by Beyond the Gap and is the product of a partnership between the DHET, DBSA, and the World Bank. The TVET sector was chosen because of its direct and significant role in achieving SDG 4 (quality education), and its enabling role in achieving several others, such as SDG 8 (decent work and economic growth) and SDG 10 (reduced inequalities).

1.2 Scope of the project

The report aims to inform policy choices and investment decisions related to TVET infrastructure. It does so by analysing the sector's infrastructure needs, the systemic factors that determine those needs, and the funding gap resulting from the cost of meeting those needs against projected levels of funding available up to 2030. It also draws on experience from South Africa and other countries to provide policy options for more and better funding for TVET infrastructure. The primary audience is policymakers in the TVET system.

While South Africa has a range of skills development options outside of TVET, such as WBL, Community Education and Training (CET) colleges, and private providers that play an important, albeit diminishing role in the TVET system, this report focuses on infrastructure needs of the public TVET system (see Section 3 for an overview of the TVET system).

The report accounts for the infrastructure needs arising from the expansion of the TVET system that is necessary to meet South Africa's 2030 objectives. The TVET enrolment objectives contained in South Africa's NDP 2030 (National Planning Commission, 2013) and PSET White Paper (DHET, 2014) are used to define the 2030 targets against which the cost of the expansion of the system is assessed (see Section 3 for an overview of the NDP 2030 and DHET 2020-25 strategic plan objectives; see Section 5 for a description of how these objectives were used to define the scenarios and model the costs required for the expansion of the TVET system). Therefore, the report considers these objectives as the relevant operational targets derived from South Africa's TVET-related SDG commitments (SDG Targets 4.3, Target 4.4, and Target 4.5)[3,4,5]. The report also analyses, to the extent possible, the infrastructure implications of technological and economic advancements that will shape TVET of the future, by considering both the

[3] Target 4.3: By 2030, ensure equal access for all women and men to affordable and quality technical, vocational, and tertiary education, including university

[4] Target 4.4: By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs, and entrepreneurship

[5] Target 4.5: By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations

demands that these advancements will place on the TVET system, and the new modes of delivery that they may enable.

1.3 South Africa's performance against TVET-related SDG targets

This section highlights South Africa's performance with respect to select SDG targets associated with TVET. South Africa lags other Upper Middle-Income Countries (UMICs) in terms of the gross enrolment ratio for tertiary education for both men and women, as indicated in Table 1.1. While 24 percent of South Africa's population in the 5-year age group immediately following upper secondary education was enrolled in tertiary education, the corresponding share for UMICs is 58 percent in 2020. The proportion of 15–24-year-olds enrolled in vocational training in the country was also relatively lower than the UMICs average.

In terms of gender parity, the gross enrolment ratio for tertiary education indicated disparity in favor of females, with a value of 1.36 for South Africa. While the UMIC average also indicates disparity in favor of females, it is less severe than in South Africa with an average gender parity index of 1.17.

Table 1.1: South Africa's Performance on SDG targets, 2020

SDG	Indicator Name	South Africa	UMICs Average
4.3.2	Gross enrolment ratio for tertiary education, both sexes (%)	24.24	58
	Gross enrolment ratio for tertiary education, female (%)	29.60	63.71
	Gross enrolment ratio for tertiary education, male (%)	18.93	52.73
4.3.3	Proportion of 15- to 24-year-olds enrolled in vocational education, both sexes (%)	2.16	7.89
	Proportion of 15- to 24-year-olds enrolled in vocational education, female (%)	2.31	7.97
	Proportion of 15- to 24-year-olds enrolled in vocational education, male (%)	2.00	7.84
4.5.1	Gross enrolment ratio for tertiary education, Adjusted Gender Parity Index (GPIA)	1.36	1.17
	Proportion of 15–24-year-olds enrolled in vocational education (GPIA)	1.14	1.02

Source: 2022 UNESCO Institute for Statistics; only data for tertiary education related indicators with data available for 2020 or later and with comparable data for UMICs is included.

2 Methodology

The methodology used to estimate South Africa's TVET funding requirements is based on the analytical framework developed in Beyond the Gap (Figure 2.1).

Figure 2.1: Beyond the Gap analytical framework (Source: Rozenberg & Fay, 2019)

This report analyses South Africa's TVET expansion and associated funding requirements in three main components. The first component is the expansion of the TVET system to accommodate new trainees based on the projected increase in the number of youths to join TVET. A simulation model – that encompasses the five steps in the Beyond the Gap analytical framework described in Figure 2.1 – has been developed for this component (refer Annex 3 for user guide for simulation model). It estimates (a) the youth who will probably join TVET from the projected population in the country (refer Annex 2 for population estimates) (given that access to TVET is measured as participation per 100 000 population), (b) the facilities they would require, and (c) the associated cost of capital investment to put up the said facilities. The simulation model provides various scenarios aligned to different sector ambitions, which are unpacked in later sections.

The second component includes the investments required to bring existing campuses to the required standards, or in other words, to upgrade them. This component is predicated on assessments of more than 250 existing campuses. The campuses are categorized as good, fair, or poor condition, with each group being associated with a given unit cost for upgrade – which also considers the size of campuses.

These two components give the total TVET infrastructure investment needed up to 2030. In addition to infrastructure investment, the report also acknowledges that an expanded TVET system will need an expanded operational ecosystem. The simulation model therefore estimates, based on the distribution of expanded capacity into different trades, the number of instructors needed to sustain existing and

additional trainees. Leveraging historic data and the unit spending on instructors and trainees, the model estimates the potential recurrent costs required to sustain such an expanded system.

Finally, the model accounts for the role of technology by simulating different scenarios on the use of distance education. Here, distance education is used as a proxy for the efficiencies that can be obtained through the increased use of technology that reduces demands on infrastructure and equipment.

The results presented in this study may be affected by some limitations, including the incomplete TVET enrolment in 2020 for the NCV programmes, attributed to the COVID-19 related closure of institutions. 2019 enrolments for these programmes have been used to estimate the full participation in 2020. Another limitation is the potential misestimating of the status of infrastructure in TVET institutions arising from visit of fewer than the scheduled institutions. During the planning phase, the study team had planned to visit 30 institutions, but at implementation, visited half of the institutions.

3 Overview of the TVET system[6]

3.1 South Africa's TVET objectives

The NDP: Vision 2030 (National Planning Commission, 2013) lays out ambitious targets for the growth of the PSET system, with TVET at its centre. This report assumes that these targets are South Africa's context specific operational targets derived from the TVET-related SDGs. Achieving the NDP's target of 5.4 million students enrolled in PSET by 2030 will require enrolment to increase 2.3 times from the 2.35 million students enrolled in 2019 (2.7 times from the 2.03 million students enrolled in 2020). Further, the NDP envisages a change in the structure of PSET enrolment, with TVET outgrowing other systems and replacing university education as the largest PSET sub-system (Figure 3.1).

[6] The analysis in this section is based primarily on 2019 data. 2020 data on some aspects of PSET, such as enrolment and student financial aid, only became available at the time of writing this report (from the Statistics on PSET in South Africa 2020 report (DHET, 2022)) and are provided in parentheses. COVID-19 related disruptions impacted enrolments (both in terms of scale and composition across sub-systems) significantly in 2020 and the extent to which enrolments have returned to pre-2020 levels is unknown. Based on discussions with the DHET, a combination of 2019 and 2020 (see Section 5 for details) data is used as the baseline for the simulation model in this report to reflect the full system capacity, as indicated by 2019 enrolments, while using the latest data available to the extent possible.

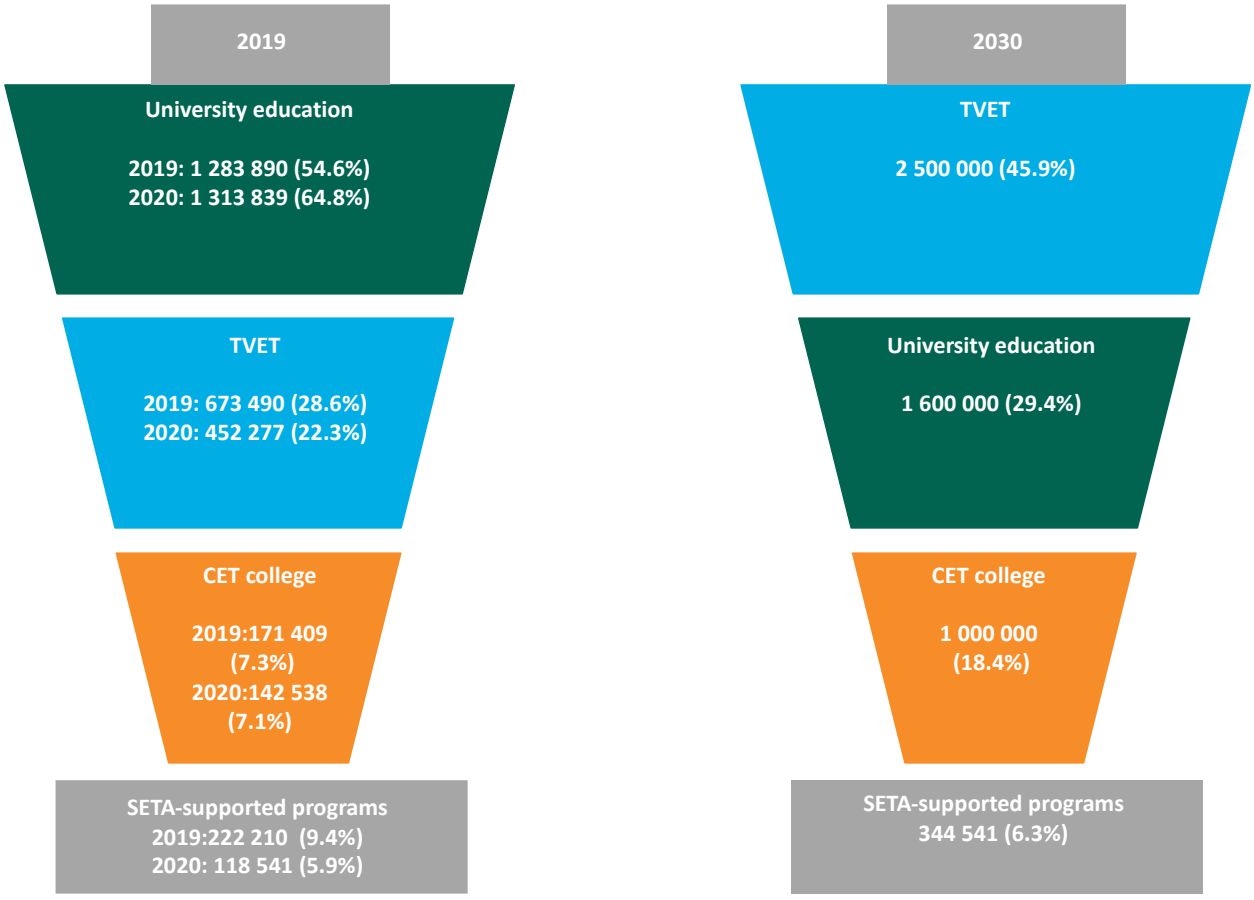


Figure 3.1: PSET enrolment in 2019 and PSET White Paper's interpretation of NDP enrolment targets for 2030 by sub-system

Source: PSET Monitor (Khuluvhe et al., 2021)

Current trends fall well short of what is needed to meet the NDP's targets. TVET enrolments more than doubled from 2010 to 2015 (see Figure 3.3 below) but have since declined from a peak of 740 000 in 2015 to 673 500 in 2019 (with a further COVID-19 related decline to 452 000 in 2020). In the next few years, enrolments are unlikely to increase at the rate required to meet the PSET White Paper's interpretation of the NDP target, which is 2.5 million students enrolled in TVET programs by 2030, or even the target described by the NDP itself, which is 1.25 million students enrolled in TVET by 2030. Recognizing this, the DHET's revised 2020-25 strategic plan (DHET, 2021b), aims for a modest increase in enrolment to 620 000

by 2024. It cites inadequate funding as the main constraint to reaching the trajectory implied by the NDP's 2030 target.

The strategic plan also establishes several other targets related to improving access to TVET, the quality of TVET services, and the outcomes of TVET students. These include targets related to student financial aid, teacher qualifications, and on-time completion (Table 3.1).

Table 3.1: Selected TVET-related targets in the DHET's 2020-25 strategic plan

Indicator	Baseline (2019)	Target by 2024
Number of student enrolments at TVET colleges annually	673 490	620 000
Number of TVET college students receiving funding through NSFAS bursaries annually	200 339	400 000
Number of TVET college students completing N6 qualification annually	114 012	76 000
Number of TVET college students completing NC(V) Level 4 annually	10 921	14 000
Throughput rate of TVET (NC(V))	31.8%	45%
Percentage of TVET college lecturers with professional qualifications	60%	90%
Percentage of TVET college lecturing staff appropriately placed in industry or in exchange programs	8.8%	18%
Number of universities offering accredited TVET college lecturer qualifications	9	10

Source: Revised 2020-25 strategic plan (DHET, 2021b)

When these targets are combined with the expansion of TVET enrolment that the NDP targets (or even a more modest version of that target), South Africa is aiming for both a massive expansion of the TVET system and a significant improvement in quality over the coming years.

3.2 The youth employment problem

Almost 60 percent of South Africa's 10.3 million 15-24-year-olds were unemployed in early 2020 (prior to the economic disruption caused by COVID-19) and 34 percent were Not in Employment, Education, or

Training (NEET); i.e., they were disengaged from both employment and education (Statistics South Africa, 2020). Youth in South Africa face particularly difficult and non-linear labour market transitions. Research from 2008 indicates that six months after exiting the education/training system and entering the labour market, only 3 percent of youth were in formal employment, 13 percent were in informal employment, 40 percent were unemployed but actively seeking employment, and 43 percent were discouraged from seeking employment (Ranchod & Dinkleman, 2008). Moreover, not only do youth find it difficult to get a first job, but they also face unstable employment when they are able to find one (Mlatsheni & Ranchod, 2017). A recent tracer study conducted by (Papier & Rogan, 2020) shows that the situation is changing, with 40% of graduates having made transition to employment, self-employment or work-based learning. It is apparent from these results that the weak school-to-work transition remains acute in South Africa.

This youth employment problem is caused, in part, by the PSET system's inability to provide youth the skills and competencies the labour market demands. One indicator of this is the extent to which workers' educational qualifications are matched to their jobs. Educational mismatch is highly prevalent, with more than half (53 percent) of the workforce either undereducated (27 percent) or overeducated (26 percent) for their jobs (Grapsa, Mncwango & Rogan, 2019). The Government of South Africa has repeatedly modified skills development policies to address this challenge, and solutions to the jobs crisis are high on its agenda. The President, in 2019, launched the 5by5 plan, which focuses on five priority interventions to optimize the delivery of skills development services and improve youth employment outcomes in five years[7]. Despite this focus, the COVID-19 pandemic, and resulting economic slowdown (the worst in three decades), have worsened the youth employment problem. By the second quarter of 2021, 64 percent of 15-24-year-olds were unemployed (Quarterly Labour Force Survey: Q2 2021, 2021). The economic slowdown is also likely to exacerbate the PSET system's many challenges, especially chronically low funding.

3.3 The PSET system

The PSET system is diverse and offers South African youth a broad range of options. It comprises all education and training provision for those who have (a) completed primary and secondary education, (b) not completed school, and (c) never attended school. The system is made up of four main sub-systems:

[7] These are: (i) pathway management network; (ii) workforce solutions for growing jobs; (iii) tech-enabled youth self-employment and township enterprise; (iv) workplace-based experience; and (v) opportunity to do service.

university education, TVET colleges, CET colleges (that provide adult and general education programs), and Sector Education and Training Authorities (SETAs) (that channel skills levies collected from the private sector to fund sector-specific and workplace-based training) as indicated in Figure 3.2. In 2019, total enrolment in the PSET system was 2.28 million students (2. 5 million students in 2020, including registration in SETAs programmes). The largest share of this enrolment was in university education at 56.3 percent in 2019 (65.5 percent in 2020), TVET colleges had 28.6 percent (22.3 percent in 2020) of total enrolment, CET colleges had 7.3 percent (7.1 percent in 2020), and the remaining 7.8 percent (6.1 percent in 2020) was in SETA-supported programs (DHET, 2021a).

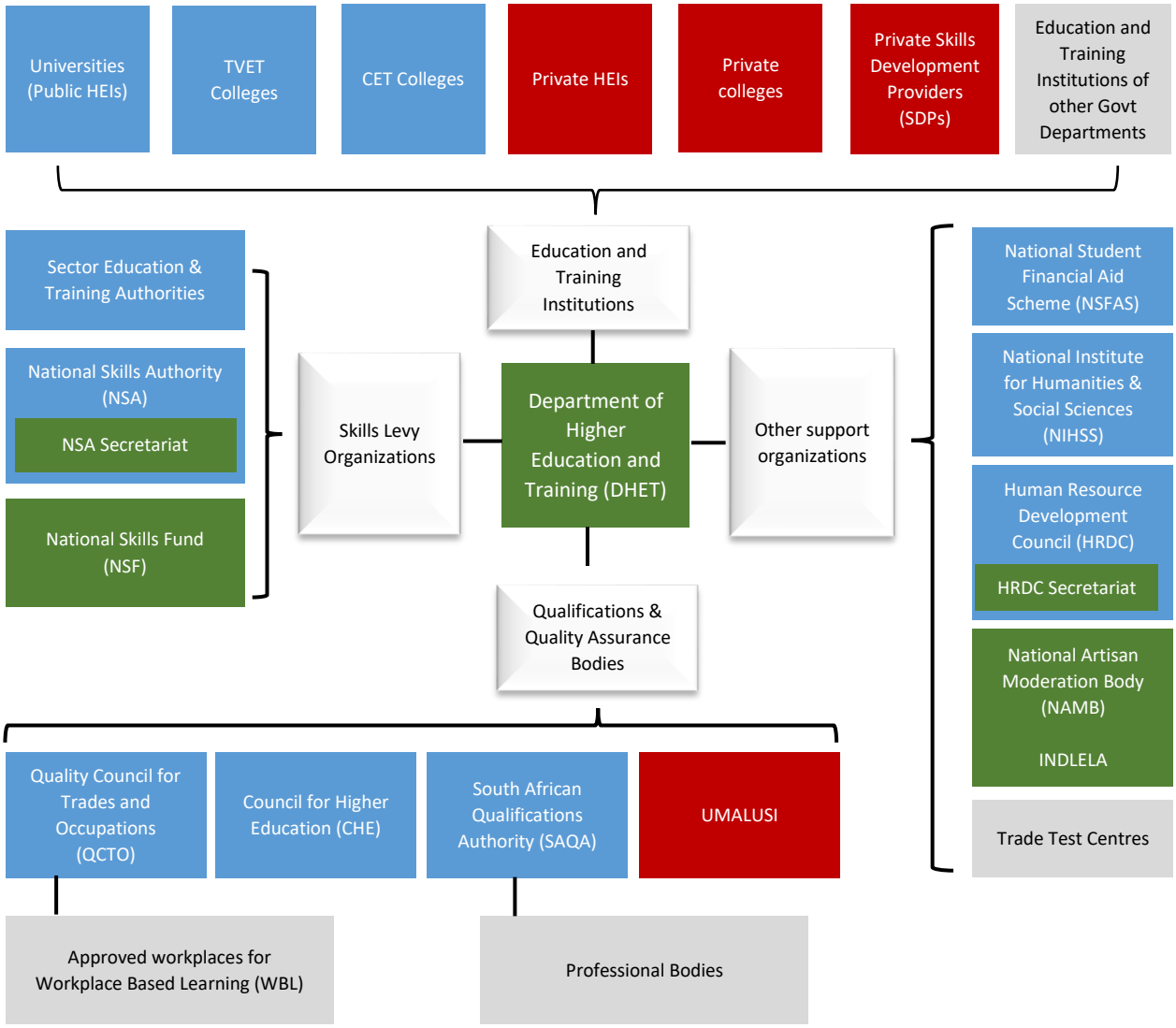


Figure 3.2: The PSET system

Source: Revised Strategic Plan of the Department for Higher Education and Training, 2020-2025

Since the amendment of the Skills Development Act in 2008, the DHET is fully responsible for the public provision, financing, regulation, and quality assurance of skills development. This includes programs offered by TVET and CET colleges, and SETA-supported programs. It executes these functions both directly and through autonomous and semi-autonomous statutory bodies that operate under it. These include the National Skills Authority (NSA) that oversees policy development, monitoring, and research, and the Quality Council for Trades and Occupations (QCTO) that is responsible for the quality assurance of artisan training and occupational qualifications. The South African Qualifications Authority (SAQA) is the custodian of the National Qualifications Framework (NQF). NSFAS and National Skills Fund (NSF) are key funding mechanisms for skills development.

Data on the private provision of skills development is scarce. According to DHET statistics, there are 287[8] private colleges (which are different from private universities and provide mostly TVET programs) that enrolled 151 000[9] students in 2019 (97 000 students in 2020), of which 46 percent (70 percent in 2020) were in National Accredited Technical Education Diploma[10] (NATED) programs, 22 percent in occupational qualifications courses (11.6 percent in 2020), and the remaining 32 percent (19 percent in 2020) in other skills development programs and short courses (DHET, 2021a). However, these figures are likely to be an underestimate of enrolment in private colleges as DHET is in the process of re-establishing a private provider registration system that had been suspended in 2011 (Ward, 2018a).

Access to formal workplace-based learning (WBL), funded mostly by SETAs, is limited. Further, of the 238 000 learners (222 000 were enrolled) that were registered by the SETAs in 2019-20, only around 145 000 came from the ranks of the unemployed (Franz, Dulvy & Marock, 2022). This is because too few companies participate in the system to offer workplace learning opportunities. WBL increases the labour market

[8] The number of registered private colleges declined from 287 in 2019 to 126 in 2020, due to DHET communique 1 of 2020, which stated that Skills Development Providers that offer occupational qualifications and part-qualifications on the OQSF are no longer required to register with the Department, but they must be accredited by the QCTO or its delegated Quality Assurance Partners (DHET, 2022).

[9] This number is based on a survey of TVET colleges conducted by the DHET to which only 54 percent of private colleges responded. The number was reported as-is, with no imputations for missing data. In 2018, the response rate was 81 percent, and the resulting total enrolment was 220 000.

[10] NATED programs are 36-month TVET programs that combine 18-month college-based learning with an 18-month internship. Engineering programs require a minimum of 24 months (2 670 hours) of applicable work experience or a relevant trade test certificate to obtain a Diploma

relevance of skills development programs and the employability of graduates, thereby easing education to work transitions. Engaging in WBL can also help micro and small enterprises secure skilled labour and increase their productivity. Therefore, while currently operating at a limited scale, WBL has significant potential to complement TVET training provided by colleges.

3.4 Public TVET provision and participation

Public TVET colleges, that are the focus of this report, are the largest providers of TVET services. In 2019 there were 50 public TVET colleges (hereafter referred to as TVET colleges) with 253 (254 in 2020) registered campuses (DHET, 2021a). These colleges offer 4 main types of programs, which can be accessed at different entry levels with either a Grade 9 or Grade 12 certificate:

- NATED programs require a grade 12 certificate for entry and combine 18-month college-based learning with an 18-month internship. Engineering programs require a minimum of 24 months (2670 hours) of applicable work experience or a relevant trade test certificate to obtain a Diploma. NATED programs go up to level 6 (one level below a bachelor's degree) of the NQF
- National Certificate (Vocational) (NC(V)) programs can be accessed with a grade 9 certificate and provide 3 years of training up to level 4 (equivalent to a grade 12 certificate) of the NQF
- Pre-vocational learning programs (PLP) is a foundational learning programme to prepare students for access into a specific vocational or occupational learning pathway at TVET colleges such as the NCV programmes at NQF level 2, N1 Engineering Studies programmes (Report 190) and occupational programmes at NQF levels 2 to 4. The PLP aims to address identified learning gaps and to improve students' chances of academic success in the qualifications and programmes they progress into after completing the PLP. Although the PLP has no assigned credits, there is formal assessment of competence and progress, and these results are endorsed by the Academic Boards of colleges.
- Occupational qualifications and part-time qualifications, including workplace-based learning, many of which are funded by SETAs and the NSF through the levy grant system

Enrolment in TVET colleges was 670 000 in 2019, up 88 percent from 2010 (Figure 3.3). Most of this growth was driven by NATED programs, where enrolment increased by more than 300 000 students over this period. As a result, TVET colleges are the fastest growing PSET sub-system, growing nearly four times faster than university education. However, COVID-related disruptions led to a sharp decline in enrolment,

to 452 000 in 2020, driven mostly by a reduction in NATED enrolments by more than 200 000 students. The pace at which NATED enrolments recovered will be known once data for subsequent years becomes available.

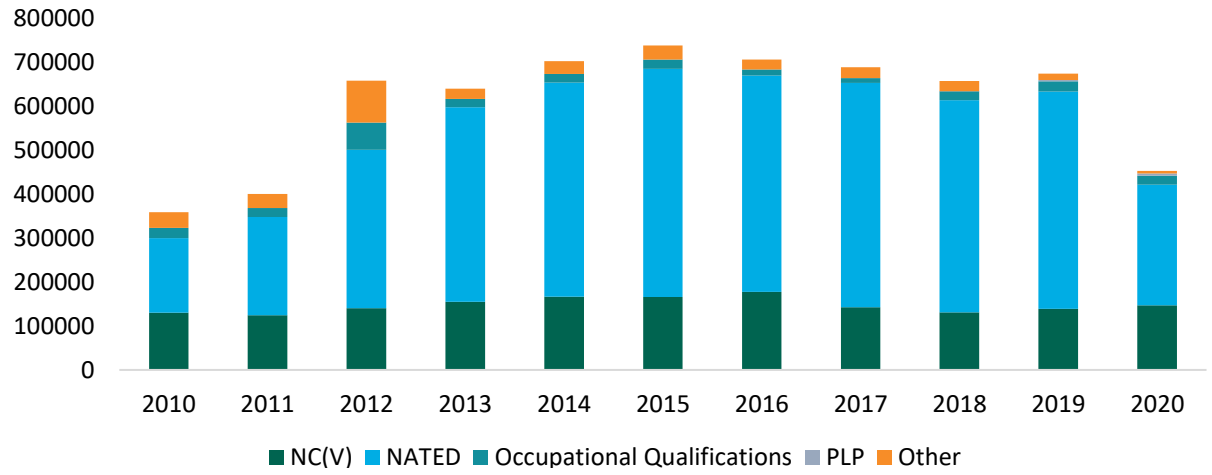


Figure 3.3: Enrolment in TVET colleges by type of qualification (2010-20)

Source: Statistics on PSET in South Africa 2020 (DHET, 2022)

Most students in TVET colleges are enrolled in engineering, business, finance, and management courses. While this pattern of enrolment may appear, at first glance, to be aligned with labour market demand (see, for instance, National List of Occupations in High Demand, DHET, 2020), the broad categorization of trades used conceals the prevalence of outdated courses and curricula that do not meet the significant demand for science- and technology-based occupations at the professional and technician levels (Figure 3.4).

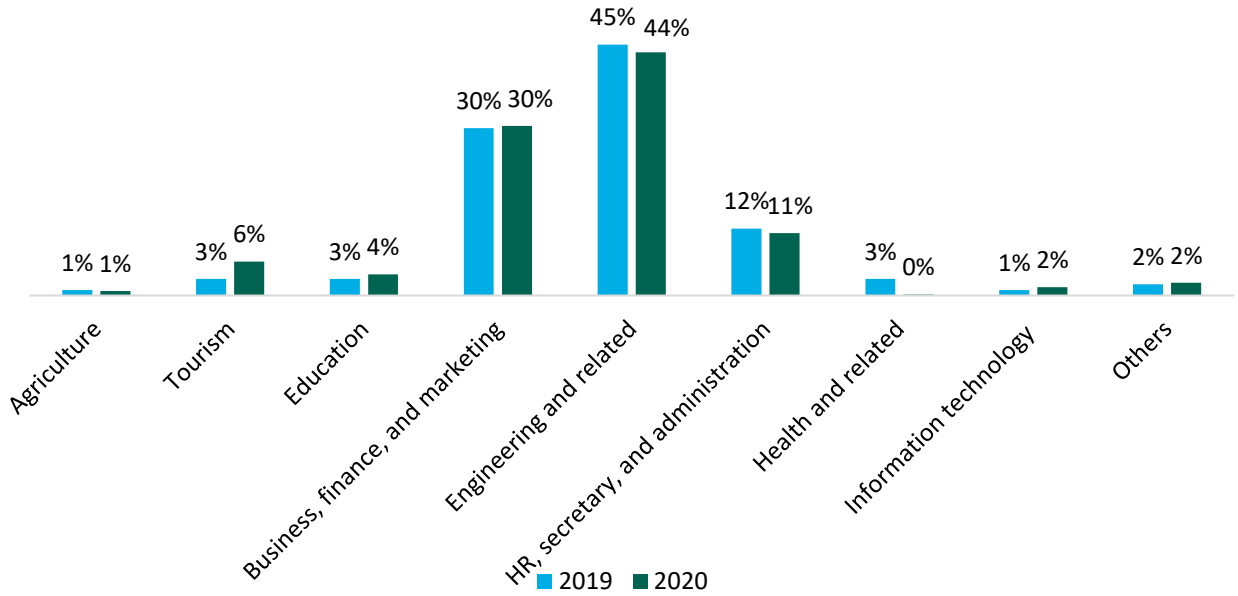


Figure 3.4: Percentage share of enrolment in TVET colleges by categories of trades (2019 and 2020)

Source: Authors' categorization of trades based on data enrolment provided by the DHET.

Not enough data is available on students' background characteristics. In particular, the DHET does not publish data on TVET college students' background characteristics, such as socioeconomic status and prior educational qualifications that would help analyse the pattern of demand for TVET and potential barriers to access. However, there is some data to suggest that TVET colleges play a significant role in catering to groups who are traditionally unserved by PSET. For instance, Black African students account for 92 percent of enrolment in TVET colleges (growing at 10 percent per annum since 2010), compared to 76 percent of enrolment in university education (growing at 4 percent per annum since 2010). Over time, more women than men have begun to enrol in TVET colleges. The gender parity index of enrolment rose from 0.9 in 2010 to 1.4 in 2019 (DHET, 2022). This trend, however, is not unique to TVET colleges and is observed in other PSET sub-systems as well.

3.5 Student outcomes in TVET colleges

The internal efficiency of TVET colleges is low, which increases per-completer costs and places additional demands on campus infrastructure. High levels of repetition and dropout mean that students do not complete programs in the expected timeframe. For instance, only 9.2 percent of students enrolled in NC(V) programs in 2016 completed the three-year program by 2018 (Khuluvhe et al., 2021). This is despite significant increases in passing rates in certification examinations for NC(V) and NATED programs over

recent years (Figure 3.5), indicating that repetition and dropout prior to certification examinations rather than low passing rates in certification examinations are largely responsible for the low internal efficiency. Some of the potential causes of repetition and dropout are the low quality of training caused by poorly trained and unmotivated instructors who lack qualifications in TVET instruction and relevant industry experience (Green, 2018), low availability and quality of instructional facilities (Alexander & Masoabi, 2017), outdated programs and curricula (DHET, 2021b), low private returns to TVET, especially when the training duration is long (World Bank, 2019), and students' financial constraints (World Bank, 2019). For students in NATED programs, completion is also delayed because many students are unable to find internships required to complete the 18-month internship requirement. Repetition causes students to spend longer than expected on campus and places a high burden on campus infrastructure such as student accommodation, which is already in short supply (el Zayat et al., 2020).

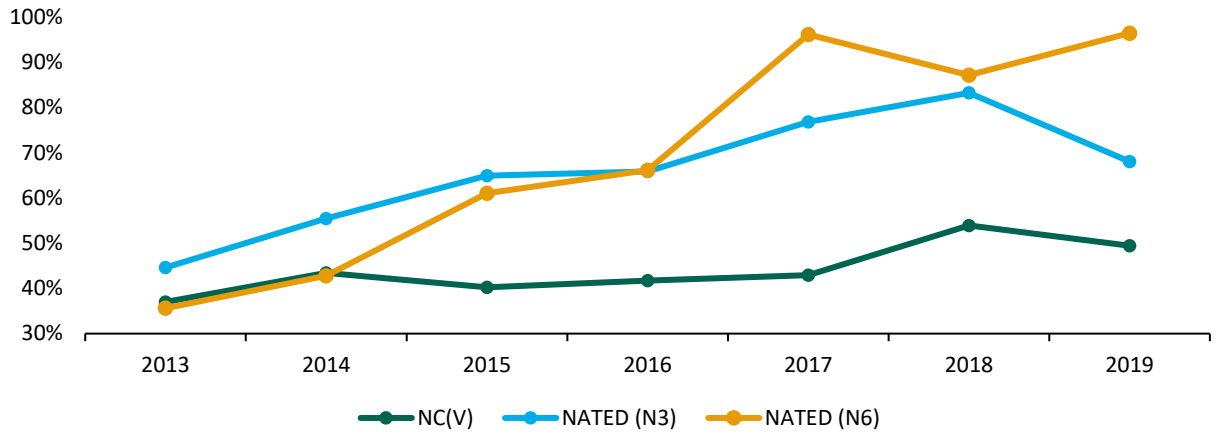


Figure 3.5: Certification rates for candidates who wrote NC (V) and NATED examinations (2013-19)

Note: NATED N3 certification is equivalent to a senior secondary certificate (NQF level 4), while NATED N6 certification is equivalent to a national diploma (NQF level 6).

Source: PSET Monitor (Khuluvhe et al., 2021).

Students' employment outcomes are mixed, with NATED programs outperforming NC (V) programs. There is no systematic data collection on employment outcomes. As a result, comparable data on the employment outcomes of TVET programs versus other PSET programs, or those of different TVET programs is not available. However, some tracer studies provide partial understanding of employment outcomes. A 2016 graduate tracer study of the Labour Market Intelligence Partnership (LMIP), the most recent study on employment outcomes of NATED programs (Papier et al., 2018), found that 52 percent of completers found employment. The LMIP study showed that employment outcomes were better for male

than for female graduates, and for engineering programs than for business programs. NATED N6 completers had a 10 percent higher rate of employment than NC (V) completers, which suggests that higher-skilled technicians have better employment outcomes. The study also revealed significant employment differences between fields of study ranging between a 40 percent employment rate among graduates from the public relations courses and a 100 percent employment rate (albeit based on a relatively small number of cases) for manufacturing graduates. Very few graduates opted for self-employment, mostly because of a lack of employment opportunities. A more recent tracer study (CBPEP and DHET, 2020) found a 40 percent absorption rate into either wage employment, self-employment, or workplace-based learning for TVET graduates.

While directly comparable data is not available for NC (V) programs, their employment outcomes are inferior to those of NATED programs. A 2016 study of engineering graduates from the North West province found that 15 percent of all graduates were wage earners or self-employed, while 18 percent were unemployed. A considerable share continued education and training – 27 percent continued as students and 40 percent, the largest group in the survey, were in workplace training (Mashongoane, 2018). Another tracer study from 2015, which traced 2010 graduates over five years post-graduation (Swiss-South African Cooperation Initiative, JET Education Services & National Building Initiative, 2016), showed that while more than 60 percent of completers were employed at some stage between 2011 and 2015 (including apprenticeships or internships), employment was often part-time and poorly paid, with wages less than ZAR 3 000 per month.

3.6 Funding public TVET provision

TVET colleges are funded through a combination of government expenditure, student fees, and employer contributions (via the skills development levy). Government expenditure in TVET is based on programmes offered by colleges, enrolment in each institution, the cost of delivery, and capital infrastructure need. Government expenditure on TVET was ZAR 16.7 billion (including NSFAS) in 2019-20, about 16 percent of the total expenditure on PSET of ZAR 107 billion (Khuluvhe et al., 2021). Per-Full-Time Equivalent (FTE) expenditure on TVET colleges has ranged from a quarter to half of that on public universities in recent years (Figure 3.6). The increase in TVET expenditure since 2017-18 is because of an increase in DHET subsidies to TVET colleges (from about ZAR 1.5 billion in 2017-18 to about ZAR 5.2 billion in 2018-19) and an increase in NSFAS funding in 2019 (from ZAR 2.7 billion in 2018-19 to ZAR 5.1 billion in 2019-20).

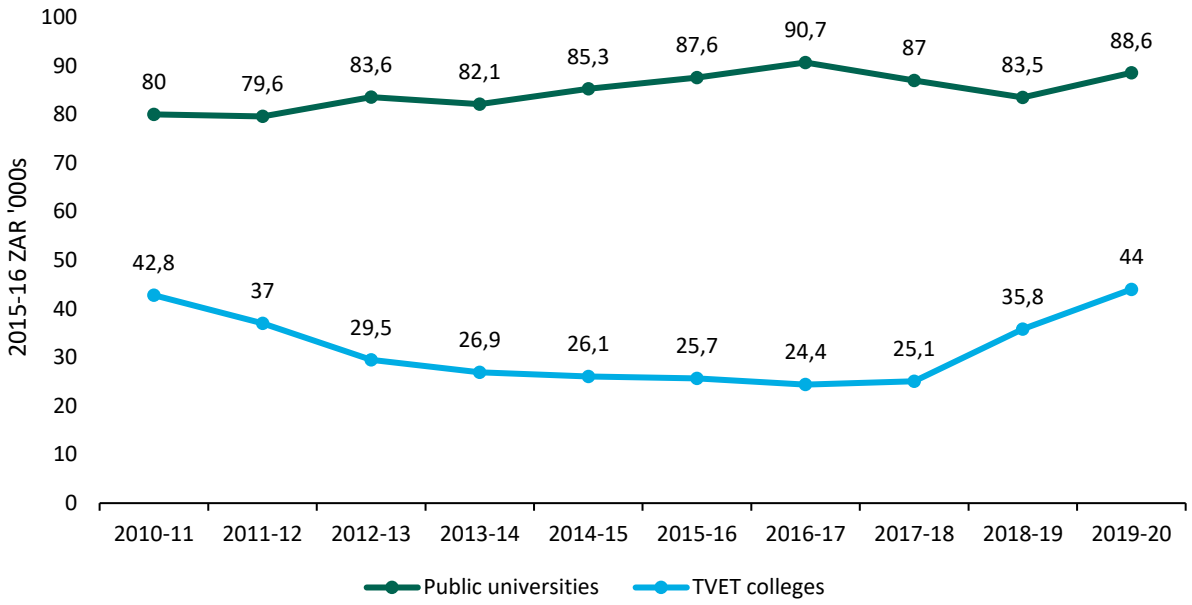


Figure 3.6: Per-FTE student expenditure on TVET colleges and universities (2010-11 to 2019-20)

Notes:

1. Per FTE-student expenditure on public universities is calculated by dividing the total expenditure on public universities (government, student fees, and third-stream income) by the number of public university FTE students.
2. Per student FTE expenditure on TVET colleges is calculated by adding together subsidies to TVET colleges plus conditional grants or operational costs, plus TVET NSFAS then dividing the figure by the number of TVET colleges FTE students.

Source: PSET Monitor (Khuluvhe et al., 2021)

DHET allocations to TVET colleges are expected to follow financing norms and standards[11], but these are not fully implemented. The DHET allocated ZAR 11.5 billion to TVET colleges in 2019-20. The DHET's allocations are divided into two streams — program funding and earmarked funding. Program funding, which is expected to cover 80 percent of (non-capital) program costs according to the norms, is based on a funding formula that accounts for enrolment (which determines 90 percent of the program funding amount) and completion rates in previous years (which determine the remaining 10 percent) for each program (DHET, 2019). The portion of program funding that is based on enrolment is a function of a fixed level of baseline funding per student, the number of FTE enrolees, and the number of students from historically disadvantaged backgrounds or with special education needs. Earmarked funding includes general capital funding (which the norms mandate to be at least 10 percent of total funding), separate

[11] Financing norms and standards contained in the Continuing Education Training Act 16 of 2006, revised in 2015

capital funding for student accommodation, and college operational costs paid directly by the DHET. In practice, DHET allocations do not meet the norms. In 2013-14, the Expenditure Performance Review (DNA Economics, 2016) found that allocations to TVET colleges were only 50 percent to 80 percent of the amounts implied by the norms. Further, non-staff funding is very limited. Of the DHET funding to TVET Colleges, 80 percent is allocated to cover staff costs, and only 20 percent is directly transferred to colleges to be used for goods, services, and operational costs (DHET, 2018).

Student fees vary considerably across programs and an increasing proportion of TVET college students receive financial aid from the NSFAS. TVET colleges have limited autonomy in determining fees. The DHET establishes an "assumed fee" for each program and colleges can set fees up to 10 percent above this assumed fee (exceeding this limit requires permission from the DHET on a case-by-case basis). The assumed fee is set at a level that covers 20 percent of the program cost and the remaining 80 percent is, in principle, to be covered by DHET program funding (DHET, 2019). While there is no comprehensive dataset on fees charged, fees tend to reflect the cost of provision. Engineering, Information Technology (IT), and hospitality programs are the most expensive, while business and administration programs are considerably cheaper. An increasing proportion of TVET college students receive financial aid, in the form of bursaries or loans from the NSFAS. Students from families with gross combined annual incomes of less than ZAR 350 000 are eligible for bursaries that cover full tuition fees and the cost of learning materials in full, with additional subsidies available for transport and accommodation. In 2019, more than 51 percent (58 percent in 2020) of TVET college students received NSFAS aid, compared to less than 30 percent in 2011. However, recent increases in NSFAS spending, in response to the "FeesMustFall" student protests in 2015-16, have prioritized the university education sub-system. As a result, per-student NSFAS aid to TVET students has not kept pace with the increase in per-student NSFAS aid to university students, which was approximately 4 times as high in 2019 (3 times as high in 2020) (Figure 3.7). Inadequate financial aid, which often doesn't cover the full training duration, is one of the causes of the high rates of drop-out from TVET programs because students are unable to fully fund their studies.

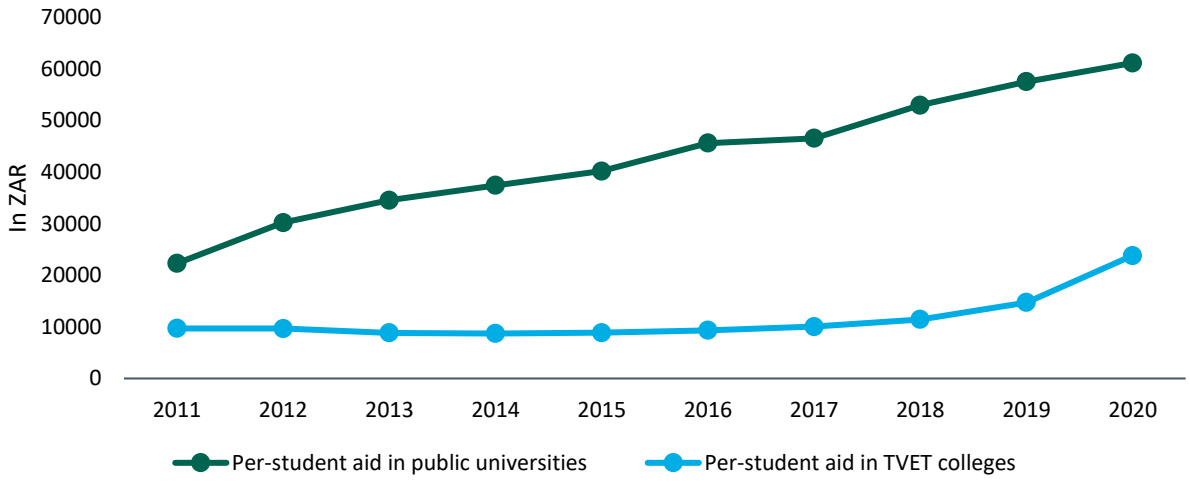


Figure 3.7: Per-student nominal NSFAS aid (in ZAR) to public university and TVET college students (2011-20)

Source: Statistics on PSET in South Africa 2020 (DHET, 2022)

A portion of funds collected through the skills development levy accrue to TVET colleges in the form of SETA-supported programs and NSF grants for priority skills development programs. However, data on the amount of funding TVET colleges receive through these channels is not available. The NSF also spends part of its budget directly on systems, capacity, and infrastructure development in the PSET sector. Its expenditure under these heads (systems, capacity, and infrastructure development) in 2019-20 was ZAR 589 million (National Skills Fund, 2020). However, how much of this accrued to TVET colleges is not clear.

Overall, TVET colleges have limited financial incentives to improve quality, funding for investments in infrastructure and quality improvements is insufficient, and internal efficiency is very low. The current model for determining fees and program funding from DHET, which is based primarily on the cost of provision rather than indicators of quality, does not incentivize quality improvements. This is reinforced by inadequate funding, including because of the DHET's inability to meet the funding norms, which means that colleges do not have funds to invest in infrastructure and quality improvements. For instance, an analysis of the 2015 annual financial statements of TVET colleges found that instead of spending 10 percent of their budgets on capital infrastructure replacement (as mandated by the funding norms), colleges spent 96 percent of their budgets on recurrent expenditure, with the remaining 4 percent spent on furniture and equipment (DHET, 2021b). Finally, the very low internal efficiency (as measured by the percentage of on-time completers) of TVET programs raises the cost of TVET provision, lowering both the fiscal rates of return to TVET provision and private rates of return for students (World Bank, 2019). Taken

together, distorted financial incentives, inadequate funding, and low efficiency constrain the expansion of quality TVET in South Africa.

3.7 Constraints to the expansion of high-quality TVET services and the role of infrastructure

There are several systemic constraints to achieving South Africa's TVET objectives. Systemic gaps in funding, infrastructure, instructor qualifications and competencies, management capacity, internal efficiency, and curriculum and training constrain the expansion of high-quality TVET services required to meet South Africa's objectives (Figure 3.8). These constraints are mutually reinforcing and policies and programs to address one constraint must consider the limitations imposed by the others. For instance, gaps in funding, such as inadequate student financial aid for long duration programs, contribute to dropouts, which reduces internal efficiency. Conversely, low internal efficiency increases per-completer costs and limits funding available for student financial aid.

The lack of a planned expansion of infrastructure limits the expansion of high-quality TVET services. At the system level, the TVET sub-system has not had a planned infrastructure expansion program since the Recapitalisation Program, which ended in 2008. Since then, most infrastructure development at the college level has focused on refurbishing buildings or constructing a few extra buildings on existing campuses (DHET, 2021b). An evaluation of the College Expansion and Capacity Development Program implemented by the DHET and NSF between 2012 and 2015 found that poor infrastructure and inadequate funding for infrastructure investments, among other factors, hindered the envisaged expansion in access under the program (Southern Hemisphere, 2018). Alongside limiting expansion, poor infrastructure limits quality because of, for instance, poor instructional facilities. Further, while poor infrastructure is a consequence of inadequate funding, it also contributes to the lack of funding by limiting efficiency. For instance, the lack of information and communication technology on campuses prevents the adoption of alternate, cheaper modes of delivery.

Figure 3.8: Systemic gaps that constrain the achievement of South Africa's TVET objectives

Source: Authors' illustration

Investments in infrastructure must be grounded in effective policy and planning processes. First, in terms of policy, the TVET sub-system needs well-defined norms and standards for campus infrastructure that could provide the basis for future infrastructure investments. Second, on planning, there is a need for tools to forecast infrastructure needs, and the associated funding required, based on the various factors (such as demographic trends, enrolment across trades etc.) that will determine the size and structure of the TVET sub-system in the future. Finally, once infrastructure needs have been determined, policy and programmatic options for the implementation of infrastructure investments must be analysed, keeping in mind the availability of funding and the likely needs of TVET colleges of the future, as addressed in the following sections. Besides the forecast of the future infrastructure needs, TVET, like other tertiary

institutions in South Africa and globally, can contribute immensely to the drive towards sustainable cities and communities through green building and construction. Box 1 highlights some of the benefits of green buildings, with successful examples in South Africa and beyond.

Box 1: Climate change sensitive expansion of TVET: Green construction

Buildings are said to be some of the largest carbon emission agents in the world, generating almost 28 percent of all carbon emissions globally.[12] Projected growth in the population across the world and especially in Africa shows that the demand for buildings will rise dramatically, and that up to 80 percent of buildings that will exist in 2050, are yet to be built[13] today. The implication being that alternatives to conventional construction must be found if carbon emissions are to be reduced or completely eliminated. In 2007, the Green Building Council South Africa (GBCSA) was founded to bring together architects, developers, government, business leaders as well as schoolchildren to transform the way in which South Africa builds into its future; recognizes and scales building solutions to accommodate the vast geographic landscape, cultural and historic traditions in the country.[14]

The estimated number of TVET campuses needed to accommodate the expected increase in trainees is high. One approach that can be considered by the Government to meet the expected demand is using tested green building solutions. Although the expansion of TVET has been costed using conventional approaches, using the green buildings approach could contribute to the achievement of SDG 11 and 13 on sustainable cities and communities and climate action respectively. Green buildings will not only offer opportunities to reduce carbon emissions, but also create efficiency savings. Green buildings are estimated to cost around 5 percent more than conventional construction but reduces operating costs by about 8 percent, most of these savings coming through reduced energy and water usage and lower operating and maintenance costs.[15] The benefits of sustainable buildings, can be achieved through the framework on Figure BX1.

12 Yanu Aryani (2020) Green Buildings for College Campuses. Universities are going green with EDGE in Cambodia, Colombia, Indonesia, and Mexico. https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf

13 Africa Manifesto for Sustainable Cities and the Built Environment. https://worldgbc.org/worldgbc-africa-manifesto/

14 Terry Wills (2022) Green building in Africa: reinventing growth. Climate Action. https://www.climateaction.org/climate-leader-papers/green_building_in_africa_reinventing_growth. Accessed 2 December 2022

15 Benefits of green buildings far outweigh the costs. https://www.absa.africa/world-economic-forum/africa/absa-at-wef/op-ed-piece-1/. Accessed on 02 December 2022

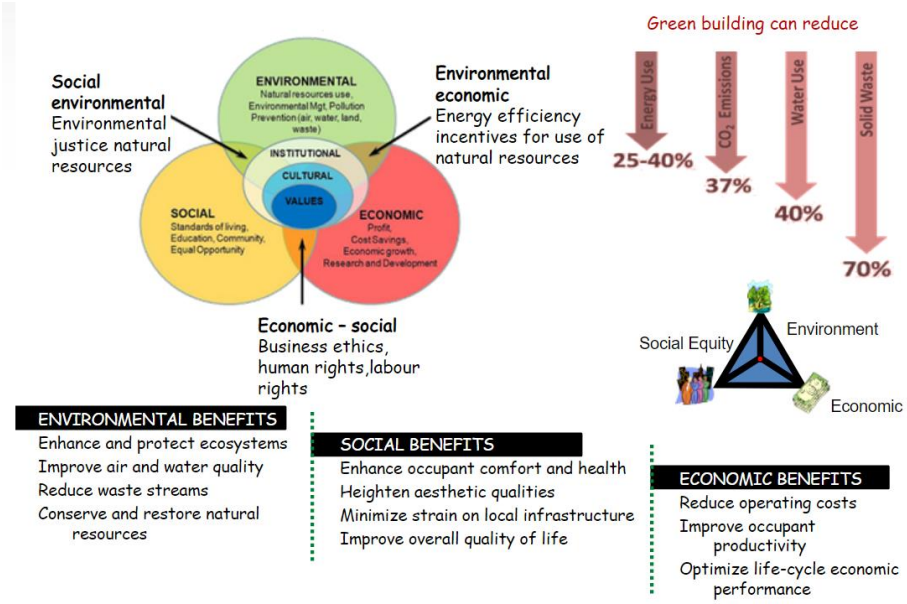


Figure BX1: Environmental, Social and Economic benefits of green buildings
Source: (Bridges, 2016) [16]

The GBCSA has certified more than 500 buildings across South Africa and Africa, each responding to a specific environmental need. Successful examples of green buildings from South Africa include the University of Cape Town's New Lecture Theatre located in the upper campus, which is built from a range of green features and natural finishes to ensure low or zero maintenance. The theatre has automatically opening and shutting windows depending on heat and carbon monoxide levels, motion-sensor lighting and the harvesting of rain water used in flushing of toilets.17 UTC's School of Education (SOE), has been awarded four Green Stars by GBCSA for its environmentally friendly design, increasing UTC's green awards to four. The design at SOE is expected to provide users with a healthy and comfortable space to study, work and play18 and entails (i) retention of existing landscape and matching the landscape with new plants where necessary, thereby minimizing the need for irrigation and reducing water use by rates of up to 80% an efficiency achieved through the innovative use of water sub-meters that highlight where water is being used and also detect leaks; (ii) harnessing daylight and making use of natural ventilation to cut down on energy consumption by up to 40%.

Green School South Africa, a sustainable schooling model in the Western Cape, is another successful example where the buildings are constructed from naturally and locally sourced materials, such as dek-riet19 ceilings, clay and soil and pebbles harvested from the site, all for the integration with the surroundings and utilizing the materials and workmanship from the local area. In other selected countries across the continent, the Agostinho Neto University in Angola is putting up a host of buildings and outdoor spaces adapted to hot and dry climate conditions.20 The Green Building Designs at Strathmore University Business School21, whose preference of glass over block/brick lets in ample

16 Benefits of green buildings https://slideplayer.com/slide/10318390/
17 https://www.news.uct.ac.za/article/-2017-05-03-green-rating-a-first-for-uct
18 https://www.news.uct.ac.za/article/-2021-11-29-uct-gains-another-green-star-building-rating
19 Dek-riet is the reed cover of a roof. See the dictionary of South African English on historical principles. https://m.dsae.co.za/#!/word/1902/dakriet
20 https://www.architecturalrecord.com/articles/7904-universidade-agostinho-neto
21 https://sbs.strathmore.edu/3-impressive-green-building-designs-at-strathmore-university-business-school/

natural lighting, minimizing the need for external lighting fixtures; a rainwater harvesting system collects and treats the water before supplying 90 percent of the building's water needs; evaporative cooler improves air quality at a fraction of the cost of traditional mechanical coolers. The designs in Strathmore have earned the university the Best Green Building Development in Africa award from the African Real Estate and Housing Finance (AREHF) in 2012, including a Leadership in Energy and Environmental Design (LEED) certification, the first university in Africa to receive this.

The expansion of TVET can offer an opportunity for the country to further expand its network of green buildings across tertiary education institutions. Although the campaign for sustainable or green buildings and construction has been gaining traction, its reach in African countries (and especially in South Africa) remains low. This is attributed to low levels of knowledge on green buildings and capacity to implement sustainable building approaches. An entry point could be an increase in the dissemination of materials on successfully completed green buildings and address any apprehension that stakeholders may have on the approach

4 TVET infrastructure space norms and costs of construction

The construction of new infrastructure will be a key driver of the cost of expansion of the TVET system. Achieving efficiency in the construction and utilization of infrastructure, while ensuring that constructed spaces are flexible and functional, will require effective space planning and management systems, of which space norms are an important component.

Space norms describe an allowance of space for a given set of activities. Norms are used as an element of the decision-making processes required for new construction proposals, the reconfiguration and refurbishment of existing buildings, and the allocation of spaces across academic disciplines or different uses, such as teaching facilities and non-teaching areas. Making these decisions effectively requires a balance between norms-based standardization (which can lead to cost efficiencies) and differentiation based on academic, cultural, and climatic conditions. Therefore, space planning based on norms should be augmented and adjusted by considering the specific needs of colleges that they determine for themselves. When appropriately differentiated, norms-based space planning should result in efficiently constructed spaces that translate institutional objectives into effective spatial relationships between functions and between the people who perform these functions.

This section provides a comparative analysis of space norms for higher education institutes in South Africa, Australia, and India to identify opportunities to strengthen the norms for TVET infrastructure in South Africa. Australia and India were chosen as comparator countries because they have detailed, published

space norms for TVET infrastructure. It also describes how optimizing space norms can optimize costs of construction and maintenance. It concludes with an analysis of the prevailing unit cost of construction for TVET colleges in South Africa, which can be used to inform construction cost estimates at both the system- and college-levels and is used in this report to project the construction expenditure required for the expansion of the TVET system.

4.1 Comparative analysis of space norms in South Africa, Australia, and India

Space norms required to inform planning at the system level differ in their level of detail from those required to inform space planning at the college level. The analysis in this section uses a framework of three categories of norms (Figure 4.1) to compare space norms in South Africa, Australia, and India. These categories are:

- Macro level 1: Norms at this level provide broad ratios for the space needed per student. They are used to assess infrastructure needs at the system level and, when combined with the unit cost of construction, can be used to calculate the infrastructure investment needs of the system
- Macro level 2: These norms describe space needs for specific academic organization units (such as a faculty or group of disciplines) based on the unit's staff and student numbers and the trades to be taught. These are used for overall financial planning at the campus level
- Micro level: At this level, norms provide the areas for and student numbers to be housed in each facility (such as a classroom, laboratory, or workshop). These are used to prepare building designs and cost estimates

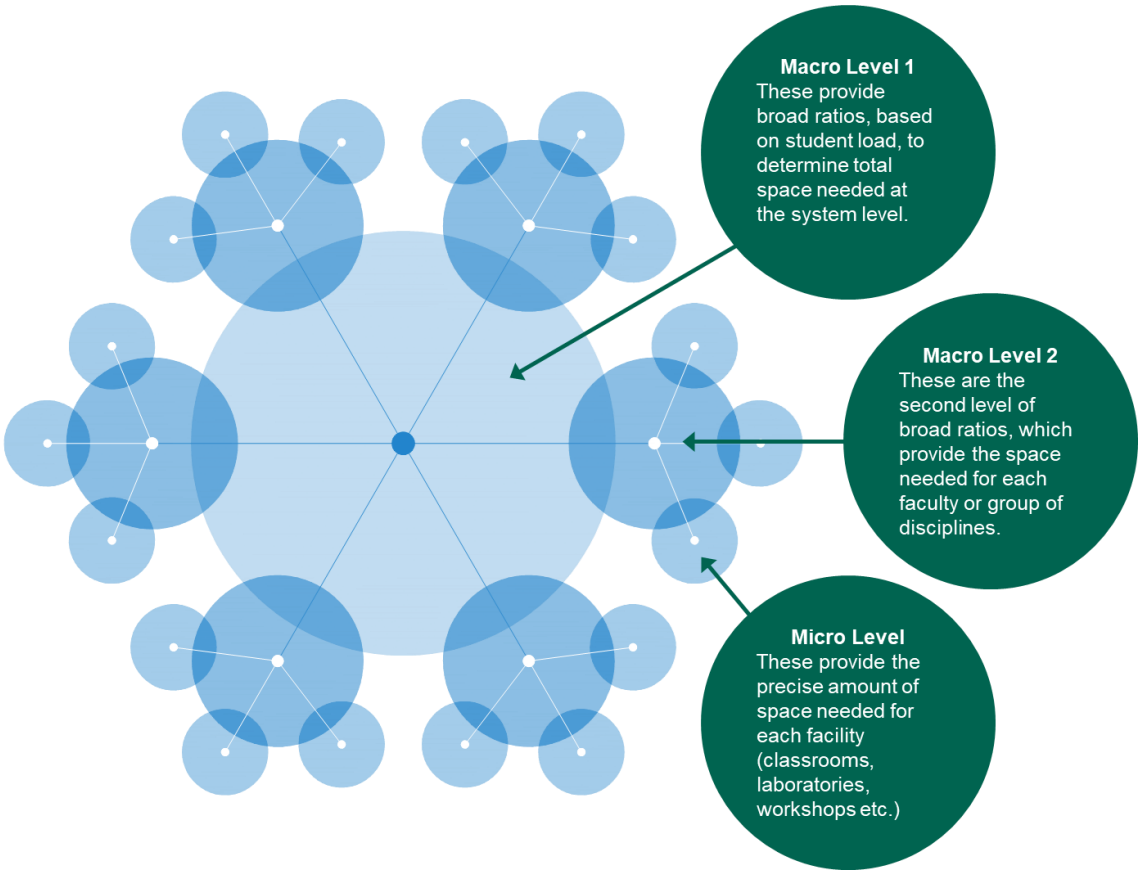


Figure 4.1: Categories of space norms

Source: Authors' illustration

4.1.1 Tertiary education space norms in South Africa

Space norms for TVET colleges in South Africa are contained in a document titled "Construction Funding Norms for Buildings and Other Land Improvements at TVET Institutions - September 2017" (DHET, 2017), which is henceforth referred to as the "2017 TVET space norms". A second document, titled "University Macro-Infrastructure Framework (MIF) – Infrastructure Management Guidelines for Universities - January 2021" (DHET, 2021c), provides broad principles for updating current space norms (for all higher education institutes) and is henceforth referred to as the "MIF".

The 2017 TVET space norms provide macro level 2 norms, which provide broad ratios of academic space needed per student for specific faculties or other academic groupings. Micro level norms, which provide detailed areas for each facility, can be inferred from the macro level 2 norms provided. However, macro level 1 norms are not provided.

The norms are based on FTE student numbers and the unit area to be assigned per FTE student. The unit areas to be assigned per FTE student for academic functions are calculated using three variables: utilization of classroom, laboratory, or workshop facilities; student contact hours; and mean surface area per student. These vary to allow for differences in the needs of various programs. These variables are combined to calculate the unit area per FTE student for each program, termed Assignable Square Meters (ASM), using the formula in Figure 4.2.

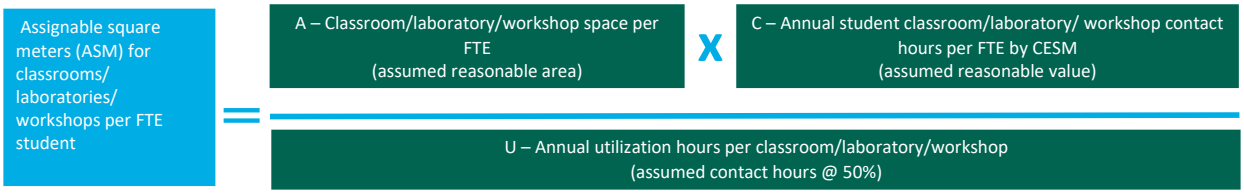


Figure 4.2: Calculation of ASM for classrooms, laboratories, and workshops

Notes:

A (classroom/laboratory facilities space per station) = 1.5 m^2 is suggested as an 'assumed reasonable area'. In the Australian norms it is 1.7-2.0 m^2 (TEFMA, 2009), depending on the number of students to be housed, while it is 1.1 m^2 in the Indian norms (AICTE, 2021).

U (annual utilization hours per station) – An annual average utilization rate of 45-50 percent is assumed. For example, U is 600 hours per station for distance learning, assuming 1200 class hours per annum (30 weeks per year times 40 hours per week) and that each station is occupied 50 percent of the time.

C (annual student-classroom contact hours per FTE student for each Classification of Education Subject Matter (CESM) category (a CESM is a grouping of similar courses) – These values are assumed and vary between 240 and 500 hours depending on the CESM category.

Source: (DHET, 2017)

The resulting ASM values vary significantly across programs, from 1.5 m^2 per FTE to 7 m^2 (Figure 4.3).

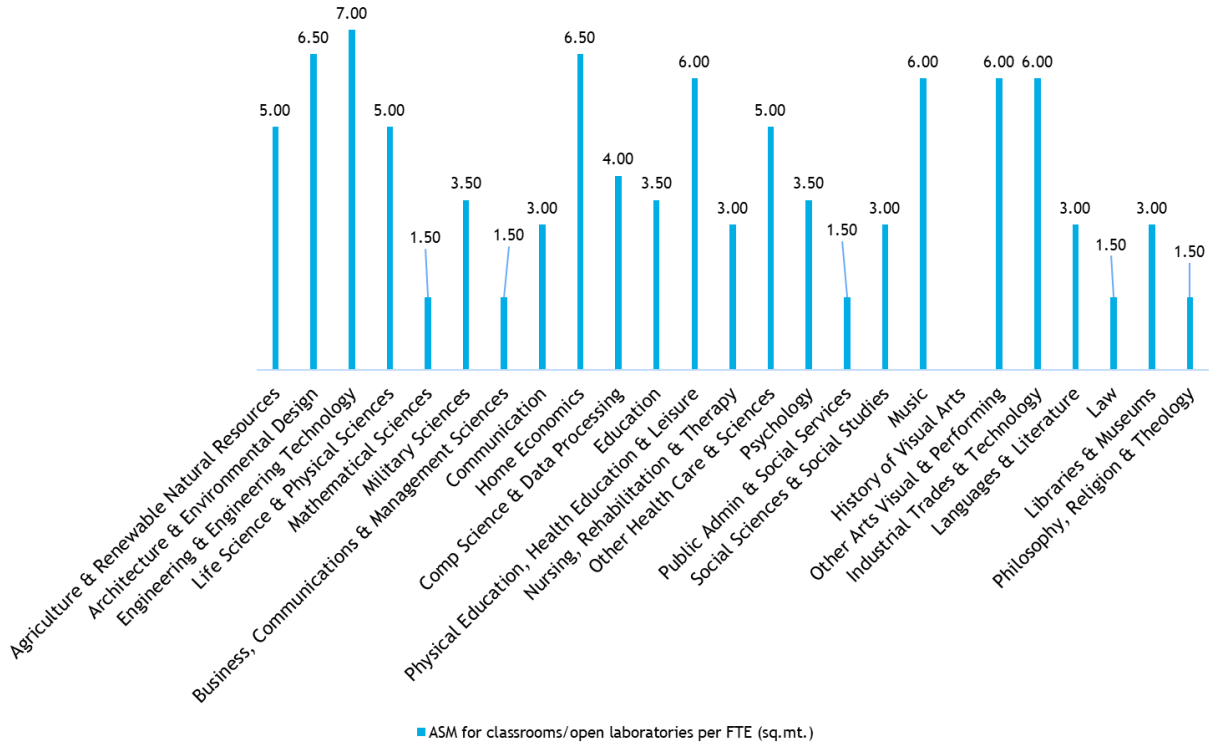


Figure 4.3: ASM per FTE, by program

Source: (DHET, 2017)

The 2017 TVET space norms also provide ASM values for non-academic facilities, such as academic support, student services, institutional support, and auxiliary enterprises, but do not specify how these values were derived. The norms note that the mix of these non-academic facilities constructed and the relevant ASMs will vary across colleges.

There is an opportunity to improve the utilization rate of classrooms implied by the 2017 TVET space norms. The norms recommend increasing the utilization rate beyond the assumed 45-50 percent, but do not specify an optimum or target utilization rate. In contrast, the Australian norms recommend a utilization rate of 70-75 percent, and the Indian norms recommend a 75 percent utilization rate. Specifying a higher target utilization rate in South Africa will reduce the area to be constructed, and consequently, the construction cost of TVET infrastructure (see Figure 4.4).

Figure 4.4: The impact of increasing utilization rates on ASM

Source: Authors' illustration based on (DHET, 2017)

Another area where the norms can be strengthened is the approach to determining the areas of laboratories and workshops. While the formula described in Figure 4.2 is suitable for determining the area of classrooms, it is not suitable for laboratories and workshops. For laboratories or workshops, the minimum space required needs to be determined by the type of equipment, or type and number of workstations to be used, instead of being based on the assumed percentage utilization of workshops or laboratories (see Figure 4.5 for illustrations). Once the minimum space required for the relevant equipment or workstations is determined, the number of each to be installed, and hence the space required can be minimized by timetabling. For example, stipulating that only half of the students in a program will use a laboratory or workshop at a given point of time means that they can be designed to accommodate only half of the student strength of the program.

The area of a workshop depends on the type of equipment to be installed

The area of a laboratory depends on the type of workstations to be installed

Figure 4.5: The area of laboratories and workshops depends on the types of equipment or type and number of workstations to be accommodated

Because the approach suggested by the norms is not suitable for workshops or laboratories, some colleges have adopted alternate approaches to designing them. These colleges collaborate closely with industry to develop designs for workshops and laboratories based on the types of equipment and workstations used by industry. These designs, if collected and analysed systematically, can be used by the DHET to develop trade-specific norms and standards for laboratories and workshops. Figure 4.6 illustrates the approach adopted by colleges in the Western Cape to design and construct academic spaces, including laboratories and workshops.

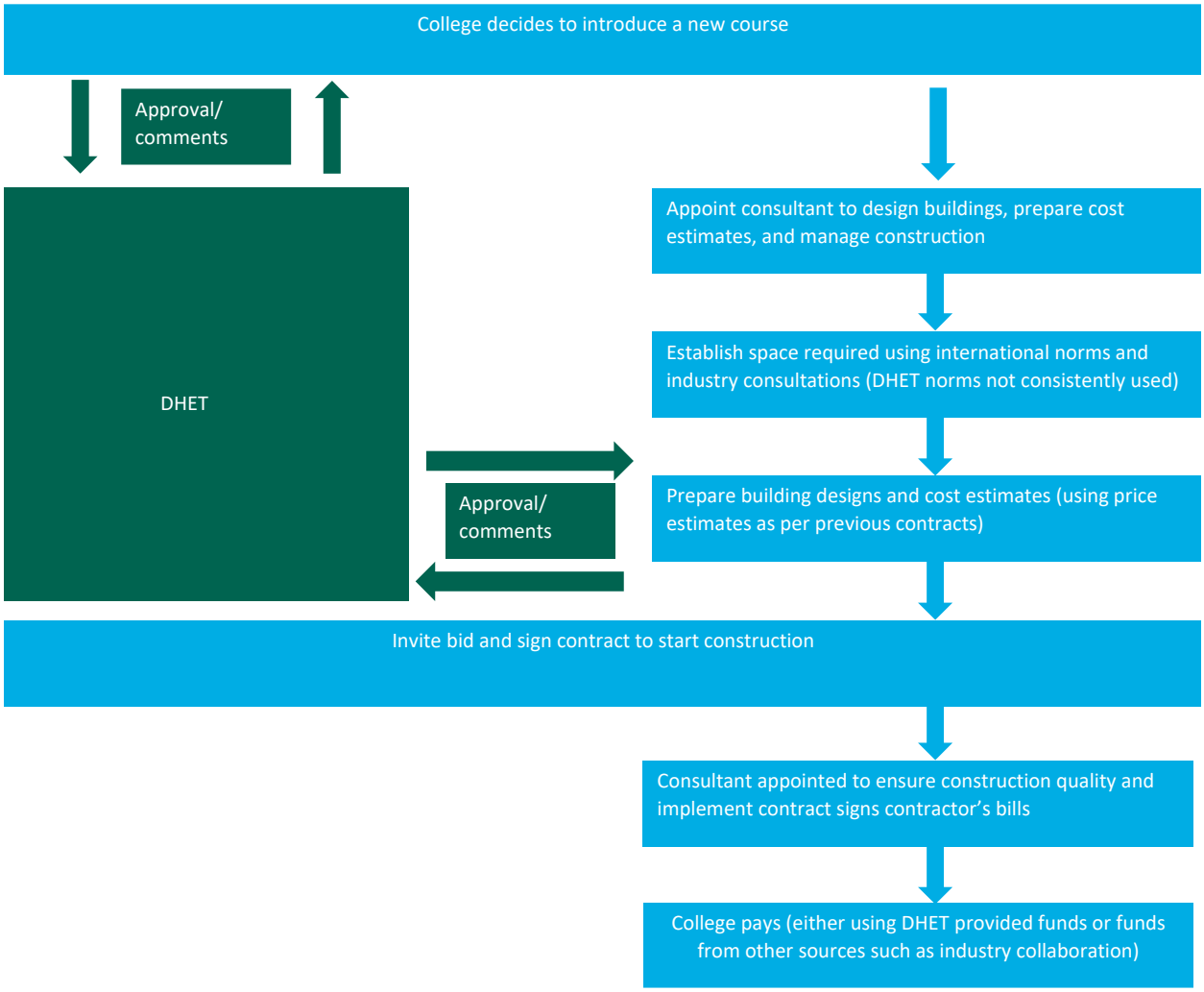


Figure 4.6: Industry collaboration to develop designs for and construct laboratories and workshops

Source: Authors' illustration based on information obtained during visits to colleges in the Western Cape and Johannesburg

Further, because of the development of technology and pedagogy, many aspects of the 2017 TVET space norms are no longer relevant. For example, the current space norms for libraries include large book

stacking spaces. However, the shift to electronic documents means that such book-stacking spaces are no longer necessary. Recognizing these shortcomings, the MIF notes that the current norms:

- Lack provisions for standardized or best practice guidelines for what the minimum or maximum areas per FTE should be
- Lack guidance on how to deal with existing buildings where spaces are too large for present day use (alongside other space use issues)
- Do not provide a framework to plan for what the future of higher education institutes will look like
- Lack guidance on how spaces should be managed to optimize their utilization and on the resulting optimum utilization factors

The MIF recommends that the current norms undergo a critical review through a four-step process: (a) questioning the status quo (which it calls using future gazing principals), (b) conducting a critical analysis of current norms, (c) studying the international architectural norms prescribed in various planning standards, and (d) visiting national and international institutes to study their utilization of spaces.

4.1.2 Tertiary education space norms in Australia

Space norms for tertiary education in Australia are developed by the Tertiary Education Facilities Management Association (TEFMA). The third and latest edition of the TEFMA space planning guidelines (TEFMA, 2009) was published in 2009. It provides space norms at the macro level 1, macro level 2, and micro levels.

At macro level 1, it suggests that a Gross Floor Area (GFA) of 14-15 m^2 per FTE be used as a broad rule of thumb for all campus facilities, except student housing. The suggested GFAs per FTE vary by the size of campus, with higher GFA per student suggested for larger campuses (Table 4.1). While this may appear to be at odds with economies of scale, the TEFMA guidelines explain that larger campuses tend to have a greater variety and number of support services, which results in higher per-student GFA.

Table 4.1: TEFMA-recommended area per FTE by campus size

	Size of institution		
	Small	**Medium**	**Large**
GFA (m^2)	<12 m^2	12-17 m^2	>17 m^2
UFA (m^2)	<7.8 m^2	7.8 – 11 m^2	>11 m^2
Average student / teacher ratio	19.1	16.4	11.4
Percentage of institutes in category	33	46	21

Source: (TEFMA, 2009)

The total Usable Floor Area (UFA) per FTE is divided into groups of academic and non-academic spaces (Table 4.2).

Table 4.2: TEFMA-recommended UFA per FTE

	Average percentage of total space on campus	**UFA /FTE in m^2**
Academic	46.8	2.1 - 9.5 (average: 5.2)
Central Administrative	11.97	0.6 - 1.5 (average: 1.12)
Teaching spaces	9.4	0.5 - 2.02 (average: 0.93)
Library Space	8.5	0.4 – 1.64 (average: 0.91)
Student and Staff Services	5.9	0.2 – .75 (average: 0.57)
Commercial	4.81	0.1 - 1.85 (average: 0.51)
Other	5.19	0.1 – 2.9 (average: 0.75)

Source: (TEFMA, 2009)

These guide ratios are useful for an initial assessment of the space needs of faculties/other academic units but need to be adjusted according to the types of courses being taught and their FTE loads for detailed planning. Guidance for this adjustment is provided in the form of macro level 2 norms. The course-specific recommended areas per FTE for academic spaces are comparable to those recommended by the 2017 TVET space norms for South Africa, except for engineering and related technologies, health, IT, management and commerce, and natural and physical sciences courses (Figure 4.7). The recommended areas for workshops and laboratories differ by their specific use to account for the size of equipment and workstations to be installed, unlike the South African norms where a fixed station area is assumed.

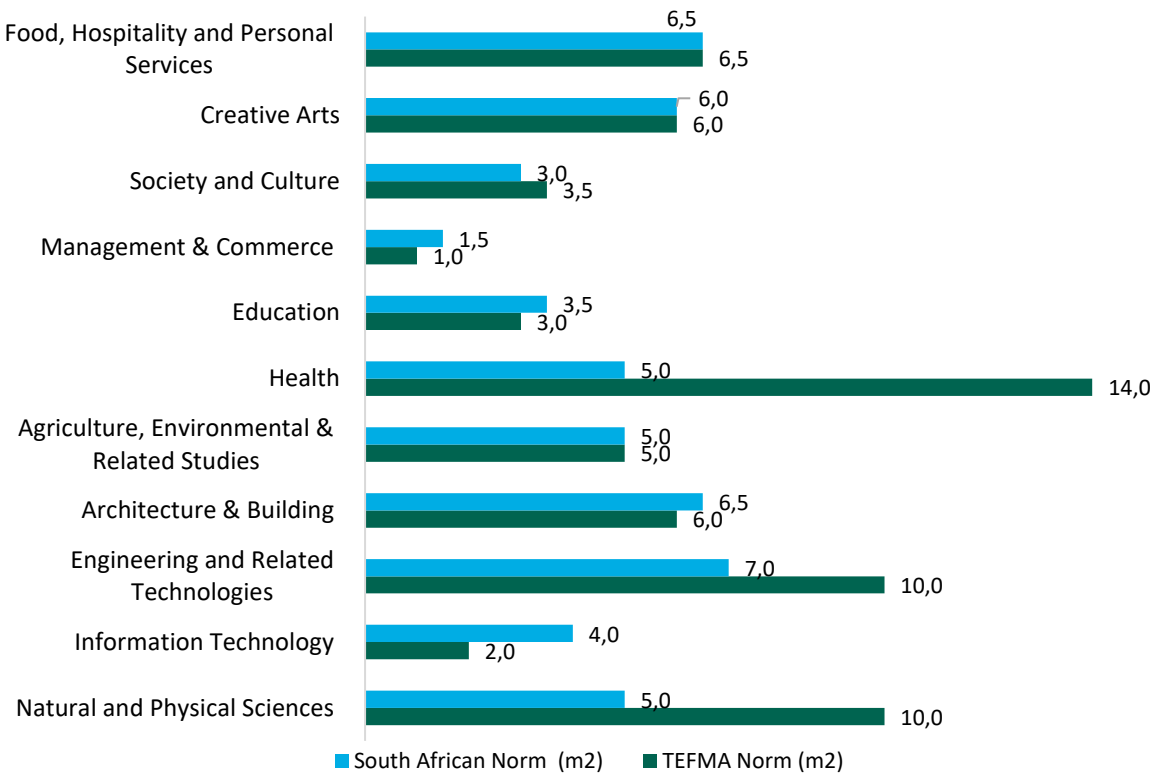


Figure 4.7: Recommended UFA per FTE in South Africa and Australia by academic grouping

Source: (DHET, 2017); (TEFMA, 2009)

Finally, the TEFMA also provides micro-level norms (recommended areas for each facility and the student numbers to be housed), which are not detailed in this report.

4.1.3 TVET space norms in India

The All-India Council for Technical Education (AICTE) provides highly detailed micro level norms for TVET colleges in India (AICTE, 2021), including the minimum number of facilities, carpet areas, and furniture and equipment to be installed. No macro level norms are available. Table 4.3 provides an example of the AICTE space norms for engineering and technology diploma and post-diploma courses.

Table 4.3: AICTE-recommended space norms for engineering and technology courses

	Number of rooms required	Carpet area in m^2
Classroom	Total number of divisions X 0.75	66/33*
Tutorial room	25% of classrooms	33
Laboratory	2 per course per year	66
Laboratory for post-graduate students	1 per course	66
Workshop	1	200
Additional laboratory/workshop	1	200
Computer centre	1	150
Drawing hall	1	132
Seminar hall	1 per 2 undergraduate courses	132
	1 per postgraduate department	66
	1 per diploma institution	132
Library	1 per degree institution	400
	1 per diploma institution	300
Language laboratory	1	66

Source: (AICTE, 2021)

The AICTE has approved 750 courses and space norms are recommended for each course. As can be seen from the example provided, these norms are highly prescriptive and do not provide flexibility to account for the varying needs of institutions. Similar micro level norms are also provided for administrative and other non-academic functions.

A positive aspect of these norms is that they provide specific standards for each type of laboratory and workshop, based on the type of equipment and workstations to be used, along with norms for their utilization and timetabling.

4.1.4 Summary and recommendations from comparative analysis

A comparison of South African, Australian, and Indian space norms is summarized in Table 4.4.

Table 4.4: Comparison between tertiary education space norms in South Africa, Australia, and India

	South Africa	Australia	India
Categories of norms available	Macro level 2 (micro level norms can be inferred)	Macro level 1, macro level 2, and micro level	Micro level
Per-student classroom space recommended	1.5 m^2	1.7-2.0 m^2	1.1 m^2
Classroom utilization rate	45-50% (assumed)	70-75% (recommended)	75% (recommended)
Laboratory/workshop utilization rate	45-50% (assumed)	Varies by type	Varies by type with norms to improve utilization by timetabling
Basis for determining areas of laboratories and workshops	Assumed fixed station space per student	Type of equipment and workstations to be used	Type of equipment and workstations to be used

Source: Authors' compilation based on (DHET, 2017); (TEFMA, 2009); (AICTE, 2021)

Based on this analysis, the South African norms can be strengthened in the following ways:

- Develop macro level 1 norms to guide infrastructure planning and costing by the DHET
- Update norms to reflect changes in pedagogy and technology use. Institute a process to revise norms regularly based on observed good practices in colleges and the evolution of international norms and standards
- Revise ASM calculations to incorporate a target utilization rate of classrooms of 70-75 percent
- Provide guidance on improving the utilization of laboratories and workshops by timetabling and sharing spaces between courses

- Collect and analyse the laboratory and workshop designs prepared by TVET colleges in collaboration with industry to develop trade- and equipment-specific norms for laboratories and workshops
- Provide guidance for flexible space planning to account for the effect of technological change on space use

4.2 Unit costs of TVET infrastructure construction in South Africa

When establishing new TVET colleges, construction expenses are usually the highest expenditure category, and the maintenance cost of the constructed spaces is generally the second-largest recurring expense, after staff salaries. For any investment in building infrastructure, norms that define the optimum area to be constructed, accurate cost estimates, and subsequent effective management of constructed areas are key to controlling costs. Figure 4.8 describes the relationship between norms, constructed area, the costs of construction, and maintenance costs.

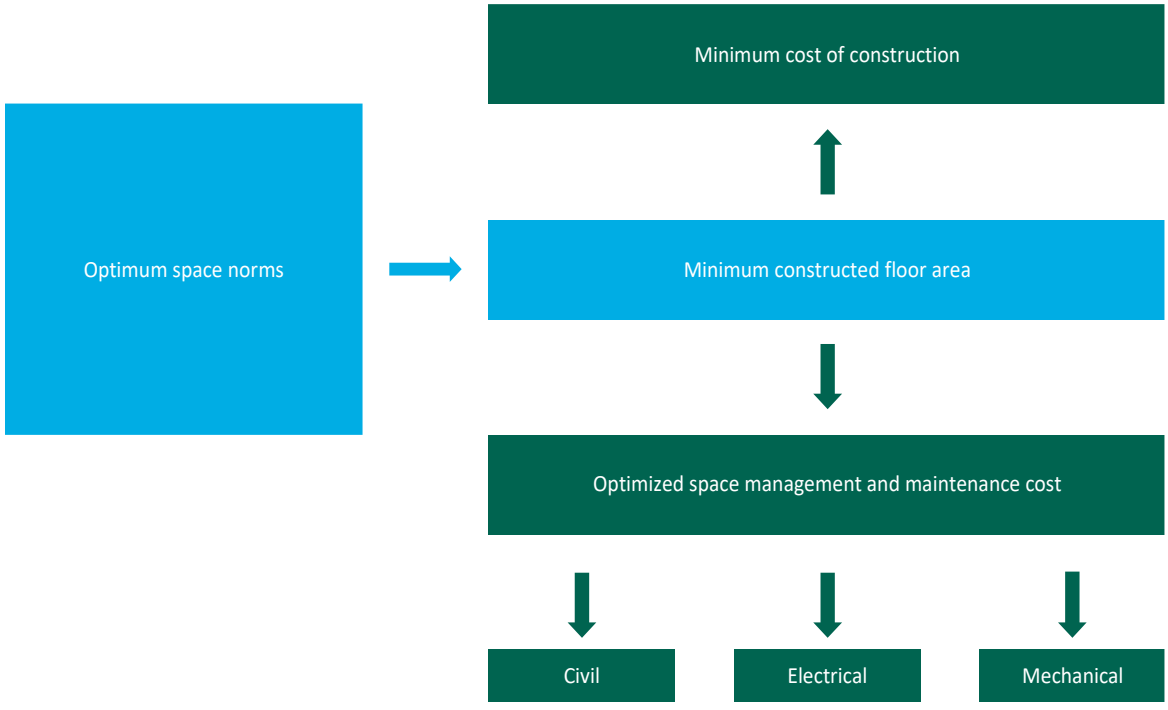


Figure 4.8: The relationship between norms and the costs of construction and maintenance

Source: Authors' illustration

The accuracy required of construction cost estimates varies at different stages of project development, ranging from broad estimates at the empirical cost inference stage to more precise estimates for budget

control at the detailed cost estimate stage. Since design decisions made at early stages of a project are more tentative than those made at later stages, the cost estimates made at earlier stages are, expectedly, less accurate. Generally, the accuracy of a cost estimate will reflect the information available at the time of estimation.

Cost estimates are governed by an equation that establishes the relationship between a base cost estimate, uncertainties, and risks to determine a range within which costs are anticipated to lie (Figure 4.9).

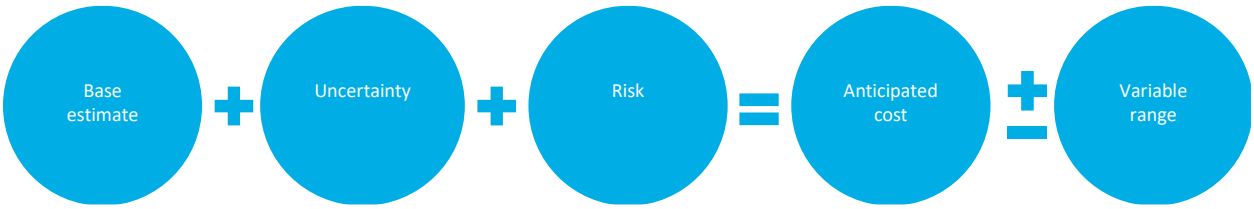


Figure 4.9: The relationship between anticipated costs, base estimates, uncertainties, and risks

Source: Authors' illustration

Empirical cost estimation, which is used at early stages of a project, estimates the cost of constructing a facility based on prevailing average unit costs for similar projects in terms of construction methodology and finishing materials. The estimates obtained are used to determine the size of projects and assess their feasibility within the budget available. Therefore, information about prevailing construction unit costs is needed to inform critical policy decisions. In many countries, governments prescribe best practice approaches to cost estimation based on prevailing unit costs, which are to be used for all major infrastructure projects. The 2017 TVET space norms for South Africa were developed with this intent. They mention, *"the cost unit is defined annually to be the current ZAR equivalent as may be agreed with Treasury by the Universities Branch. In the absence of this the Base Cost Unit (BCU) will be determined by increasing from the base year by the annual building cost indices as published within the construction industry. An annual value of the cost unit is to be provided by DHET each year"*. However, this intent did not translate into action and no BCUs are available.

Given the absence of BCUs published by the DHET, this section estimates the prevailing unit cost of construction for TVET colleges using completion costs of colleges constructed by the DHET in the last ten years and unit costs of construction published by AECOM (AECOM, 2021). Unit costs published by the Bureau of Economic Research (BER) at Stellenbosch University were also considered but not used, because

they were significantly higher than other estimates and the elements of construction costs that they include (for example, consultant fees) could not be ascertained.

4.2.1 Unit costs derived from the completion costs of DHET-funded TVET college construction projects

In the last decade, the DHET has funded the construction of thirteen TVET colleges. Of these, the DHET provided the completion costs of three colleges (two refurbishments at uMzimkhulu and Nongoma and one new college at Nkandla A) to the report team. Table 4.5 describes the details of the buildings constructed and their constructed areas.

Table 4.5: Details of construction projects in uMzimkhulu, Nongoma, and Nkandla A

Description	uMzimkhulu (refurbishment)	Nkandla- A (New)	Nongoma (refurbishment)
	Area (m^2)	Area (m^2)	Area (m^2)
Administration		912	912
Library & E-learning centre		1 574	
Workshop	3 060	3 060	3 060
Kitchen and dining		2 194	
2 story hostels		1 973	
Covered walkway and ramps	-	-	-
Student centre (small)	928		
Student centre and multipurpose hall		1 170	
Supplies store		239	
Gate house	33	33	
Pump room		78	78
Generator House	189	189	189
4 classroom and 2 computer lab blocks	1 144	1 144	1 144
Matron and master house		131	

Description	uMzimkhulu (refurbishment)	Nkandla- A (New)	Nongoma (refurbishment)
	Area (m^2)	Area (m^2)	Area (m^2)
Simulator room		600	
Maintenance building		162	
Refuse enclosure	30	30	30
Total constructed area	**5 384**	**13 489**	**5 413**

Source: Data provided by the DHET

The costs of completion provided by the DHET were divided into the construction costs of buildings and external development-related costs. To calculate the total cost of construction, the Preliminaries and General (P&Gs) costs were added to these two costs, and an escalation factor was used to update the cost to the completion date for each project. Finally, an inflation factor derived from cost-indices provided by the BER was applied to the resulting cost at the completion date to bring it to June 2020 prices. Table 4.6 summarizes these calculations.

Table 4.6: Calculation of total costs of DHET-funded TVET college construction projects at 2020 prices

Description	uMzimkhulu (refurbishment)	Nkandla- A (New)	Nongoma (refurbishment)
Total building cost (ZAR)	66 638 896	152 187 107	76 547 786
Total external cost (ZAR)	19 111 434	45 317 776	15 730 298
P&G - %age	12.86%	22.80%	20.76%
Base date for Escalation	June 18	November 14	June 16
Completion date	February 21	April 16	November 19
Total escalation amount to completion date as per contract (ZAR)	10 761 627	19 117 009	9 966 383
Escalation amount in contract attributable to building on pro-rata basis (ZAR) = 6 X 1/(1+2)	8 363 151	14 730 584	8 267 451

Description	uMzimkhulu (refurbishment)	Nkandla- A (New)	Nongoma (refurbishment)
8. Escalation amount in contract attributable to external works on pro-rata basis (ZAR) = 6 X 2/(1+2)	2 398 476	4 386 425	1 698 932
COMPUTATION (BUILDING)			
9. Builder's work including P&G (ZAR) = 1+ (1 X 3)	75 208 658	186 885 768	92 439 107
10. Add 70% of escalation to update cost to completion date (ZAR) = 7 X 70%	5 854 206	10 311 409	5 787 216
11. Total including escalation at completion date (ZAR) = 9+10	81 062 863	197 197 176	98 226 322
12. CPAP % escalation from completion to June 2020	-7.87%	19.17%	0.53%
13. Total anticipated cost at June 2020 (ZAR) = 11 X 12	74 683 216	234 999 875	98 746 922
COMPUTATION (EXTERNAL DEVELOPMENT WORKS)			
14. Builder's work including P&G (ZAR) = 2+ (2 X 3)	21 569 165	55 650 229	18 995 908
15. Add 70% of escalation to contract to update cost to completion (ZAR) = 8 X 70%	1 678 933	3 070 497	1 189 252
16. Total including escalation at completion date (ZAR) = 14 + 15	23 248 098	58 720 726	20 185 160
17. Total anticipated cost at June 2020 prices after factoring in CPAP (ZAR) = 16 X 12	21 418 473	69 977 489	20 292 141

Description	uMzimkhulu (refurbishment)	Nkandla- A (New)	Nongoma (refurbishment)
18. Total cost (building + external works) at June 2020 prices (ZAR)	**96 101 689**	**304 977 365**	**119 039 063**

Source: Authors' calculations based on completion costs provided by the DHET

The total cost above was used to derive the unit cost of construction per square meter for building and external development works. Since these buildings were constructed using steel as the structural framing system, which is more expensive than traditional concrete structures, the unit cost has been reduced by 15 percent to reflect the costs of traditional structural systems. Table 4.7 describes the calculations used to obtain unit cost.

Table 4.7: Unit cost of construction of DHET-funded TVET college construction projects at 2020 prices

Description	uMzimkhulu (refurbishment)	Nkandla- A (New)	Nongoma (refurbishment)
Date of completion	February 21	April 16	November 19
Total cost (building + external works) at June 2020 prices (ZAR)	96 101 689	304 977 365	119 039 063
Unit building cost (ZAR per m^2)	13 871	17 422	18 243
Unit external cost (ZAR per m^2)	3 978	5 188	2 906
Total unit cost (building + external development)	17 849	22 609	21 991
Building cost adjusted to traditional concrete column beam structure (-15% from steel-based structural system)	11 791	14 808	15 506
Total unit cost for conventional construction (building + external development)	**15 769**	**19 996**	**18 412**

Source: Authors' calculations based on completion costs provided by DHET

Even though only new buildings were constructed both at the new college (Nkandla A) and existing colleges (uMzimkhulu and Nongoma) there are large variations in the unit cost of construction, for which technical justifications were not available.

An additional data point was obtained during the report team's visit to the Malmesbury campus of the West Coast TVET College. At this campus, the average building cost was ZAR 11 500 per m^2. Combined with an estimated 30 percent additional cost for external development and bulk services, the unit cost at this site was approximately ZAR 15 000 per m^2.

4.2.2 Unit cost of construction published by AECOM

The AECOM Africa Property and Construction Guide 2020-21 (AECOM, 2021) estimates the average unit cost for a secondary school was ZAR 8 900 per m^2 at July 2020 prices. The report team used this value to estimate the unit cost of construction for TVET colleges. Based on the team's international experience, the higher finishing specifications, and service requirements of TVET colleges, results in approximately 40 percent higher unit cost than secondary schools. This yields a building cost of ZAR 11 970 per m^2 for TVET colleges. With an additional 30 percent for external development and bulk services, the resulting unit cost is approximately ZAR 15 000 per m^2, which is close to the unit cost at the Malmesbury site.

4.2.3 Best-estimate unit cost of construction for TVET colleges in South Africa

The report team's best estimate of the unit cost of construction for TVET colleges in South Africa is the average of the five available data points — three DHET-funded construction projects from the last decade, the unit cost of construction at the Malmesbury site, and the estimate derived from data published by AECOM. The resulting unit cost of ZAR 17 000 per m^2 at 2020 prices (Figure 4.10) is used in the next section to project the construction expenditure required for the expansion of the TVET system up to 2030.

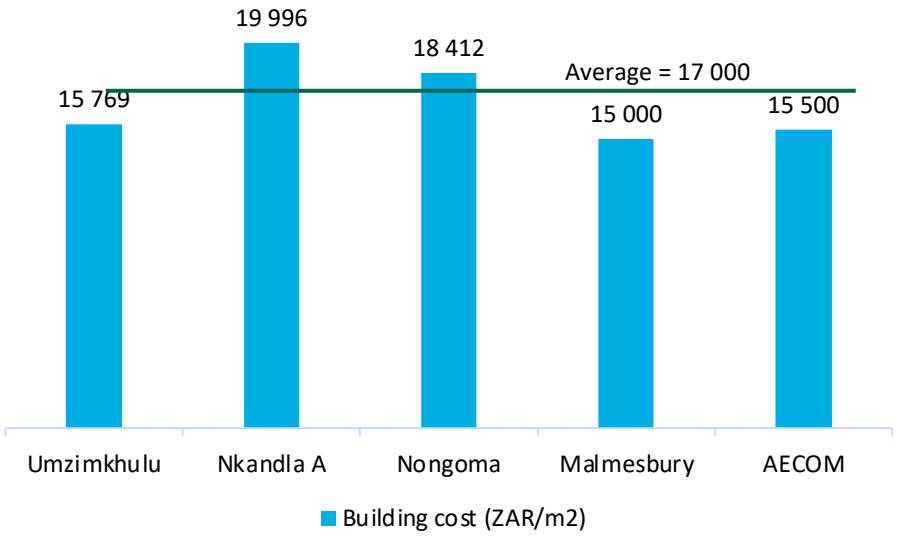


Figure 4.10: Unit costs of TVET infrastructure construction in South Africa

Source: Completion costs provided by DHET, data obtained during visits to TVET campuses, (AECOM, 2021)

5 The cost of meeting South Africa's TVET objectives[22]

This section describes the results from a simulation model used to estimate the cost of the TVET expansion, and the resulting funding gap, required to meet South Africa's 2030 objectives. The expansion is simulated through a mix of scenarios, which estimate the possible future capacity of TVET, and especially how much distance education will potentially contribute to this capacity; the associated cost of expanding TVET, as well as the cost of maintaining the system once expanded.

presents a summary of the broad policy objectives applied in the expansion scenarios, highlighting the key differences across scenarios. The specific objectives for each scenario are discussed in later sections. Besides this summary, the simulation model is provided alongside the report (in MS Excel), with Annex 1 providing the details on how to navigate the simulation model. In addition to the expansion to accommodate additional trainees, the cost of upgrading existing campuses to meet their infrastructure deficits is also analysed.

[22] The total TVET enrolment for 2020 used in this section is 671 440 students. This number was obtained by adding enrolment in NATED courses in 2019 to enrolment in non-NATED courses in 2020. NATED enrolment was most affected by COVID-19 related disruptions and is expected to eventually recover to pre-pandemic levels (data on the extent of recovery is not currently available). Therefore, 2019 NATED enrolments are a better indicator of system capacity. On the other hand, total non-NATED enrolment was not substantially different in 2020 from 2019. Based on discussions with the DHET, this combination of 2019 NATED enrolments and 2020 non-NATED data is used as the baseline for the simulation model to reflect the full system capacity, while using the latest data available to the extent possible. The resulting total enrolment is close to the 2019 value of 673 500 students.

Table 5.1: Overview of the expansion scenarios

Focus area	BAS Scenario: Maintaining status quo	PSET White Paper Scenario: Ambitious expansion	NDP Scenario: Moderate expansion with efficiency
Population growth	Modest (1.3%)	Modest (1.3%)	Modest (1.3%)
Trainee participation	Baseline participation rate in TVET per 100 000 population	Triple participation rate in TVET per 100 000 population	Double participation rate in TVET per 100 000 population
Training modalities/ pathways	No students in distance education	Distance education offering beginning 2024; 50% of trainees on distance education by 2030	Distance education offering beginning 2024; 30% of trainees on distance education by 2030
Supply of instructors/ teachers	Baseline student teacher ratio sustained across all programs	Improved student teacher ratio across all programs	Improved student teacher ratio across all programs
Support staff	Teacher to non-teacher ratio fixed to the baseline	Teacher to non-teacher ratio fixed to the baseline	Improved efficiency in the teacher-to-non-teacher ratio per the 2016 staffing norms
Housing	No additional student is housed in TVET institutions	20% of additional students housed in TVET institutions	10% of additional students housed in TVET institutions
Welfare support	59.6% of trainees receiving welfare support from National Student Financial Aid Scheme (NSFAS)	59.6% of trainees receiving welfare support from NSFAS	All trainees receive welfare support from NSFAS

5.1 Expansion Scenarios

The policy objectives for the expansion of TVET are anchored on population growth, which is similar across the three scenarios developed for this report. Although the population projections have been made to simulate rural and urban migration, these projections affect movement between provinces but retain similar national totals. Given that TVET uses nationally computed access related parameters, the population used in the three expansion scenarios will remain similar. The scope of expansion is limited to public TVET colleges, due to the limited information on the state of private TVET.

The first dimension where three scenarios have different objectives is the participation rate in TVET. The BAS scenario (or baseline scenario) retains the current participation rate, the PSET White Paper Scenario (targeting the enrolment of 2.5 million students enrolled in TVET by the end of the decade) projects a tripling in the participation rate, and the NDP scenario is a compromise between the BAS and PSET White Paper Scenarios and doubles participation rate from the baseline. Another key objective is the introduction of distance education, which is seen in the PSET White Paper and NDP scenarios, while the BAS scenario continues to expand without the distance education option. The introduction and expansion of distance education, which reduces both capital and recurring costs, can be considered a proxy for the potential impact of technology on the cost of TVET provision or for alternate modes of delivery, such as WBL, which reduces the cost of TVET provision incurred by the government.

Technology can reduce costs in several ways, including by enabling cheaper modes of delivery (such as distance education) and reducing the cost of equipment by using, for example, simulator-based training. Some of the policy implications of technological change on TVET infrastructure are discussed in Section 6.

With respect to the supply of instructors, the baseline scenario continues to recruit and deploy instructors in line with the instructor-to-FTE trainee ratios observed in 2020, while the PSET White Paper and NDP scenarios seek to improve the ratios, with the PSET White Paper Scenario aligning with ratios observed in Organisation for Economic Co-operation and Development (OECD) countries. The provision for non-teaching staff also influences the resources spent in the expanded system, with the NDP scenario departing from the baseline to seek alignment with the provisions of the 2016 prescription on staffing norms (the Continuing Education and Training Act, 2016). On student housing, the PSET and NDP scenarios include installation of housing facilities for additional students, whereas in the baseline scenario, the status quo remains. Finally, in the welfare support received from NSFAS, an expansion is targeted in two

scenarios: the PSET White Paper Scenario because of the tripling of trainees in the system, and in the NDP scenario, because it targets providing support to all trainees in public institutions.

The expansion is underpinned by modest population and strong economic growth. The expansion takes place in a context of a growing population, with a modest annual growth of 1.3 percent (see

Table 5.2), where the population is expected to grow to about 68 million people by 2030. Economic growth, which influences recurrent and capital costs, is projected to average 2 percent annually, throughout the simulation period. The simulation applies differentiated growth rates in the three scenarios as seen in Table 5.2 and resulting in the differences in GDP by 2030 for each of the scenarios. This, coupled with the modest population growth, will see the GDP per capita increase from ZAR 86 000 in 2020 to more than ZAR 94 000 in 2030 under scenario 1 growth assumption (a 10% increase between the two periods), to nearly ZAR 93 000 under scenario 2, and to about ZAR 91 000 under scenario 3 assumption. These will influence how costs, especially staff salaries, will evolve under each scenario.

Table 5.2: Macroeconomic and global enrolment driving parameters

Parameter	Baseline (2020)	Macroeconomic projection, 2030		
		Scenario 1	Scenario 2	Scenario 2
Total population (Thousand)	59 643	67 715	67 715	67 715
Annual growth rate		1.3%	1.3%	1.3%
GDP, Million Rand	5 150 000	6 408 275	6 265 523	6 143 724
GDP annual growth rate		2.21%	1.98%	1.78%
GDP per capita (Rand)	86 347	94 636	92 528	90 729

Source: Authors' compilation based on population projections by the World Bank and discussions with DHET

5.1.1 BAS Scenario: Baseline or status quo

Most parameters under the BAS scenario remain as observed at baseline (i.e., the values reported in 2020). The number of trainees per 100 000 population (one of the key measures of participation in TVET) is expected to remain at 1 126 under this scenario. Notwithstanding this assumption, it is expected that there would be more trainees in TVET, owing to the growth in population. At the program delivery level, enrolments have been split into two main categories, the first comprising programs with fixed capacity, while the second group based on dynamic capacities. In the second category, the capacities are linked to the proportions of each program as observed in 2020. Agriculture, education, and tourism fall in the first

category and will see their enrolment capacities fixed at 5 700, 40 700, and 25 700 students respectively by 2030 (see Table 5.3).

Table 5.3: Parameters driving the share of enrolments, BAS Scenario

Decision parameter	Baseline (2020)	Target (2030)
Trainees in TVET per 100 000 population	1 126	1 126
% of students in public institutions	**100.0%**	**100.0%**
Trades with fixed capacity		
1.1 Agriculture	5 701	5 701
1.2 Tourism	40 672	40 672
1.3 Education	25 702	25 702
Total non-fixed capacity		
2.1 Business, finance, and marketing	34.0%	34.0%
2.2 Engineering and related	48.9%	48.9%
2.3 HR, secretary, and administration	12.5%	12.5%
2.4 Health and related	0.2%	0.2%
2.5 IT	1.7%	1.7%
3.1 Others	2.6%	2.6%

Source: Authors' compilation based on administrative data and discussions with DHET

At the operational level, the expansion is driven by Human Resources (HR) available for instruction and administration. The student teacher ratio influences how many instructors are required while the student to non-teaching staff ratio determines the number of administrators required in the expanded system. As shown in

Table 5.4, the FTE student teacher ratio is maintained at 2020 levels. Although the ratio remains the same, the demand for teachers/instructors grows due to the expected increase in the number of students. The ratio between teaching and non-teaching staff is also assumed to remain the same in this scenario, with 100 non-teaching staff for every 120-teaching staff.

Table 5.4: Drivers of HR needs, BAS Scenario

Decision parameter	Baseline (2020)	Target (2030)
Student (FTE)/Teacher Ratio	48	48
Student (Head count)/Teacher Ratio		
1.1 Agriculture	86	86
1.2 Tourism	86	86
1.3 Education	86	86
2.1 Business, finance, and marketing	86	86
2.2 Engineering and related	86	86
2.3 HR, secretary, and administration	86	86
2.4 Health and related	86	86
2.5 IT	86	86
3.1 Others	86	86
Teachers to Non-teachers Ratio	1.2	1.2

Source: Authors' compilation based administrative data and discussions with DHET

The expansion in the student population, instructors, and administrators is associated with increased expenditure. The model projects that the expansion under the BAS scenario will require additional operational spending at the central (DHET) level, which is set to grow at an annual rate of 4 percent (see

Table 5.5). This would cover functions like the monitoring of TVET colleges, accreditation processes, capacity building and provision of working tools for the staff at central level. On salaries, TVET teachers earned an average of ZAR 535 000 in 2020, which was 6.2 times the GDP per capita, a level which will be sustained in the BAS scenario. It is important to note that future salaries are pegged on the growth of the economy such that even with the salary remaining constant at 6.2 times per capita GDP, the growth in

the economy will accommodate real growth in teacher salaries. The expected teacher salary is estimated to reach ZAR 700 000 by the end of the decade, a 30 percent increase. Similarly, non-teacher salaries remain constant at 4 times per capita GDP, increasing from an average of ZAR 350 000 in 2020 to ZAR 450 000 in 2030.

Table 5.5: Drivers of recurrent costs of expansion, BAS Scenario

Decision parameter	Baseline (2020)	Target (2030)
Annual growth rate for recurrent expenditure at central level	0%	4%
Average annual salary in GDP per capita		
Teachers	6.2	6.2
Non-teachers	4.0	4.0
Subsidies and Grants		
% assisted student through NSFAS	59.6%	59.6%
Per student support	13 780	13 780
Other recurrent as % of total teacher salary	128.9%	128.9%

Source: Authors' compilation based on National Treasury and NSFAS data, discussions with DHET, and simulation model results

Another significant expenditure in the current system is the grant funding provided as support to TVET students through NSFAS. In 2020, about 6 in 10 students received support. The baseline scenario holds this proportion constant up to the end of the simulated period. Although the share of supported students remains constant, the anticipated increase in population, and the subsequent increase in student enrolment means more students will benefit from grants. The average spending on grants is also assumed to remain constant at ZAR 13 800[23]. Other recurrent expenditures that support the operations of TVET colleges, remain at 130 percent of the teacher salaries. This means that as the wage bill grows, the consolidated spending on other recurrent items also increase.

[23] This is the projected amount of support provided in 2020, calculated using National Treasury data from 2019. While (DHET, 2022) reports higher per student support in 2020, the report team did not have access to 2020 National Treasury data to verify the amounts reported.

Capital costs under the BAS scenario are driven by maintenance and upgradation costs of existing TVET colleges, construction of additional colleges, and provision of housing for existing and additional students. In 2020, the College Capital Infrastructure Efficiency Grant (CIEG) for the maintenance and upgradation of colleges was ZAR 393 million. The model projects, under the BAS scenario, that this will grow at an annual average of 4 percent to facilitate maintenance of the existing and additional facilities (see

Table 5.6). Another key capital expenditure is the creation of additional capacity to accommodate the increased enrolment. The creation of additional capacity is driven by the creation of large, medium, and small campuses with the capacity of 8 000, 5 000 and 1 500 students respectively. The model further assumes that these new schools will take up 30, 40, and 30 percent of the additional enrolment respectively. This expansion is also informed by the assumption that existing institutions have space to accommodate only 10 000 additional students, beyond which new students will require additional schools.

Table 5.6: Drivers of capital cost of expansion, BAS Scenario

Decision parameter	Target (2030)
Annual growth of Maintenance budget	4.0%
Available capacity to accommodate new student in existing	10 000
Percentage of student by Institution by size (in 2030)	
Small	30.00%
Medium	40.00%
Large	30.00%
Average size of Institution	
Small	1 500
Medium	5 000
Large	8 000
Percentage of learners in student housing	2.00%

Source: Authors' compilation based on discussions with DHET and simulation model results

5.1.1.1 Expected enrolments under the BAS Scenario

The conditions described in the BAS scenario will see enrolment in TVET increase by nearly 100 000 to 762 300 students in 2030 (see

Table 5.7 for the projected distribution of enrolments across the program areas). Notably, the enrolments in agriculture, education, and tourism remain static throughout the decade, capped at 5 700, 40 700, and 25 700 respectively. This implies that the nearly 100 000 additional students will be shared among the six remaining program areas. Business and finance related programs will need to increase capacity by around 30 000 students; engineering by nearly 45 000; HR and administration related programs expanding by about 11 000; and IT by more than 1 500 students.

Table 5.7: Projected growth in enrolments, BAS Scenario

	Enrolment			**%**		
	Baseline	**2025**	**2030**	**Baseline**	**2025**	**2030**
In person, Public						
1.1 Agriculture	5 701	5 701	5 701	0.80%	0.80%	0.70%
1.2 Tourism	40 672	40 672	40 672	6.10%	5.70%	5.30%
1.3 Education	25 702	25 702	25 702	3.80%	3.60%	3.40%
2.1 Business, finance, and marketing	204 027	219 003	234 959	30.40%	30.60%	30.80%
2.2 Engineering and related	293 080	314 592	337 514	43.60%	44.00%	44.30%
2.3 HR, secretary, and administration	74 883	80 379	86 236	11.20%	11.20%	11.30%
2.4 Health and related	1 420	1 524	1 635	0.20%	0.20%	0.20%
2.5 IT	10 251	11 003	11 805	1.50%	1.50%	1.50%
3.1 Others	15 704	16 857	18 085	2.30%	2.40%	2.40%
Overall	671 440	715 433	762 309	100.00%	100.00%	100.00%

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

According to the population projections used (World Bank 2021), it is estimated that in 2030, the country's population will grow to about 68 million, with 7.9 million being youth aged 18-24. The projected enrolment under the baseline scenario conditions will translate to a TVET Gross Enrolment Rate of about 10 percent.

5.1.1.2 Expected personnel under the BAS Scenario

The additional enrolments will require the total number of TVET personnel to increase by nearly 2 000 from 14 300 in 2020 to 16 200 in 2030 (see

Table 5.8). A net increase of 2 000 staff is quite modest and is attributed to the expected slow growth in enrolments under the baseline scenario.

Table 5.8: Expected Personnel, BAS Scenario

	Baseline (2020)	Expected (2025)	Expected (2030)
Number of teachers	7 765	8 274	8 816
Number of non-teachers	6 488	6 913	7 366
Total	14 253	15 187	16 182

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

5.1.1.3 Expected expansion of facilities under the BAS Scenario

The model allows for the expansion of facilities on multiple fronts, the first being the construction of new campuses to accommodate the additional students (in this case, the nearly 100 000 additional students by 2030). The second and third elements are the construction of housing facilities to accommodate additional students, and the increase in existing housing capacity to accommodate more students on campus. The fourth element is the acquisition and installation of relevant infrastructure to support open and distance learning.

Table 5.9: Expected physical facilities, BAS Scenario

Facility/Expansion area	Size/Capacity	Number
New campuses for additional trainees		

Small	1 500	16
Medium	5 000	6
Large	8 000	3
Housing		
Students accommodated in additional housing facilities	-	
Students accommodated in upgraded housing facilities	-	
Acquisition of distance learning infrastructure	-	

Source: Authors' computations based on discussions with DHET and simulation model results

With respect to the conditions under the BAS scenario, the expected expansion of infrastructure facilities focuses on 25 new campuses only, including 16 small, 6 medium and 3 large campuses. While constructing the new campuses, the specific facilities to be included will be guided by the schedule presented in Table *5*.10. In all the three categories (small, medium, and large campuses), the unit cost of constructing a square metre is fixed at ZAR 17 000 (at 2020 prices). The notable difference in the facilities is seen in the number of workshops, classrooms, and laboratories to be constructed in each of the new campuses, owing to the different capacities of these new campuses. Small campuses are expected to accommodate 1 500 students; medium ones 5 000 students, while large campuses are expected to accommodate about 8 000 students. The assumed specifications of these new campuses were developed based on recent DHET-funded construction projects.

Table 5.10: Schedule of facilities to be constructed in new campuses

Description	Area (Sqm)	Small Campus	Medium Campus	Large Campus
A: Administration	912	1	1.5	2
C: Library & E-learning centre	1 574	-	-	-
H: Workshop	3 060	2	6	9
J: Kitchen dining	2 194	1	2	2
K: 2 story hostel	1 973	-	-	1
L: Covered walkway and ramps	0	-	-	-
M: Student centre small	928	1	-	-

Description	Area (Sqm)	Small Campus	Medium Campus	Large Campus
M1: Student centre & multipurpose hall	1 170	-	1	1
S: Supplies store	239	-	1	1
T: Gate house	33	1	1	1
U: Pump room	78	1	1	1
W: Generator House	189	1	1	1
X: 4 classrooms and 2 Computer laboratories	1 144	5	17	28
Z: Matron and master house	131	-	1	1
JS: Simulator room	600	-	-	-
MS: Grounds men & maintenance building	162	1	1	1
RE: Refuse enclosure	30	1	1	1
Total constructed area		**15 799**	**45 365**	**70 341**
Unit cost of construction per square meter		**17 000**	**17 000**	**17 000**

Source: Authors' computations based on recent DHET-funded construction projects and discussions with DHET

5.1.1.4 Expected Costs under the BAS Scenario

5.1.1.4.1 Recurrent costs associated with the expansion under the BAS Scenario

The total recurrent cost to sustain the expansion of TVET under the BAS scenario amount to ZAR 189.2 billion between 2022 and 2030. This will cater for the payment of salaries for administrator, instructor and support staff, student support etc., with the driver of the additional spending being the additional students in the sub-system. Out of this, ZAR 181 billion will be used directly by institutions (see

Table 5.11), accounting for 95 percent of the total recurrent cost, and ZAR 8.2 billion will be used for administration at the DHET level. On average, it will cost the Government about ZAR 19.2 billion annually to sustain the TVET sub-system under the discussed conditions, translating to about 0.35 percent of GDP.

Table 5.11: Recurrent costs associated with the expansion, BAS Scenario

	Baseline	2025	2030	Total (2022-2030)	Average 2022-2030
Summary of recurrent expenditure					
Expenditure at central level	718	874	1 063	8 223	914
Expenditure for in-person education	17 266	18 845	20 574	181 011	19 199
Expenditure for distance education	0	0	0	0	0
Total recurrent (Million Rand)	17 985	19 719	21 638	189 234	20 112
As % of GDP	0.35%	0.35%	0.34%		0.35%

Source: Authors' computations based on simulation model results

5.1.1.4.2 Capital and infrastructure maintenance costs under the BAS Scenario

The nine-year expansion of TVET will lead to an additional capital and infrastructure maintenance cost of ZAR 16.2 billion, triggered by the need for additional campuses as well as maintenance of existing and additional facilities. Maintenance alone will take up ZAR 4.5 billion. Construction of new campuses will require nearly ZAR 11.7 billion, or ZAR 1.3 billion annually (see

Table 5.12).

Table 5.12: Capital costs associated with the expansion, BAS Scenario

	Cumulative (2022-30)	Annual average (2022-30)	Annual projection relative to GDP
Maintenance of facilities	4 496	500	0.01%
Construction of new campuses	11 664	1 296	0.02%
Total (Mn ZAR)	**16 160**	**1 796**	**0.03%**

Source: Authors' computations based on simulation model results

5.1.2 PSET White Paper Scenario: Ambitious expansion and benchmarking with OECD countries

The PSET White Paper scenario is characterized by an ambitious expansion of TVET, with the number of students per 100 000 population projected to increase from the baseline of 1 126 to 3 700 by the end of the decade. This is derived from the PSET White Paper's (DHET, 2014) target of 2.5 million trainees in TVET by 2030, which the White Paper notes as its interpretation of the NDP target of 1.25 million trainees, because it assumes that the NDP target is not expressed as FTE. A part of these trainees is expected to be progressively accommodated in distance education programs, whose capacity is projected to hit 50 percent by the end of the decade. The increased number of students will be admitted to the various programs based on filling a predetermined capacity in agriculture, education, and tourism. The rest of the programs will share the remaining enrolees in the proportions they had at baseline. In the fixed capacity group, agriculture is projected to grow up to a maximum of 15 000 spaces; education, up to a maximum of 75 000 and tourism, hospitality and related programs being capped at a capacity of 120 000 (Table 5.13).

Table 5.13: Parameters driving enrolments and personnel, PSET White Paper Scenario

Decision parameter	Baseline (2020)	Target (2030)
Trainees in TVET per 100 000 population	1 126	3 700
% of students in public institutions	100%	100%
% of students in distance education	0%	50%
Trades with fixed capacity		
1.1 Agriculture	5 701	15 000
1.2 Tourism	40 672	120 000
1.3 Education	25 702	75 000
Total non-fixed capacity		
2.1 Business, finance, and marketing	34.0%	34.0%
2.2 Engineering and related	48.9%	48.9%
2.3 HR, secretary, and administration	12.5%	12.5%

Decision parameter	Baseline (2020)	Target (2030)
2.4 Health and related	0.2%	0.2%
2.5 IT	1.7%	1.7%
3.1 Others	2.6%	2.6%
Student (FTE)/Teacher Ratio	1:48	1:15
Teachers to Non-teachers Ratio	1:1.2	1: 1.2

Source: Authors' computations based on administrative data and discussions with DHET

The demand for teachers under the PSET scenario is driven by student teacher ratio (based on the FTE enrolments). This is projected to improve from the baseline of 1:48 in 2020 to 1:15 in 2030, the OECD average, a desired benchmark for South Africa. This scenario retains the ratio between teachers and non-teaching staff at 1:1.2 (Table 5.14).

Table 5.14: Drivers of recurrent costs, PSET White Paper Scenario

Decision parameter	Baseline (2020)	Target (2030)
Recurrent cost		
Annual growth of recurrent at central level	-	4%
Average annual salary in GDP per capita		
Teachers	6.2	6.2
Non-teachers	4.0	4.0
Subsidies and Grants		
% assisted student through NSFAS	59.6%	59.6%
Per student support	13 780	13 780
Other recurrent as % of total teacher salary	128.9%	128.9%

Source: Authors' computations based on administrative data and discussions with DHET

Other drivers of recurrent costs remain largely unchanged, with the PSET scenario assuming that the expansion will need the recurrent spending at the central level (DHET administrative offices) to grow by at least 4 percent annually. Under this scenario, the share of students receiving grants from NSFAS will remain at 60 percent. The unit spending per student annually on grants remains unchanged at nearly ZAR

14 000 annually throughout the expansion period. Salaries for teachers and support staff remains unchanged in terms of multiples of GDP per capita.

Development costs are driven by the maintenance costs of the institutions, projected to grow at an annual average rate of 4 percent to facilitate maintenance of the existing and additional facilities (see Table 5.15). Another key capital cost is the additional campuses to accommodate the increased enrolments, which is driven by the creation of large, medium, and small schools with capacity for 8 000, 5 000, and 1 500 trainees respectively. The PSET scenario further assumes that half of the new campuses will be medium-sized, 30 percent are small, and 20 percent, are large.

Table 5.15: Drivers of capital costs, PSET White Paper Scenario

Decision parameter	Target (2030)
Annual growth of maintenance budget	4.0%
Available capacity for new student in existing	10 000
% of student by Institution by size (in 2030)	
Small	30.0%
Medium	50.0%
Large	30.0%
Average size of Institution	
Small	1 500
Medium	5 000
Large	8 000
% learners for student housing	20.0%
Unit Cost of student housing ('000 ZAR)	204

Source: Authors' computations based on administrative data and discussions with DHET

5.1.2.1 Expected enrolments under the PSET White Paper Scenario

The parameters set in this scenario result in a massive increase in the number of trainees coming into the system, with significant capacity generated by distance education.

Table 5.16 presents the evolution of enrolment under the projected expansion pathways. In 2020, the total student population in TVET was 671 000, translating to 1 126 students per 100 000 population.

Increasing this to 3 700 results in a huge surge in TVET enrolment. By 2025, under the conditions of this expansion scenario, there will be more than 1.5 million students in TVET, while in 2030 TVET enrolments will have passed the 2.5 million.

Table 5.16: Projected growth in enrolments, PSET White Paper Scenario

	Total			%		
	Baseline	**2025**	**2030**	**Baseline**	**2025**	**2030**
Contact, Public						
1.1 Agriculture	5 701	10 351	15 000	0.8%	0.7%	0.6%
1.2 Tourism	40 672	80 336	120 000	6.1%	5.2%	4.8%
1.3 Education	25 702	50 351	75 000	3.8%	3.3%	3.0%
2.1 Business, finance, and marketing	204 027	421 772	354 949	30.4%	27.5%	14.2%
2.2 Engineering and related	293 080	605 866	509 876	43.6%	39.5%	20.4%
2.3 HR, secretary, and administration	74 883	154 801	130 275	11.2%	10.1%	5.2%
2.4 Health and related	1 420	2 935	2 470	0.2%	0.2%	0.1%
2.5 IT	10 251	21 191	17 834	1.5%	1.4%	0.7%
3.1 Others	15 704	32 464	27 320	2.3%	2.1%	1.1%
Total Contact, Public	671 440	1 380 068	1 252 724	100.0%	90.0%	50.0%
Distance education enrolment	-	153 341	1 252 724	0.0%	10.0%	50.0%
Overall	**671 440**	**1 533 408**	**2 505 449**	**100.0%**	**100.0%**	**100.0%**

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

With the assumed introduction of distance education in 2024, this new delivery model will also experience massive growth, growing to accommodate more than 150 000 trainees by 2025, and more than 1.2 million trainees by the end of the decade. Overall, this growth in TVET translates to a TVET Gross Enrolment Ratio (GER) of 32 percent.

5.1.2.2 Expected personnel under the PSET White Paper Scenario

Given the large number of students expected to enter TVET with the tripling of the participation rate under the PSET White Paper Scenario, a huge demand for teachers will be triggered. The demand for teachers will also be driven by the staffing norms applied in this scenario, which as discussed in the previous section, with a FTE trainee to instructor ratio of 1:15.

Table 5.17: Expected personnel, PSET White Paper Scenario

	Baseline	2025	2030
Number of teachers	7 765	24 326	46 407
Number of non-teachers	6 488	20 325	38 775
Total	**14 253**	**44 651**	**85 182**

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

As shown in Table 5.17, teachers are projected to grow six-fold from 7 800 in 2020 to more than 53 000 by the end of the decade, an addition of nearly 39 000 teachers during the expansion period. It is important to note that the additional teachers are projected for the group of students who will be in the in-person learning pathway. The trainees in the distance pathway will have their instruction embedded in the cost of setting up the infrastructure for the distance education program. Elsewhere, the size of the non-teaching staff is expected to grow in the same proportion as teachers, with the full staff complement expected to be more than 85 000 by the end of the decade.

5.1.2.3 Expected expansion of facilities under the PSET White Paper Scenario

The huge increase in enrolments under the PSET White Paper Scenario will trigger the need for about 190 additional campuses (114 small, 57 medium and 14 large; see Table 5.18). In addition, to accommodate 20% of the additional students, there will be need to construct housing facilities that can accommodate more than 217 000 students, progressively over the years. According to the 2020 administrative reports on TVET campuses, there were nearly 14 000 existing bed spaces – inadequate to address the current accommodation needs. In addition to the new housing facilities, existing facilities will be upgraded to accommodate an additional 120 600 trainees.

Table 5.18: Expected physical facilities, PSET White Paper Scenario

	Size/Capacity	Number
New Campuses for additional trainees		
Small	1 500	114
Medium	5 000	57
Large	8 000	14
Housing		
Students accommodated in additional housing facilities	217 088	
Students accommodated in upgraded housing facilities	120 587	

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

5.1.2.4 Expected costs under the PSET White Paper Scenario

5.1.2.4.1 Recurrent costs associated with the expansion under the PSET White Paper Scenario

The recurrent cost to sustain the large increase in enrolments expected under the PSET White Paper Scenario is estimated at nearly ZAR 597.4 billion over the nine-year period, with ZAR 551.6 billion (or 92%) expected to be spent directly by TVET colleges (see Table 5.19). The introduction of the distance education program will see its operations take up nearly ZAR 37.5 billion, growing to surpass the recurrent spending at the DHET level. On average, it will cost the Government about ZAR 61.3 billion annually to sustain operations in the expanded system, translating to slightly over one percent of the GDP.

Table 5.19: Recurrent costs associated with the expansion, PSET White Paper Scenario

	Baseline (2020)	2025	2030	Total (2022-2030)	Average (2022-2030)
Expenditure at central level	718	874	1 063	8 223	914
Expenditure for in-person education	17 266	49 468	85 645	551 634	56 207
Expenditure for distance education	0	857	15 398	37 549	4 172
Total recurrent (Million Rand)	17 985	51 198	102 107	597 407	61 293
As % of GDP	0.35%	0.90%	1.62%		1.07%

Source: Authors' computations based on simulation model results

5.1.2.4.2 Capital and infrastructure maintenance costs under the PSET White Paper Scenario

The expansion of TVET will have capital costs of ZAR 151 billion (Table 5.20), triggered by the construction of nearly 190 additional campuses, expansion and upgradation of housing facilities, acquisition of equipment for distance education and training, as well as the maintenance of these facilities. The construction of new campuses will cost about ZAR 82.6 billion (or 55% of the total capital cost), while housing (both expansion and upgrading) is projected to take up about ZAR 61.6 billion, accounting for about 41% of the total capital cost. On average, the capital cost of expansion under the conditions of this scenario will be about ZAR 16.8 billion annually, translating to about 0.3% of GDP, and a more than forty-fold increment over the sums spent in 2020.

Table 5.20: Capital costs associated with the expansion, PSET White Paper Scenario

	Cumulative (2022-30)	**Annual average**	**Relative to GDP**
Maintenance of facilities	4 496	500	0.01%
Construction of new campuses	82 642	9 182	0.16%
Housing for additional students	41 955	4 662	0.08%
Upgrade of existing housing facilities	19 680	2 187	0.04%
Acquisition of distance education infrastructure	2 314	257	0.00%
Total (Mn ZAR)	**151 087**	**16 787**	**0.30%**

Source: Authors' computations based on simulation model results

5.1.3 NDP Scenario: Trade-off between status quo and ambition

This NDP Scenario is characterized by trade-offs between the status quo and the ambitious scenario, with the view of meeting the NDP access target by 2030. In this scenario, the participation rate is expected to double from 1 126 students per 100 000 population in 2020 to 2 250 in 2030. In addition, the capacity of programs is driven by the two broad categories seen in the first two scenarios i.e., those with fixed capacity, and those where enrolment evolves based on shares of enrolment at baseline. Following the doubling of participation rates, the fixed capacity programs are also projected to increase two-fold, with agriculture expected to increase from 5 700 in 2020 to 10 000 in 2030 and education to 50 000 by the end of the decade. While tourism, hospitality and other related programs are expected to peak their capacity

at 80 000 in 2030 (see Table 5.21). In the second category of programs, this scenario accounts for the rising demand for IT related programs and its central role in shaping future economies (Chuah, Loayza & Schmillen, 2019), and targets more capacity in IT-related programs. The share is expected to triple, from accounting for 1.7 percent in 2020 to 5 percent by the end of the decade. Health and related programs are another key departure from the proportions observed at baseline, where the capacity is expected to increase tenfold by the end of the decade. These adjustments reduce the shares for business and engineering related programs as shown in Table 5.21.

Table 5.21: Parameters driving the share of enrolments among programs, NDP Scenario

Decision parameter	Baseline (2020)	Target (2030)
Trainees in TVET per 100 000 population	1 126	2 250
% of students in public institutions	100%	100%
% of students in distance education	0%	30%
Trades with fixed capacity		
1.1 Agriculture	5 701	10 000
1.2 Tourism	40 672	80 000
1.3 Education	25 702	50 000
Total non-fixed capacity		
2.1 Business, finance, and marketing	34.0%	32.0%
2.2 Engineering and related	48.9%	45.0%
2.3 HR, secretary, and administration	12.5%	12.5%
2.4 Health and related	0.2%	2.0%
2.5 IT	1.7%	5.0%
3.1 Others	2.6%	3.5%

Source: Authors' computations based on administrative data and discussions with DHET

The number of teachers in the expanded TVET system is determined by a two-stage process, the first involves determining the number of teachers needed in the system, and the second involves the distribution of the teachers to the various programs. The first step is driven by an improved teacher to student (FTE) ratio, from 1:48 in 2020 to 1:30 by 2030 (see Table 5.22), and the second by applying the

staffing norms of 2016 to distribute teachers to the various programs. In addition to teachers, the NDP scenario progressively moves towards the desired balance between teaching and non-teaching staff, improving from a factor of 1.2 teachers to non-teaching staff to 1.3 in 2030.

Table 5.22: Parameters driving HR needs, NDP Scenario

Decision parameter	Baseline (2020)	Target (2030)
Student (FTE)/Teacher Ratio	48	30
Student (Head count)/Teacher Ratio		
1.1 Agriculture	86	60
1.2 Tourism	86	60
1.3 Education	86	60
2.1 Business, finance, and marketing	86	60
2.2 Engineering and related	86	60
2.3 HR, secretary, and administration	86	60
2.4 Health and related	86	60
2.5 IT	86	60
3.1 Others	86	60
Teachers to Non-teachers Ratio	1.2	1.3

Source: Authors' computations based on administrative data and discussions with DHET

The financial parameters expected to drive costs in the NDP scenario is similar to the BAS and PSET White Paper Scenarios, with DHET-level central recurrent expenditure expected to grow at 4%, teacher salaries sustained at 6.2 times per capita GDP, while those of non-teaching staff remain at 4 times per capita GDP. Another key driver of recurrent costs in this scenario is student support, where 100 percent of the students in public campuses are assumed to receive welfare support. The cost per student will be sustained at about ZAR 14 000. Finally, the NDP scenario seeks efficiency in the use of resources, progressively reducing the amount spent on other recurrent expenses to 100 percent from the near 130 percent reported in 2020 (see Table 5.23).

Table 5.23: Parameters driving recurrent spending on the expansion, NDP Scenario

Decision parameter	Baseline (2020)	Target (2030)

Recurrent cost		
Annual growth rate for recurrent exp. at central level	0%	4%
Average annual salary in GDP per capita		
Teachers	6.2	6.2
Non-teachers	4.0	4.0
Subsidies and Grants		
% assisted student through NSFAS	59.6%	100.0%
Per student support	13 780	13 780
Other recurrent as % of total teacher salary	128.9%	100.0%

Source: Authors' computations based on administrative data and discussions with DHET

Development costs under the NDP scenario will be driven by (i) the cost of maintaining campuses, which is projected to grow at 4% annually; (ii) construction of additional campuses and their maintenance, which is predicated on the assumption that the current capacity can accommodate 10 000 more students, beyond which the need for additional campuses will be triggered. Like in the BAS and PSET White Paper Scenarios, the NDP scenario assumes that the capacity of a new campus will range from 1 500 in a small campus, to 5 000 in a medium campus and 8 000 in a large campus. In terms of implementation, the expansion will comprise 20 percent small campuses, 40 percent medium, and 40 percent large campuses. The third component of expansion is housing of students, with the proportion of students benefitting from housing pegged at 10% of the student population (Table 5.24).

Table 5.24: Parameters driving capital spending in the NDP Scenario

Decision parameter	Target (2030)
Annual growth of maintenance budget	4.0%
Available capacity to accommodate new students in existing campuses	10 000
% of students by Institution by size (in 2030)	
Small	20.0%
Medium	40.0%
Large	40.0%
Average size of Institution	
Small	1 500

Decision parameter	Target (2030)
Medium	5 000
Large	8 000
% of students benefitting from student housing	10.0%

Source: Authors' computations based on administrative data and discussions with DHET

5.1.3.1 Expected enrolments under the NDP Scenario

Considering the expansion conditions highlighted above, the NDP scenario will see enrolment in TVET increase from 671 000 reported in 2020 to more than 1.5 million in 2030. With an estimated population of 7.9 million youth aged 18-24 in 2030, the expected enrolment in TVET will translate to a GER of about 19 percent. The introduction of distance education in 2024 will see it gradually accommodate a significant part of the TVET offering, with nearly 460 000 trainees expected to be trained through distance education (Table 5.25).

Table 5.25: Projected growth in enrolments, NDP Scenario

	Total			**%**		
	2020	**2025**	**2030**	**2020**	**2025**	**2030**
1.1 Agriculture	5 701	7 851	10 000	0.8%	0.7%	0.7%
1.2 Tourism	40 672	60 336	80 000	6.1%	5.6%	5.3%
1.3 Education	25 702	37 851	50 000	3.8%	3.5%	3.3%
2.1 Business, finance, and marketing	204 027	295 570	296 483	30.4%	27.6%	19.5%
2.2 Engineering and related	293 080	420 250	416 929	43.6%	39.2%	27.4%
2.3 HR, secretary, and administration	74 883	111 833	115 755	11.2%	10.4%	7.6%
2.4 Health and related	1 420	10 012	18 530	0.2%	0.9%	1.2%
2.5 IT	10 251	30 033	46 325	1.5%	2.8%	3.0%
3.1 Others	15 704	27 419	32 486	2.3%	2.6%	2.1%
Total Contact, Public	671 440	1 001 153	1 066 509	100.0%	93.3%	70.0%

	Total			%		
	2020	**2025**	**2030**	**2020**	**2025**	**2030**
Distance education	**-**	71 511	457 075	0.0%	6.7%	30.0%
Overall	**671 440**	**1 072 664**	**1 523 584**	**100.0%**	**100.0%**	**100.0%**

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

5.1.3.2 Expected Personnel under the NDP Scenario

Improving the teacher to student (FTE) ratio will see the number of teachers increase by close to 12 000 during the decade to reach 19 750. Also, due to the evolution in the weighting of the different programs (the growth of IT and health), the number of teachers in each program will evolve as shown in Table 5.26. The number of non-teaching staff will grow by nearly 8 400, to reach 15 000 by the end of the decade. Overall, the personnel in TVET will increase by more than 20 000 to cater to the doubling of the student population. Also notable is the expected decline in the share of non-teaching staff, which will be lower by 3 percentage points to reach 43 percent by the end of the decade.

Table 5.26: Expected personnel, NDP Scenario

	Baseline (2020)	Projected (2025)	Projected (2030)
Number of teachers	**7 765**	**14 255**	**19 754**
1.1 Agriculture	66	112	185
1.2 Tourism	470	859	1 482
1.3 Education	297	539	926
2.1 Business, finance, and marketing	2 360	4 209	5 492
2.2 Engineering and related	3 389	5 984	7 723
2.3 HR, secretary, and administration	866	1 592	2 144
2.4 Health and related	16	143	343
2.5 IT	119	428	858
3.1 Others	182	390	602
Number of non-teachers	**6 488**	**11 283**	**14 853**
Total staff	**14 253**	**25 539**	**34 607**

	Baseline (2020)	Projected (2025)	Projected (2030)
Number of teachers	**7 765**	**14 255**	**19 754**
% of staff that is non-teaching	**45.5%**	**44.2%**	**42.9%**

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

5.1.3.3 Expected expansion of facilities under the NDP Scenario

The increased enrolments will trigger the need for 100 additional campuses (51 small, 31 medium and 19 large). Moreover, the conditions under this scenario require the construction of housing facilities to accommodate more than 73 000 additional trainees while also upgrading existing facilities to accommodate about 53 500 trainees (see

Table 5.27).

Table 5.27: Expected physical facilities, NDP Scenario

	Size/Capacity	Number
New Campuses for additional trainees		
Small	1 500	51
Medium	5 000	31
Large	8 000	19
Housing		
Students accommodated in additional housing facilities	73 163	
Students accommodated in upgraded housing facilities	53 443	

Source: Authors' computations based on administrative data, discussions with DHET, and simulation model results

5.1.3.4 Expected Costs under the NDP Scenario

5.1.3.4.1 Recurrent costs associated with the expansion under the NDP Scenario

Projected recurrent costs for expansion under the conditions of this scenario will amount to ZAR 336.4 billion, ZAR 320.6 billion of which is expected to be spent directly by TVET colleges, about ZAR 8.2 billion will be spent at the DHET level, and ZAR 7.6 billion will fund distance education programs. On average,

the Government will need to spend about ZAR 35.6 billion annually on recurrent to support this expansion, translating to about 0.6% of the GDP (Table 5.28).

Table 5.28: Recurrent costs associated with the expansion, NDP Scenario

	Baseline (2020)	2025	2030	Total (2022-2030)	Average (2022-2030)
Expenditure at central level	718	874	1 063	8 223	914
Expenditure for in-person education	17 266	31 992	42 889	320 586	33 868
Expenditure for distance education	0	303	2 469	7 554	839
Total recurrent (Million Rand)	**17 985**	**33 169**	**46 421**	**336 364**	**35 621**
As % of GDP	0.35%	0.58%	0.74%		0.61%

Source: Authors' computations based on simulation model results

5.1.3.4.2 Capital and infrastructure maintenance costs under the NDP Scenario

The expansion of physical infrastructure under the conditions of this scenario will cost about ZAR 84.2 billion, with ZAR 54.5 billion (or two-thirds) expected to go towards the construction of new campuses. Housing facilities for additional students will cost about ZAR 22.9 billion and will translate to more than one quarter of the overall projected capital cost. Acquisition of equipment for distance education programs, a one-off expenditure, is projected to cost ZAR 2.3 billion (and about 3 percent of the capital cost). Maintenance will take up ZAR 4.5 billion, accounting for 5 percent of the capital costs. On average, it will cost the about ZAR 11.4 billion annually (an average of 0.19% of the GDP) to complete the infrastructure expansion (Table 5.29).

Table 5.29: Capital costs associated with the expansion, NDP Scenario

	Cumulative (2022-30)	Annual average	Relative to GDP
Maintenance of facilities	4 496	500	0.01%
Construction of new campuses	54 513	6 057	0.10%
Housing for additional students	14 140	1 571	0.03%
Upgrade of existing housing facilities	8 722	969	0.02%
Acquisition of distance education infrastructure	2 314	257	0.00%

	Cumulative (2022-30)	Annual average	Relative to GDP
Total (Mn ZAR)	**84 185**	**9 354**	**0.17%**

Source: Authors' computations based on simulation model results

5.2 Comparison of different expansion scenarios

The conditions described under the PSET White Paper Scenario will see enrolments surpass the 2.5 million students, the highest among the three expansion scenarios (see Table 5.30). To accommodate this increment by 2030, public campuses will need to increase their capacity by about 183 400 trainees annually, a twenty-fold increase in the growth rate, when compared to the baseline scenario. The NDP scenario, which is a compromise between the status quo and the ambitious PSET, will see enrolments grow to more than 1.5 million trainees by the end of the decade, and in terms of annual increase, will need to create 85 000 additional spaces every year, which would be nine times the annual increase under the BAS scenario.

Table 5.30: Comparison on enrolments and teachers, by scenario

	BAS Scenario	PSET White Paper Scenario	NDP Scenario
Total enrolment in public colleges			
Projected for 2030	762 309	2 505 449	1 523 584
Annual increase	9 087	183 401	85 214
Enrolment in distance education			
Projected for 2030	-	1 252 724	457 075
Annual increase	-	204 279	72 884
Teachers			
Projected for 2030	8 816	46 407	19 754
Annual increase	105	3 864	1 199

Source: Authors' computations based on administrative data and discussions with DHET

The distance education pathway is emphasized in the PSET White Paper Scenario, which will see more than 1.2 million trainees accessing TVET through this pathway compared to the 457 000 projected in the

NDP scenario. In the PSET White Paper Scenario, the share of trainees pursuing distance education programs is targeted at 50 percent, while in the NDP scenario, the proportion is targeted at 30 percent to allow for the gradual setup of this new modality of TVET delivery. Alongside having by far the highest number of trainees, the PSET White Paper Scenario has the highest need for teachers, which is 5 times more than the BAS scenario, and more than double when compared to the NDP scenario at the end of the decade. The cost of upgrading existing facilities and expanding the TVET system is estimated to be between ZAR 211.6 billion under the baseline scenario and ZAR 754.7 billion under the ambitious PSET White Paper scenario between 2022 and 2030, these costs covering recurrent and capital funding needs (see Table 5.31).

Table 5.31: Total Funding needs for expansion and upgrade of TVET system, 2022-2030

In Million ZAR	BAS Scenario	PSET White Paper Scenario	NDP Scenario
Total projected costs	**211 599**	**754 698**	**426 753**
Recurrent	189 234	597 407	336 364
Capital	22 364	157 291	90 389
Expansion	16 160	151 087	84 185
Upgrade	6 204	6 204	6 204

Source: Authors' computations based on administrative data, simulation model results, and discussions with DHET

When annualized, the costs of expanding and upgrading the TVET system range between ZAR 22.6 billion in the baseline scenario to ZAR 78.8 billion in the PSET White Paper scenario, annually for the nine years between 2022-2030 while NDP scenario would cost ZAR 45.7 billion (see Table 5.32) with these costs covering recurrent and capital needs. Recurrent costs would include salaries for teachers and non-teaching staff; non-salary operational costs (goods and services, utilities etc.); and support to students through the NSFAS. Compared to the BAS scenario, expansion in the PSET White Paper scenario would be three and eight times higher in recurrent and capital costs respectively. The NDP scenario, which also targets an improvement in system efficiency, would be about two and five times costlier in recurrent and capital costs respectively, compared to the BAS scenario.

Table 5.32: Average annual costs for the upgrade and expansion of the TVET system, by scenario

	BAS Scenario	PSET White Paper Scenario	NDP Scenario
Recurrent costs (in Million ZAR)	**20 112**	**61 293**	**35 621**

Expenditure at central level	914	914	914
Expenditure for in-person education	19 199	56 207	33 868
Expenditure on distance education	-	4 172	839
Recurrent costs as % of GDP	0.34%	1.04%	0.61%
Capital costs (in Million ZAR)	**2 485**	**17 477**	**10 043**
Upgrading	**689**	**689**	**689**
Expansion	**1 796**	**16 787**	**9 354**
Maintenance of facilities	500	500	500
Construction of new campuses	1 296	9 182	6 057
Housing for additional students	-	4 662	1 571
Upgrade of existing housing facilities	-	2 187	969
Distance education infrastructure	-	257	257
Capital costs as % of GDP	**0.04%**	**0.30%**	**0.17%**
Annual funding needs (Million ZAR)	**22,597**	**78 769**	**45 664**
Annual funding needs as % of GDP	**0.38%**	**1.34%**	**0.78%**

Source: Authors' computations based on administrative data, simulation model results, and discussions with DHET

5.3 Upgradation of existing campuses

The expansion scenarios have considered the need for additional space to accommodate the anticipated growth in enrolled trainees. The expansion does not deal with the maintenance needs or upgrading of facilities available in the existing campuses. According to data provided by DHET there are 254 campuses. DHET staff provided a subjective classification of the state of infrastructure on these campuses into three categories: good (requires minimal renovation), average (requires considerable renovation; current physical condition may adversely impact operations), or poor condition (requires significant renovation; current physical condition adversely impacts operations). There are only five existing campuses that were classified as being in good condition. Nearly 130 campuses (or more than half) were classified as being in poor condition, while the remaining were classified as being in average condition. In each of the three

categories, the campuses need upgrading to bring them up to the desired condition, contemplated in the TVET norms and standards. The cost of upgrade is predicated on the size of the campuses, as described in

Table 5.33. For instance, the average cost of upgrading a campus in good condition is ZAR 7 million (ranging from ZAR 2 million in a campus with less than 1 000 trainees to ZAR 12 million in a campus with more than 4 000 trainees). These costs are broad estimates based on visits to 15 campuses by the study team, which included architects and experts from the construction industry in South Africa.

Table 5.33: Upgradation of facilities in existing campuses

	Condition of college facilities			
	Good	**Average**	**Poor**	**All**
Number of campuses	5	120	129	254
<1000	4	20	30	54
1000-4000	1	72	69	142
Above 4000		28	30	58
Unit Costs (Mn ZAR)				
<1000	2	5	10	
1000-4000	6	15	30	
Above 4000	12	30	60	
Amounts (Mn ZAR)				
<1000	8	100	300	408
1000-4000	6	1 080	2 070	3 156
Above 4000	-	840	1 800	2 640
Grand Total	**14**	**2 020**	**4 170**	**6 204**

Source: Authors' estimates based on data provided by DHET

Given the distribution of the campuses in the three categories and the unit costs for upgrading, the total cost of upgrading will be about ZAR 6.2 billion (ZAR 14 million for campuses in relatively good condition; ZAR 2 billion for those in average condition; and ZAR 4.2 billion for those in poor condition).

5.4 The funding gap in meeting South Africa's TVET objectives

The NDP, in its economy and employment pillar, seeks to *eliminate poverty and reduce inequality, by raising levels of employment and productivity growth*. This will call for the creation of a diversified economy and making substantial investments in strengthening municipal infrastructure and services, in strengthening education systems, and in providing access to capital for new and expanding firms. The GDP is projected to follow three different growth profiles, based on the socioeconomic projections (World Bank, 2021). The first projection scenario is expected to grow at an annual average rate of 2.21%, the second at 1.98%, while the third scenario projects that the GDP will grow at an annual average of 1.78%.

Assuming that the public expenditure to TVET will remain at the levels recorded in 2020 i.e. 0.35% in recurrent and 0.01% in capital, and applying the assumed funding levels on the projected GDP, ZAR 189 billion will potentially be available for spending on TVET over the 9-year period under the first GDP projection scenario; ZAR 186.3 billion under the second GDP projection scenario; and ZAR 184.1 billion under the third GDP projection scenario (see Table 5.34). Against the total costs of expansion and upgrade costs: ZAR 211.6 billion under the BAS scenario; ZAR 754.7 billion under the PSET White Paper Scenario; and ZAR 426.8 billion under the NDP scenario, the funding gap is will range from ZAR 22.7 – 27.5 billion under the BAS scenario; ZAR 565.8 – 570.6 billion under the PSET White Paper scenario; and ZAR 237.9 – 242.7 billion under the NDP scenario.

Table 5.34: Funding gap for expansion by scenario, 2022-2030

In Million ZAR	BAS Scenario	PSET WP Scenario	NDP Scenario
Total projected costs	**211 599**	**754 698**	**426 753**
Recurrent	189 234	597 407	336 364
Capital	22 364	157 291	90 389
Expansion	16 160	151 087	84 185
Upgrade	6 204	6 204	6 204
Total Projected resources			
Under GDP Growth Scenario 1	188 877	188 877	188 877
Under GDP Growth Scenario 2	186 284	186 284	186 284

In Million ZAR	BAS Scenario	PSET WP Scenario	NDP Scenario
Under GDP Growth Scenario 3	184 057	184 057	184 057
Funding gap			
Under GDP Growth Scenario 1	(22 721)	(565 821)	(237 875)
Under GDP Growth Scenario 2	(25 315)	(568 414)	(240 469)
Under GDP Growth Scenario 3	(27 541)	(570 641)	(242 695)
% gap - GDP Growth Scenario 1	-12.0%	-299.6%	-125.9%
% gap - GDP Growth Scenario 2	-13.6%	-305.1%	-129.1%
% gap - GDP Growth Scenario 3	-15.0%	-310.0%	-131.9%

Source: Authors' computations based on the NDP, simulation model results, and data on TVET expenditure obtained from the National Treasury

Against the estimated annual costs of expansion and upgrade of TVET: ZAR 22.6 billion annually under the BAS scenario; ZAR 78.8 billion annually under the PSET White Paper Scenario; and ZAR 45.7 billion annually under the NDP scenario, the funding gap is will range from ZAR 1.6 – 2.1 billion annually under the BAS scenario, translated to an average of 0.03 percent of the GDP; ZAR 57.8 – 58.3 billion annually under the PSET White Paper scenario, translating to translated to an average one percent of the GDP; and ZAR 24.7 – 25.2 billion under the NDP scenario, translating to translated to an average 0.43 percent of the GDP (see Table 5.35).

Table 5.35: Annual funding gap for expansion by scenario

In Million ZAR (2022-2030)	BAS Scenario	PSET WP Scenario	NDP Scenario
Annual projected costs	**22 597**	**80 826**	**47 720**
Recurrent	20 112	61 293	35 621
Capital	2 485	19 533	12 100
Expansion	1 796	18 844	11 410
Upgrade	689	689	689

In Million ZAR (2022-2030)	BAS Scenario	PSET WP Scenario	NDP Scenario
Annual projected resources			
Under GDP Scenario 1	20 986	20 986	20 986
Under GDP Scenario 2	20 698	20 698	20 698
Under GDP Scenario 3	20 451	20 451	20 451
Funding gap			
Under GDP Scenario 1	(1 611)	(57 783)	(24 678)
Under GDP Scenario 2	(1 899)	(58 071)	(24 966)
Under GDP Scenario 3	(2 146)	(58 319)	(25 213)
% Gap - GDP Scenario 1	-7.7%	-275.3%	-117.6%
% Gap - GDP Scenario 2	-9.2%	-280.6%	-120.6%
% Gap - GDP Scenario 3	-10.5%	-285.2%	-123.3%
Funding gap as % of GDP under scenario 1 projections	0.03%	-0.98%	-0.42%
Funding gap as % of GDP under scenario 2 projections	0.03%	-1.00%	-0.43%
Funding gap as % of GDP under scenario 3 projections	0.04%	-1.02%	-0.44%

Source: Authors' computations based on the NDP, simulation model results, and data on TVET expenditure obtained from the National Treasury

Figure 5.1 presents a summary of the average cost of expanding and upgrading TVET system for the BAS, PSET White Paper, and NDP scenarios alongside the resources projected to be available for TVET expansion and upgrade over the 9-year development period.

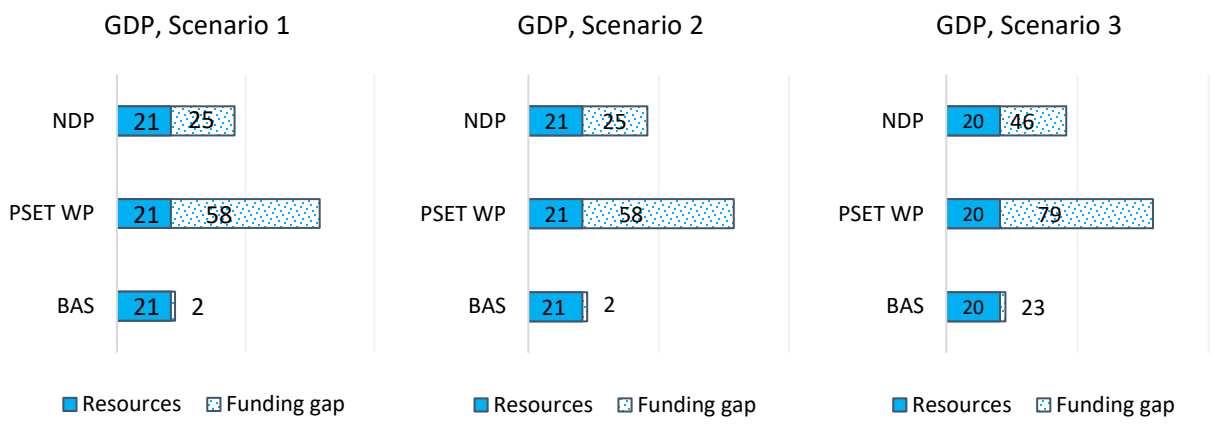


Figure 5.1: Estimated annual funding gap for TVET expansion, by scenario (ZAR Billion)

Source: Authors' computations based on the NDP, simulation model results, and data on TVET expenditure obtained from the National Treasury

Given the size of the funding gaps in the non-baseline scenarios (averaging ZAR 58 billion in the PSET White Paper scenario, and ZAR 25 billion in the NDP scenario annually), overcoming these funding gaps may be possible through a combination of policy choices, including possibly rationalizing the ambition of South Africa's TVET objectives, committing additional resources to TVET, and improving the efficiency of TVET expenditure are required.

6 Recommendations for funding the TVET infrastructure gap

Current levels of TVET funding are insufficient for South Africa to meet its TVET-related SDG commitments, regardless of whether the targets described in the NDP or the PSET White Paper are considered as the relevant operational targets derived from the SDG targets. Compared to the projected funding available over the 9-year period from 2022-2030, the NDP scenario results in an estimated annual funding gap ranging from 118-123%. The annual funding gap for the more ambitious targets described in the PSET White Paper is larger, ranging from 275-285%. An important contributor to the funding gap is the capital expenditure required to upgrade existing TVET infrastructure and construct new infrastructure to accommodate increased enrolment. Funding this expenditure, even in part, will require a substantially increased volume of spending and improved efficiency. The development of infrastructure must be accompanied by several other reforms for South Africa to meet its TVET goals. Infrastructure is only one of the several constraints to the expansion of quality TVET. Reforms in financing; infrastructure; instructor

qualifications and competencies; management capacity; internal efficiency; and curriculum and training must be implemented to resolve these constraints.

6.1 More financing for TVET infrastructure

Create an enabling regulatory and funding environment for private providers

Closing the funding gap will require diversification of financing sources. This may need to include greater support for private providers of TVET. The role of the private sector is acknowledged in South Africa's TVET objectives, with the NDP's target of 1.25 million TVET enrolees by 2030 potentially comprising both students from public and private TVET colleges (Khuluvhe et al., 2021). However, the lack of data on private TVET colleges prevents the DHET from accounting for these colleges in its strategic planning processes. Enabling the private sector to contribute to the achievement of South Africa's TVET objectives will require a simplified and more responsive quality assurance mechanism, outcomes-linked government funding, and regular and comprehensive monitoring. There is a willingness on the part of the private sector to engage in these processes. Case studies have found that private providers, who provide good quality training are prepared to work with government to achieve national education and training goals and be subjected to effective regulation and quality assurance but have found the government to be unresponsive (Private Providers and National Sustainable Development Strategy (NSDS) III, 2018).

Encourage alternate modes of training, such as workplace-based training

In addition to crowding-in private providers of college-based TVET, there is significant potential to leverage the capacities and resources of firms through alternate training mechanisms such as WBL. To improve participation in WBL, enterprises must be prepared to engage and be capable of taking on learners. However, there are barriers that influence the preparedness of enterprises to engage (such as information failures and changes in the business and qualification environment) and barriers that affect their capability to take learners. Capability barriers include bureaucracy and procedures, high costs and limited incentives, and low training capacities (Franz, Dulvy & Marock, 2022). Creating an enabling environment for WBL will require reducing the administrative requirements for WBL imposed on enterprises, incentivizing SETAs to increase their responsiveness to micro- and small-enterprises, facilitating intermediary models of micro- and small-enterprise participation in WBL, and fostering the development of demand-led programs and qualifications.

Use financial regulation to incentivise quality

More flexible fee ceilings can increase college income and incentivise quality improvements. Reforming the model for determining student fees and program funding from the DHET could also generate more income for higher performing colleges, where investments are most efficient. These reforms would entail a shift away from determining fees and program funding based solely on the cost of provision, to a model that directly incentivises quality as measured by student outcomes. The state of Gujarat in India has implemented such a model for technical education, where institutes that are granted "Centre of Excellence" status based on a set of quality standards, are exempted from government fee regulation (Government of Gujarat, 2013). In other states in India, while no institutes are exempted from fee regulation, higher performing institutes can charge higher fees. Such provisions must be accompanied by well-targeted student financial support to ensure equitable access to the best colleges.

Diversify the sources of income for public TVET colleges

Public TVET colleges should also diversify their sources of income. There is significant potential for TVET colleges to raise revenues from direct services provided to firms, drawing on models from other countries. This also has the benefit of strengthening linkages between colleges and local markets. For example, Servicio Nacional de Adiestramiento en Trabajo Industrial (National Industrial Work Training Service, Spanish) (SENATI) in Peru derives nearly 60 percent of its income from the sales of goods and services, including training programs focused on high-demand areas such as environmental technologies, in-house training for employees of private firms, and manufacturing services (SENATI, 2018). Other potential sources of income are leasing land and equipment to firms when not in use and delivering services such as small-scale construction and repairs to local communities. While pursuing these sources of income, it is important to balance the emphasis on income generating activities with the core objective of providing high quality training.

Improve the internal efficiency of the TVET system

With limited fiscal space to increase the TVET budget, improved efficiency can create room for increased capital expenditure. Extremely low internal efficiency, reflected in on-time graduation rates as low as 9.2 percent for NC (V) programs, results in a considerable waste of resources due to repetition and drop-out. Improving internal efficiency requires, amongst other measures, improved quality of instruction, sustained financial aid for long duration programs to reduce dropouts, better access to internships and industrial placement opportunities for students to meet the practical training requirements of their courses, and timely certification after examinations. Improved management and accountability at the

system level is also needed to improve efficiency. This requires strengthened capacity to design and implement well-aligned policies, norms, and standards in areas such as quality assurance, financing, and infrastructure development. This is reliant on better monitoring and evaluation based on consolidated data systems to ensure compliance. At a minimum, if budget constraints are eased due to higher budgets or improved efficiency, the DHET must ensure colleges comply with its funding norms, which require at least 10 percent of college budgets to be spent on replacement capital expenditure.

Use innovative mechanisms to fund the adoption of technology

The use of technology in TVET can be funded by leveraging emerging business models and funding sources. Digitising TVET to respond to market demand and enable new delivery models requires additional investment. Digitisation is dependent on the availability of digital infrastructure and the COVID-19 pandemic has highlighted the need for investment in digital infrastructure in the TVET sector. Compared to 80 percent of university students, only 40 percent of TVET students had any access to online learning during the pandemic (DHET, 2021d). While the government will have to invest in the enabling digital infrastructure, it can leverage the private sector to fund digital TVET platforms and content. Venture capital is driving investment in education technology globally. In 2010 venture capital investment in education technology was $500 million, by 2020 it reached $16 billion, including doubling in 2020 alone (HolonIQ, 2021). For South Africa to benefit from these investments, the government will have to develop a conducive policy and regulatory environment for private investment in education technology in TVET. To ease initial capital constraints, which are partly driven by high perceived risk, the government can provide start-up capital to incubate locally grown solutions or to facilitate the entry and piloting of global technology solutions (World Bank Group, 2021). In addition, the government also has the unique role of providing accreditation and recognition to trainee outcomes from digital products, to encourage their adoption, facilitate recognition by industry, and overcome resistance from established providers.

6.2 Better utilization of existing TVET infrastructure funding

Develop macro-level space norms and improve the norms for space utilization

Planned expansion of TVET infrastructure requires macro level space norms for TVET colleges. With no planned TVET infrastructure expansion since the Recapitalisation Program of 2008, it is essential that the next phase of expansion is informed by careful strategic planning that accounts for both trends in enrolment and the trades to be taught. As discussed in Section 4, this requires an evolution of the current

TVET space norms. First, the creation of higher-level norms that provide a broad understanding of space needed based on expected student load (described as Macro Level 1 norms in Section 4), will allow the DHET to identify future infrastructure funding needs. Second, the current space norms, which provide a breakdown of academic facilities needed by trade grouping, need to evolve to better account for the differing space needs of various trades. For instance, currently the specified areas for workshop facilities differ by trade only based on the assumed student contact hours for each trade and do not account for the differences in the equipment or machinery needed. Norms that differentiate the space requirements by trade more accurately will facilitate better forecasting and planning for infrastructure funding needs.

College level space norms can be revised to improve space utilization. Increasing the expected utilization of classroom space in the space norms from the current 50 percent of annual working hours to 75 percent will reduce the amount of classroom space needed by 33 percent. A 75 percent utilization rate is in line with other developing countries, such as India. This can be achieved by building multi-purpose classrooms that are not earmarked for specific trades or instructors and effective timetabling. Similarly, the utilization of workshops and laboratories can be increased by using each facility multiple times. This can allow these facilities to be designed for only a third or half of the student strength, significantly reducing the cost of construction and equipment.

Strengthen DHET capacity to develop and implement infrastructure norms and standards and TVET staff capacity to deal with infrastructure issues

The DHET's capacity to develop and implement standards and norms for TVET infrastructure should be strengthened. In addition, data and monitoring systems needed to ensure compliance must be developed. The DHET currently does not have a system to monitor the availability and condition of TVET infrastructure. Consequently, there is no data on existing TVET infrastructure and the extent to which it complies with the current norms. There are examples of education infrastructure monitoring systems in South Africa, such as the National Education Infrastructure Management System for basic education, which can inform the development of a TVET infrastructure monitoring system. Alongside, the DHET requires the capacity to assess the designs of planned infrastructure projects with its space norms. There is no evidence that the designs of the five recent construction projects reviewed for this study were assessed against the current space norms. In addition, an assessment needs to be undertaken to determine the capacity of staff at the TVET level to deal with infrastructure related issues such as building or maintenance. This should be considered as an area for future capacity building efforts.

Use technology for more efficient space utilisation

Technology can enable more efficient utilization of existing physical infrastructure. The use of technology, where the necessary digital infrastructure is present, can greatly reduce demands on physical infrastructure, particularly for space or equipment intensive activities. For example, at the Swiss Federal Institute for Vocational Education and Training, horticulture programs use virtual reality glasses to allow students to create and implement landscaping designs, including placement of trees, shrubs, and plants, and to simulate different seasonal effects for their virtual landscapes (UNESCO-UNEVOC, 2020). This eliminates or reduces the need for land to practice these skills. Similarly, online, or blended learning can reduce the need for classroom space. By simulating on-the-job training, these technologies can also help to bridge the gap between theoretical learning in the classroom and the skills needed to perform in professional settings. Space norms for TVET colleges must evolve in line with the adoption of these technologies. In addition, as discussed in the next section, the effective use of these solutions will require teachers, learners, and administrators to have the required digital skills.

6.3 Technology and considerations for future TVET infrastructure

Adopting education technology will place new demands on TVET governance and regulatory mechanisms. Governance mechanisms will require the capacity to develop a vision for the education system that addresses the role that technology will play in the functioning of the system. This means developing an understanding of the types of technology available, how the adoption of those technologies will affect the functioning of the system and the interests of the stakeholders involved, and the ability to coordinate across the system to develop a shared vision for the role of technology. This vision will ultimately determine investment needs for digital and physical infrastructure. The vision will also have to be aligned with a more open regulatory regime that allows importing digital infrastructure and facilitates the entry of non-traditional TVET providers, including global providers offering technology-enabled solutions (World Bank Group, 2021). The risks this poses must be balanced with more effective outcomes-based quality assurance and safeguards against violation of privacy and inappropriate content.

Both system and institutional management will also have to evolve. At the system level, as providers and training programs proliferate, the DHET will have to play a central role in collecting and disseminating information on the quality of providers and ensuring price transparency, which requires investments in more robust management information systems. It will also have to develop training verification and

certification mechanisms for skills obtained through a broad range of providers and programs. Sri Lanka's National Skills Passport (NSP), which provides recognition of skills and verifies work experience through a web-based online database, is one such example (Tertiary and Vocation Education Commission, n.d.). The NSP is a smart card issued to a skilled person who has a vocational qualification and at least a year of related work experience. The NSP is linked to recognition of prior learning systems and the online database links candidates with NSPs to labour market intermediaries and employers, thus providing a pathway to employment. At the institutional level, TVET colleges will have to develop capacities to manage digital infrastructure and devices, including remote management of devices and ensuring fair use.

Investment needs for digital infrastructure will grow relative to those for physical infrastructure. At a minimum, colleges will require subsidised broadband and will need to ensure that students have access to digital devices to enable the use of education technology. In addition, colleges may need high performance computing facilities, cloud storage services, and access to specialised equipment. The nature and volume of these additional investments in digital infrastructure will depend on the choice of education technologies deployed. These choices require a framework for decision making that differs from those used for physical infrastructure. A framework for decision making used by school districts in Ontario, Canada (Ribero, 2016) helps understand the interactions between education technology procurement and spending, its academic impact, and data-driven decision-making. Effective decision making on the adoption of education technology requires considering all three aspects simultaneously. This decision-making process will also have to be supported by new procurement processes that are optimised for education technology. Figure 6.1 presents a high-level overview of an education technology procurement process for TVET systems.

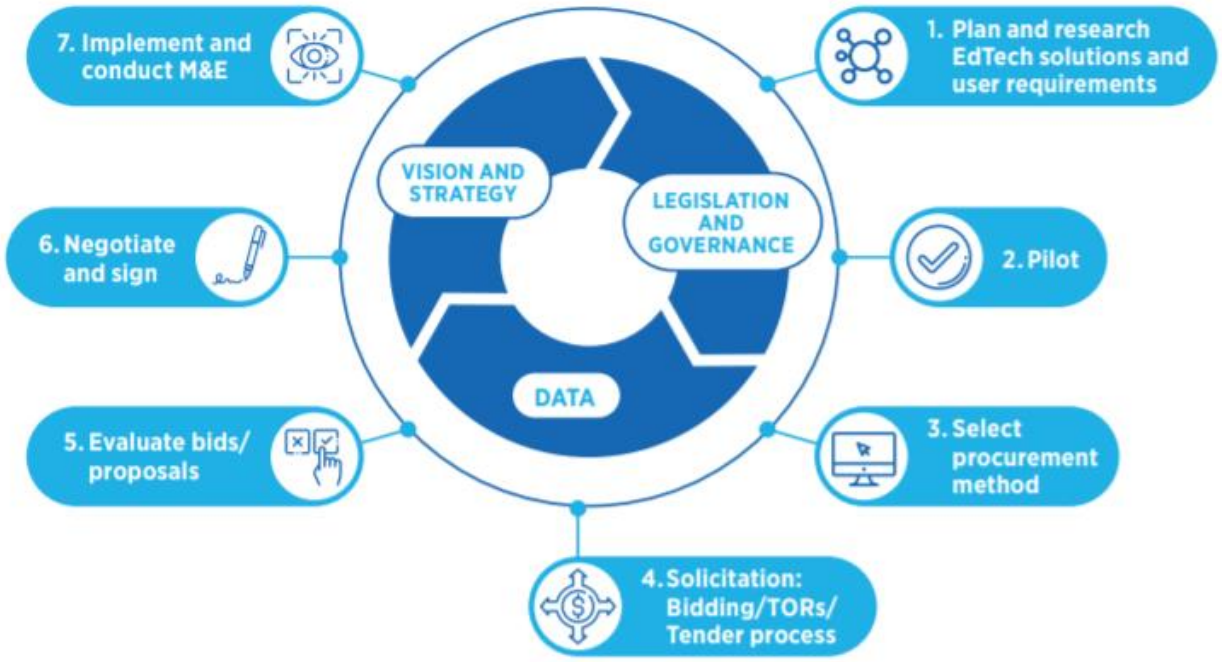


Figure 6.1: An education technology procurement process for TVET systems

Source: Unleashing the power of educational technology in TVET systems (World Bank Group, 2021)

Digital skills need to be enhanced for greater use of technology. Investments in digital infrastructure and education technology solutions will have to be aligned to students', teachers', and administrators' digital skills. The buy-in of teachers and administrators must be secured prior to the adoption of new education technologies. This requires empowering them with the digital and pedagogical skills to effectively use education technology. Both initial and in-service training for teachers should include the basics of online course development, instructional design, content production, and delivery. Moreover, teachers must be trained to understand how technology will shape demand for skills (such as increasing the demand for transversal skills) and adapt pedagogy accordingly. College administrators need to be trained in decision-making on the choice of education technologies and the incorporation of technology-enabled solutions in their institutional strategies. Finally, all students, regardless of the trades in which they are enrolled need to be provided with the basic digital skills to effectively use education technology. Therefore, planning for investments in digital infrastructure and education technology must account for the cost of and time needed for developing the requisite digital skills.

The use of technology will be an important determinant of the optimal size and degree of specialization of TVET colleges. Technology adoption may increase or decrease the optimal size of TVET colleges, depending on which of the two opposing influences prevail. On one hand, the digitisation of distance

learning can improve access for students who face geographic barriers, such as being in remote rural areas (International Labour Organization (ILO), 2020). This can reduce the need for TVET colleges in remote rural areas, which are typically smaller than those in urban and peri-urban areas, leading to a larger average college size. On the other hand, the use of technology can reduce the need for space and equipment, making smaller colleges that were previously unviable more cost-efficient. Which of these influences prevail will depend on the types of technology adopted and policy choices regarding how access to TVET is to be widened. Similarly, the extent to which TVET colleges specialize in specific trades instead of offering a broad range of trades can also depend on the use of technology. Specialization can lead to economies of scale and allow training for each trade to be concentrated close to the markets that demand skills in those trades. It can also, however, limit students' choices by reducing the range of trades offered by colleges near them. The recent introduction of Centres of Specialisation (CoS) for TVET in South Africa is a step towards greater specialisation. A CoS is a department within a TVET college campus dedicated to training artisans in a particular trade using a dual (college- and firm-based) training model. This approach shows promise and early data indicates that the per-student cost of provision is up to 50 percent lower than equivalent NC(V) programs (NSA & DHET, 2021). If combined with effective technology-enabled distance learning, this model can yield the benefits of specialisation without limiting choice geographically.

Modern construction methods hold promise but require several prerequisites to be effective. Meeting South Africa's TVET expansion objectives will require significant construction of new campuses. Methods such as off-site construction[24] have the potential to be scalable, high-quality, and cost- and time-efficient. However, their success requires a well-developed local construction industry, suitable construction materials, labour that is skilled in off-site construction, and means of transport capable of transporting building components manufactured off-site to the locations of TVET campuses. Lessons learned from other countries suggest that the use of off-site construction in the absence of these prerequisites leads to logistical challenges, and significant labour and material import costs. The extent to which conditions in South Africa are suitable for these construction methods will have to be assessed prior to their adoption. Overall, there is limited evidence on the extent to which off-site construction can save costs over traditional methods in developing countries.

[24] Off-site construction is a construction procedure that involves the planning, designing, fabrication, transportation of fabricated building items and its assembling on the site with great speed and a high degree of finish

References

AECOM. 2021. *Africa Property and Construction Cost Guide 2020-2021*.

AICTE. 2021. *Approval Process Handbook*.

Alexander, G. & Masoabi, C. 2017. Reflections on the state of pedagogy and perceived related challenges in Technical, Vocational, Education and Training (TVET) engineering studies of South Africa. In *ADVED 2017- 3rd International Conference on Advances in Education and Social Sciences*. Istanbul. 1008–1017.

Capacity Building Program for Employment Promotion and DHET, 2020. A Baseline Study on the Destination of TVET College Graduates to Strengthen Employment Promotion in South Africa

Chuah, L.L., Loayza, N. & Schmillen, A. 2019. The Future of Work: Race With — Not Against — the Machine. *World Bank Research and Policy Briefs*.

Department of Planning, Monitoring and Evaluation (DPME). 2019. *South Africa's Voluntary National Review (VNR) Report*. Available: https://sustainabledevelopment.un.org/content/documents/23402RSA_Voluntary_National_Review_Report__9_July_2019.pdf [2021, November 23].

DHET. 2017. *Construction Funding Norms for Buildings and Other Land Improvements at Technical and Vocational Education and Training Institutions - September 2017*.

DHET. 2018. *Investment Trends in Post-School Education and Training in South Africa*.

DHET. 2019. National Norms and Standards for Funding Technical and Vocational Education and Training Colleges. *STAATSKOERANT*. 22 November.

DHET. 2020. *National List of Occupations in High Demand*.

DHET. 2021a. *Statistics on Post-School Education and Training in South Africa 2019*. Pretoria. Available: https://www.dhet.gov.za/DHET%20Statistics%20Publication/Statistics%20on%20Post-School%20Education%20and%20Training%20in%20South%20Africa%202019.pdf [2021, November 25].

DHET. 2021b. Revised Strategic Plan 2020-2025

DHET. 2021c. *University Macro-Infrastructure Framework (MIF) – Infrastructure Management Guidelines for Universities - January 2021*.

DHET. 2021d. *Social impact of the COVID-19 pandemic on youth in the Post School Education and Training Sector in South Africa*. Pretoria.

DHET. 2022. *Statistics on Post-School Education and Training in South Africa*. Pretoria.

DNA Economics. 2016. *Performance and Expenditure Review: Technical and Vocational Education and Training*.

Franz, J., Dulvy, E.N. & Marock, C. 2022. *Engagement of Micro and Small Enterprises in Workplace-based Learning in South Africa*.

Government of Gujarat. 2013. The Gujarat Professional Technical Educational Colleges or Institutions (Regulation of Admission and Fixation of Fees) (Amendment) Act, 2013. *The Gujarat Government Gazette (Act no. 12 of 2013)*.

Grapsa, E., Mncwango, B. & Rogan, M. 2019. Education and skills mismatch in the South African labor market. In *Post-school education and the labor market in South Africa*. M. Rogan, Ed. Cape Town: HSRC Press. 223–242. Available: https://repository.hsrc.ac.za/handle/20.500.11910/13665 [2021, November 25].

Green, W. 2018. TVET lecturer qualifications development. In *Towards a Continuing Professional Development (CPD) Framework for TVET Colleges*. Johannesburg.

HolonIQ. 2021. *Global EdTech Funding 2021 – Half Year Update*.

ILO. 2020. *The Digitization of TVET and Skills Systems*.

Khuluvhe, M., Netshifhefhe, E., Gyanaupfu, E. & Negogogo, V. 2021. *Post-School Education and Training Monitor*. Pretoria.

Mashongoane, T. 2018. Continued learning and employment: Destinations of TVET engineering graduates in the North West Province. In *Post-school Education and the Labor Market in South Africa*. M. Rogan, Ed. HSRC Press.

Mlatsheni, C. & Ranchod, V. 2017. Youth labour market dynamics in South Africa: Evidence from NIDS 1-2-3. *REDI3x3 Working Paper 39*. Available: https://www.redi3x3.org/sites/default/files/Mlatsheni%20%26%20Ranchhod%202017%20REDI3x3%20Working%20Paper%2039%20Youth%20labour%20market%20dynamics.pdf [2021, November 24].

National Planning Commission. 2013. *National Development Plan 2030: Our future - make it work*.

National Skills Authority & DHET. 2021. *Evaluation and Amendment of the Centre of Specialization Costing Model Final Report*. Pretoria.

National Skills Fund. 2020. *2019/20 Annual Report*.

Papier, J., Powell, L., McBride, T. & Needham, S. 2018. Tracing the pathways of National Accredited Technical Education Diploma (NATED) programme graduates through Technical and Vocational Education and Training (TVET) colleges and beyond. In *Post-school Education and the Labor Market in South Africa*. M. Rogan, Ed. HSRC Press.

Ranchod, V. & Dinkleman, T. 2008. Labor Market Transitions in South Africa: What can we learn from matched Labor Force Survey Data? *SALDRU Working Paper Series 14*.

Ribero, J. 2016. Educational Technology Decision-Making: Technology Acquisition for 746,000 Ontario Students. *Canadian Journal of Educational Administration and Policy*. (176).

Rozenberg, J. & Fay, M. 2019. *Beyond the Gap : How Countries Can Afford the Infrastructure They Need while Protecting the Planet. Sustainable Infrastructure*. Washington, DC. Available: http://hdl.handle.net/10986/31291 [2021, November 23].

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. & Fuller G. 2019. *Sustainable Development Report*. New York. Available: https://s3.amazonaws.com/sustainabledevelopment.report/2019/2019_sustainable_development_report.pdf [2021, November 23].

SENATI (Servicio Nacional de Adiestramiento en Trabajo Industrial). 2018. *Memoria Anual 2018*. Lima.

Southern Hemisphere. 2018. *Implementation Evaluation of the Technical and Vocational Education and Training College Expansion and Capacity Development Programme*.

Statistics South Africa. 2020. *Quarterly Labor Force Survey: Q1 2020*. Available: https://www.statssa.gov.za/publications/P0211/P02111stQuarter2020.pdf [2021, November 24].

Statistics South Africa. 2021. *Quarterly Labor Force Survey: Q2 2021*.

Swiss-South African Cooperation Initiative, JET Education Services & National Building Initiative. 2016. *Tracer Study of the Transition of Students from TVET Colleges to the Labour Market*.

TEFMA. 2009. *TEFMA Space Planning Guidelines*.

Tertiary and Vocation Education Commission. n.d. *Skills Passport, Sri Lanka*. Available: http://www.nsp.gov.lk/#home [2022, February 22].

UNESCO-UNEVOC. 2020. *Situation-based VET Using Virtual Reality*.

Ward, M. 2018a. *Case Study: Private Providers and NSDS III*.

Ward, M. 2018b. *Private Providers and NSDS III*.

World Bank. 2019. *South Africa Economic Update: Tertiary Education Enrollments Must Rise*.

World Bank Group. 2021. *Unleashing the Power of Educational Technology in TVET Systems*. Washington, DC.

el Zayat, A., Agbeyi, E.O., Osei, K., Daniel, K. & Cairncross, L. 2020. *The Student Housing Landscape in South Africa*. Available: https://www.ifc.org/wps/wcm/connect/cc21f05d-ff9f-4f00-827a-c25e40b3c264/Market+Assessment--The+Student+Housing+Landscape+in+South+Africa_April+2021.pdf?MOD=AJPERES&CVID=nAtuGGk [2021, November 29].

Annex 1: Data Sources

- Population and GDP
  - World Bank projections developed with CSIR and Quantec Research based on StatsSA data
- Participation in TVET (Enrolments)
  - 2020 administrative data provided by the DHET
  - 2019 enrolment data used to update 2020 enrolments to reflect pre-COVID capacity
- Human Resources
  - Data on TVET staff provided by DHET (2020)
  - 2016 staffing norms
- Infrastructure conditions in existing campuses
  - Primary data collected from the a sample of 14 campuses
- Current funding levels and TVET expenditure
  - National Treasury data triangulated with DHET reports (2020)
- Data on unit costs of construction:
  - Unit cost of new construction estimated from the recent DHET-funded projects and AECOM data
  - Unit cost of upgrade of facilities estimated from the 14 surveyed campuses
- Standard package of infrastructure facilities
  - Derived from recent TVET construction projects in Umzimkhulu, Nkaandla A, and Nongoma

Annex 2: Population Estimates between 2020 and 2030

Province	Population Census	Stats SA projection for 2030						Stats SA projections updated by World Bank for 2030					
		Past population growth			Baseline scenario			Urban scenario			Rural scenario		
	2011	2020	Growth 2011-2020		2030	2020 to 2030		2030	2020 to 2030		2030	2020 to 2030	
Eastern Cape	6 555 444	6 750 832	195 388	3 %	6 666 950	(83 882)	-1 %	7 232 273	481 440	7 %	7 395 747	644 914	10 %
Free State	2 745 155	2 928 066	182 911	7 %	3 044 300	116 234	4 %	3 299 535	371 468	13 %	3 249 785	321 718	11 %
Gauteng	12 271 226	15 483 870	3 212 644	26 %	19 168 436	3 684 566	24 %	20 254 375	4 770 505	31 %	19 579 909	4 096 039	26 %
KwaZulu-Natal	10 263 829	11 532 602	1 268 773	12 %	12 865 550	1 332 948	12 %	13 726 176	2 193 575	19 %	14 272 784	2 740 182	24 %
Limpopo	5 402 393	5 856 308	453 916	8 %	6 203 542	347 234	6 %	5 578 571	(277 737)	-5 %	5 740 833	(115 476)	-2 %
Mpumalanga	4 039 512	4 684 59	644 947	16 %	5 327 623	643 164	14 %	4 465 325	(219 134)	-5 %	4 517 696	(166 763)	-4 %
Northern Cape	1 145 394	1 293 148	147 754	13 %	1 427 408	134 260	10 %	1 206 908	(86 240)	-7 %	1 187 535	(105 613)	-8 %
North West	3 509 733	4 107 035	597 302	17 %	4 769 356	662 321	16 %	3 869 242	(237 793)	-6 %	3 922 458	(184 577)	-4 %
Western Cape	5 821 810	7 006 713	1 184 903	20 %	8 241 664	1 234 951	18 %	8 082 423	1 075 711	15 %	7 848 082	841 370	12 %
South Africa	51 754 496	59 643 032	7 888 536	15 %	67 714 828	8 071 796	14 %	67 714 828	8 071 796	14 %	67 714 828	8 071 796	14 %

Source: Estimates made by Stats SA and update by World Bank

Annex 3: User guide for the TVET simulation model

Background

The Government of the Republic of South Africa is expanding TVET to enhance transition of youth to the labour market. Specifically, TVET seeks to provide the youth with opportunities to improve their skills for better participation in the world of work. The expansion of TVET will result not only in higher skilled manpower but also integrate back the youth who for one reason or another left school before prescribed exits. A simulation model has been developed to provide possible insights on how an expanded TVET might look like in future. This note accompanies the simulation model, explaining how to navigate, how to validate the data used and how to manipulate the parameters driving expansion.

What are simulation models?

Simulation models are as tools that project future possibilities, based on systematic assumptions. Simulation models are founded on the present realities, the grounds on which future ambitions can be pegged. Expansion of TVET can be simulated from a present state of limited participation of the youth to a future that has more youth participating in training. It can begin from a present system that is reserved for a few pockets to a future that is more inclusive. Although any aspect of the expansion can be forecasted, the simulation model developed for South Africa TVET is limited to a financial tool projecting likely number of students, the support structure (staff and infrastructure) and the associated cost of sustaining the structure. Simulation models can be categorized as either basic or advanced, depending on the approach used in computing the projected costs, with the main difference being in the details of the cost parameters. Although a detailed costing would result in higher precision, it is important to note that the level of detail is dependent on data availability. In choosing between basic and advanced models, it is advisable to have a good balance between detail and communication such that the resulting model has adequate detail for transparency in the projected costs but also aggregated enough to make the model easy to interpret. The expansion model behind this note is a hybrid of basic and advanced elements, details of which will be discussed in later sections.

Logic and limitations of simulation models

Simulation models are decision support tools, particularly helpful in assessing the cost and impact of different future policy options. For instance, in the expansion of TVET, various levels of ambitions and associated costs can be simulated out of which a scenario that balances the desired results and cost can be chosen. In this case, the simulation model would have aided decision makers to pick an option that is ambitious enough but also cost sensitive to the environment of the expansion. Simulation models are founded on three fundamental logical steps i.e., (i) identification of beneficiaries or the demand for training; (ii) making decisions on key policy parameters that influence the organization of learning or training; and (iii) computing the volume of needs (mostly HR and infrastructure) and their associated costs.

Structure of the TVET simulation model

Simulation models built for projecting education systems are often developed as blocks of sub sectors, in which case a model will contain as many blocks as the number of sub-sectors in a country's education system. It is common to find simulation models built in blocks of pre-school, primary, secondary, TVET, university education and teacher training. Most simulation models separate these blocks by recurrent and development needs since each sub-sector has different needs in either category. Simulation models can be full targeting an entire education system or may focus on a particular sub-sector. The advantage of a full model is that the effects of policy decisions taken in one sub-sector to another can be clear. A sub-sector specific model will often obscure the effects to other sub-sectors, especially on the balance of costs.

The expansion model is built at national level, which means that all baseline indicators are national averages. Demands simulated from averages may miss some specifics in some TVET institutions. For instance, if two departments in an institution operate with staff deficit and surplus, the model will miss this detail masked by an average.

The TVET expansion model is built on Ms Excel, an extract can be seen in Figure A.1. To understand the model, one should read it row-by-row in the following sequence (i) column A, highlighting parameters of interest, (ii) column C, showing the baseline, (iii) column B, showing the target for respective parameters, and (iv) columns D-N, displaying the projections for specific parameters (where N is the column corresponding to the last year of projection). For instance, in row 47 of the TVET model, the parameter in question is the enrolment of TVET trainees in agriculture, whose baseline is 5701, and is set to (assumed

to) expand to 10 000, with the evolution seen to be 5701 in 2020; 6131 in 2021; 6561 in 2022… 8280 in 2026 etc.

	A	B	C	D	E	F	G	H	I
1									
2		Assumption	Baseline	Projection					
3		2030	2020	2021	2022	2023	2024	2025	2026
43									
44	**Public Institution Contact**								
45	**Learners in grouping trades**								
46	Trades with fixed capacity evolution								
47	1.1- Agriculture	10,000	5,701	6,131	6,561	6,991	7,421	7,851	8,280
48	1.2 - Tourism	80,000	40,672	44,605	48,538	52,470	56,403	60,336	64,269
49	1.3 - Education	50,000	25,702	28,132	30,562	32,991	35,421	37,851	40,281
50	Total fixed capacity		72,075	78,868	85,660	92,453	99,245	106,038	112,830
51	Trades non-fixed capacity evolution								
52	2.1 - Busi&Fin&Market		204,027	226,386	249,081	272,112	288,910	295,570	300,128
53	2.2 - Engineering&Related		293,080	324,551	356,366	388,520	411,648	420,250	425,819
54	2.3 - HR&Secret&Admin		74,883	83,590	92,528	101,701	108,642	111,833	114,264
55	2.4 - Health&Related		1,420	2,765	4,366	6,234	8,193	10,012	11,842
56	2.5 - IT&ComputerScience		10,251	13,644	17,539	21,956	26,315	30,033	33,694
57	3.1 - Others		15,704	18,123	20,717	23,492	25,866	27,419	28,826
58	Total non fixed capacity		599,365	669,059	740,597	814,014	869,573	895,116	914,573
59	Share within non fixed capacity evolution								
60	2.1 - Busi&Fin&Market	32.0%	34.0%	34%	34%	33%	33%	33%	33%
61	2.2 - Engineering&Related	45.0%	48.9%	49%	48%	48%	47%	47%	47%
62	2.3 - HR&Secret&Admin	12.5%	12.5%	12%	12%	12%	12%	12%	12%
63	2.4 - Health&Related	2.0%	0.2%	0%	1%	1%	1%	1%	1%
64	2.5 - IT&ComputerScience	5.0%	1.7%	2%	2%	3%	3%	3%	4%
65	3.1 - Others	3.5%	2.6%	2.7%	2.8%	2.9%	3.0%	3.1%	3.2%

Figure A.1: Extract from the TVET Simulation Model

Take note of the colouring while inside the model. All shaded cells denote raw data. These cells may be linked to other worksheets with organized data from the sector/sub-sector or can hold absolute numbers typed directly. These green shaded cells are particularly useful if one wants to know the source of data used in the model. Shaded cells contain targets or ambitions that the sector should adopt with respect to the parameter in question. Cells in contain time when the targets are to be achieved.

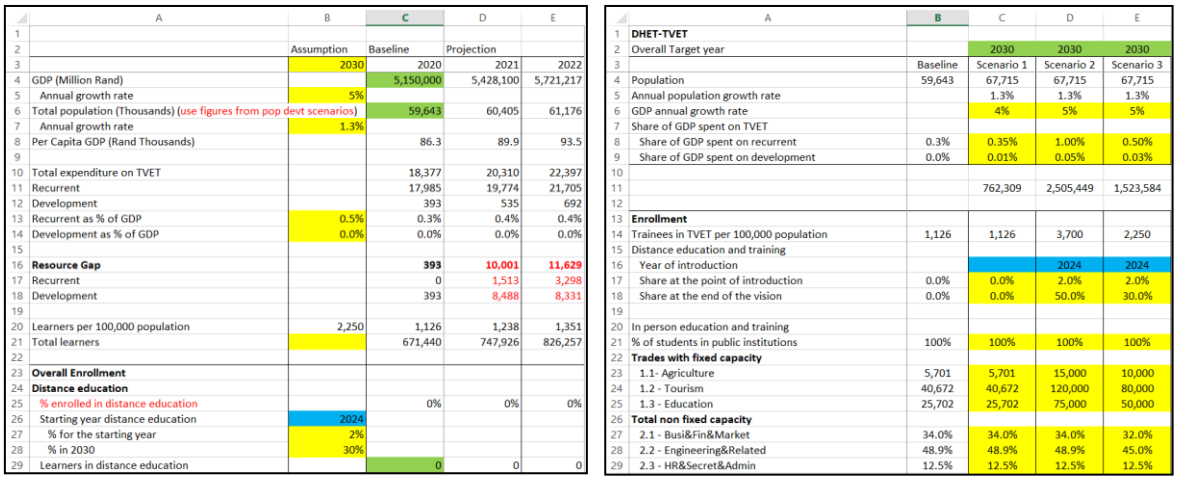
Throughout the model, entries and changes can be made in column B and column C only and in coloured cells (green, yellow and blue). All other cells contain formulas that drive the model and should not be touched unless for the purpose of understanding the operations.

Navigating the TVET expansion model

The expansion model is built on Ms Excel, and can be accessed by anyone, including those with only limited knowledge of Excel. The model can be accessed through its engine (the main model) or through a

dashboard. Figure A.2 a) illustrates the main model, an extract from the full model. Full models can be brief or detailed, depending on the nature of simulation in question. Detailed models can be overwhelming for many people, especially at policy level, not because of anything technical, but just the sheer details. To address this, models come with lighter versions (a dashboard) from which the detailed/full/main model can be driven. The dashboard often contains only useful parameters that are parsed to the main model. One can manipulate parameters of interest from the dashboard. On Figure A2 b), take cells C4, D4 and E4 for example. They can be used to manipulate the GDP growth, with the percentages set parsed directly to the full model on cell B5. The dashboard is particularly useful for policy makers as their attention is likely to be drawn to specific parameters of interest only. The other benefit of the dashboard is the fact that one can view the parameters side by side, for different scenarios (see Figure A2 b), where three scenarios are seen in the same). On the contrary, the main model sits on its own sheet, each scenario sitting in their respective worksheets.

a) Interface of the model **b) Dashboard view**



	A	B	C	D	E
1					
2		Assumption	Baseline	Projection	
3		2030	2020	2021	2022
4	GDP (Million Rand)		5,150,000	5,428,100	5,721,217
5	Annual growth rate	5%			
6	Total population (Thousands) (use figures from pop devt scenarios)		59,643	60,405	61,176
7	Annual growth rate	1.3%			
8	Per Capita GDP (Rand Thousands)		86.3	89.9	93.5
9					
10	Total expenditure on TVET		18,377	20,310	22,397
11	Recurrent		17,985	19,774	21,705
12	Development		393	535	692
13	Recurrent as % of GDP	0.5%	0.3%	0.4%	0.4%
14	Development as % of GDP	0.0%	0.0%	0.0%	0.0%
15					
16	**Resource Gap**		**393**	**10,001**	**11,629**
17	Recurrent		0	1,513	3,298
18	Development		393	8,488	8,331
19					
20	Learners per 100,000 population	2,250	1,126	1,238	1,351
21	Total learners		671,440	747,926	826,257
22					
23	**Overall Enrollment**				
24	**Distance education**				
25	% enrolled in distance education		0%	0%	0%
26	Starting year distance education	2024			
27	% for the starting year	2%			
28	% in 2030	30%			
29	Learners in distance education		0	0	0

	A	B	C	D	E
1	**DHET-TVET**				
2	Overall Target year		2030	2030	2030
3		Baseline	Scenario 1	Scenario 2	Scenario 3
4	Population	59,643	67,715	67,715	67,715
5	Annual population growth rate		1.3%	1.3%	1.3%
6	GDP annual growth rate		4%	5%	5%
7	Share of GDP spent on TVET				
8	Share of GDP spent on recurrent	0.3%	0.35%	1.00%	0.50%
9	Share of GDP spent on development	0.0%	0.01%	0.05%	0.03%
10					
11			762,309	2,505,449	1,523,584
12					
13	**Enrollment**				
14	Trainees in TVET per 100,000 population	1,126	1,126	3,700	2,250
15	Distance education and training				
16	Year of introduction			2024	2024
17	Share at the point of introduction	0.0%	0.0%	2.0%	2.0%
18	Share at the end of the vision	0.0%	0.0%	50.0%	30.0%
19					
20	In person education and training				
21	% of students in public institutions	100%	100%	100%	100%
22	**Trades with fixed capacity**				
23	1.1- Agriculture	5,701	5,701	15,000	10,000
24	1.2 - Tourism	40,672	40,672	120,000	80,000
25	1.3 - Education	25,702	25,702	75,000	50,000
26	**Total non fixed capacity**				
27	2.1 - Busi&Fin&Market	34.0%	34.0%	34.0%	32.0%
28	2.2 - Engineering&Related	48.9%	48.9%	48.9%	45.0%
29	2.3 - HR&Secret&Admin	12.5%	12.5%	12.5%	12.5%

Figure A.2: Different views of the TVET Simulation Model

Navigating simulation models from the engine

The first option of accessing the expansion model is directly through the full model or the engine (see Figure A.3). The model should be read row-by-row in the following sequence (i) column A, highlighting parameters of interest, (ii) column C, showing the baseline, (iii) column B, showing the target for respective parameters, and (iv) columns D-N, displaying the projections for specific parameters (where N is the column corresponding to the last year of projection). For instance, in row 47 of the TVET model, the parameter in question is the enrolment of TVET trainees in Agriculture, whose baseline is 5701, and is set to (assumed to) expand to 10 000, with the evolution seen to be 5701 in 2020; 6131 in 2021; 6561 in 2022… 8280 in 2026 etc.

	A	B	C	D	E	F
1						
2		Assumption	Baseline	Projection		
3		2030	2020	2021	2022	2023
4	GDP (Million Rand)		5,150,000	5,428,100	5,721,217	6,030,163
5	Annual growth rate	5%				
6	Total population (Thousands) (use figures from pop devt scenarios)		59,643	60,405	61,176	61,958
7	Annual growth rate	1.3%				
8	Per Capita GDP (Rand Thousands)		86.3	89.9	93.5	97.3
9						
10	Total expenditure on TVET		18,377	23,132	28,347	34,058
11	Recurrent		17,985	22,488	27,426	32,831
12	Development		393	644	921	1,226
13	Recurrent as % of GDP	1.0%	0.3%	0.4%	0.5%	0.5%
14	Development as % of GDP	0.1%	0.0%	0.0%	0.0%	0.0%
15						
16	**Resource Gap**		**393**	**17,253**	**19,168**	**22,075**
17	Recurrent		0	1,464	3,656	6,868
18	Development		393	15,789	15,512	15,207
19						
20	Learners per 100,000 population	3,700	1,126	1,383	1,641	1,898
21	Total learners		671,440	835,513	1,003,668	1,175,983
22						
23	**Overall Enrollment**					
24	**Distance education**					
25	% enrolled in distance education		0%	0%	0%	0%
26	Starting year distance education	2024				
27	% for the starting year	2%				
28	% in 2030	50%				
29	Learners in distance education		0	0	0	0
30	**Contact education**					

Results | Dashboard | TVET_SC1 | **TVET_SC2** | TVET_SC3 | Raw_Data | PER FTE STUDE

Figure A.3: View of the full TVET simulation model

At all times, check the scenario you are working on (TVET_SC1, TVET_SC2, TVET_SC3) so as not to mix up the inputs. This is part of the reason it is recommended to use the dashboard. Click any of the green shaded cells to reveal the source of the data for the parameter of interest. Click any of the projected cells to review the formulae at play.

Navigating simulation models from the dashboard

Unlike the main model, the dashboard (Figure A.4) contains less parameters and is used for manipulating targets behind the expansion. Apparent from the Dashboard Worksheet, the parameters in display are common to most education planners. Indicators like the gross participation rate (enrolment in TVET per 100 000 population) is known to most TVET planners and should be easy to manipulate compared to searching for it in the middle of other intermediate parameters in the main model. The dashboard manipulates the capacity of TVET through absolute enrolments. The desired volume in future can be typed by the users, against the row with the relevant parameter. Users can change the year of achieving the targets using the blue shaded. In most cases properties of a given parameter transcends a row. For instance, the parameter on the number of trainees starts from A6 to A10. It is important that when manipulating the targets, users ensure that all elements of a parameter are completed.

	A	B	C	D	E
1	**DHET-TVET**				
2	Overall Target year		2030	2030	2030
3		Baseline	Scenario 1	Scenario 2	Scenario 3
4	Population	59,643	67,715	67,715	67,715
5	Annual population growth rate		1.3%	1.3%	1.3%
6	GDP annual growth rate		4%	5%	5%
7	Share of GDP spent on TVET				
8	Share of GDP spent on recurrent	0.3%	0.35%	1.00%	0.50%
9	Share of GDP spent on development	0.0%	0.01%	0.05%	0.03%
10					
13	**Enrollment**				
14	Trainees in TVET per 100,000 population	1,126	1,126	3,700	2,250
15	Distance education and training				
16	Year of introduction			2024	2024
17	Share at the point of introduction	0.0%	0.0%	2.0%	2.0%
18	Share at the end of the vision	0.0%	0.0%	50.0%	30.0%
19					
20	In person education and training				
21	% of students in public institutions	100%	100%	100%	100%
22	**Trades with fixed capacity**				
23	1.1- Agriculture	5,701	5,701	15,000	10,000
24	1.2 - Tourism	40,672	40,672	120,000	80,000
25	1.3 - Education	25,702	25,702	75,000	50,000
26	**Total non fixed capacity**				
27	2.1 - Busi&Fin&Market	34.0%	34.0%	34.0%	32.0%
28	2.2 - Engineering&Related	48.9%	48.9%	48.9%	45.0%
29	2.3 - HR&Secret&Admin	12.5%	12.5%	12.5%	12.5%
30	2.4 - Health&Related	0.2%	0.2%	0.2%	2.0%
31	2.5 - IT&ComputerScience	1.7%	1.7%	1.7%	5.0%
32	3.1 - Others	2.6%	2.6%	2.6%	3.5%
33					
34	Share of trainees on Full Time Equivalent (FTE)	55.6%	55.6%	55.6%	55.6%

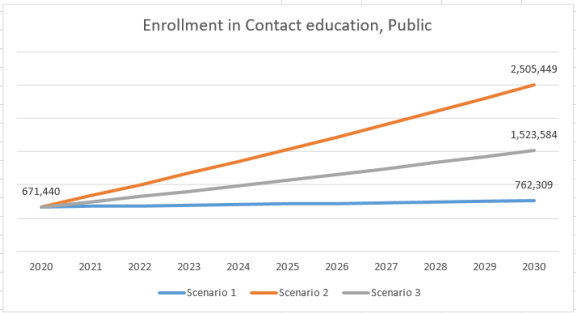
Figure A.4: Dashboard of the TVET expansion model

At all times, check the scenario you are working on (TVET_SC1, TVET_SC2, TVET_SC3) so as not to mix up the inputs. This is part of the reason it is recommended to use the dashboard. Click any of the green shaded cells to reveal the source of the data for the parameter of interest. Click any of the projected cells to review the formulae at play.

Results from the TVET expansion model

Once all possible policy choices have been made i.e., by supplying the desired targets corresponding to the selected indicators/parameters, the implication of the choices can be viewed in the results worksheet (see Figure A.5), which highlights results of the selected targets of parameters, showing enrolment in TVET at baseline as well as at the selected end line. Rows 485-492 contrast the enrolments expected in the three different expansion scenarios, which can help decision makers to discern parameter options that yield greater outputs.

	A	B	C	D	E	F	G	H	I	J	K	L
483												
484	Enrollment in Public	**2020**	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
485	Scenario 1	671,440	680,017	688,703	697,500	706,410	715,433	724,572	733,828	743,201	752,695	762,309
486	Scenario 2	671,440	835,513	1,003,668	1,175,983	1,352,537	1,533,408	1,718,680	1,908,435	2,102,758	2,301,733	2,505,449
487	Scenario 3	671,440	747,926	826,257	906,466	988,590	1,072,664	1,158,725	1,246,809	1,336,955	1,429,200	1,523,584
488												
489	Enrollment in Distance education	**2020**	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
490	Scenario 1	0	0	0	0	0	0	0	0	0	0	0
491	Scenario 2	0	0	0	0	27,051	153,341	309,362	496,193	714,938	966,728	1,252,724
492	Scenario 3	0	0	0	0	19,772	71,511	131,322	199,490	276,304	362,064	457,075
493												



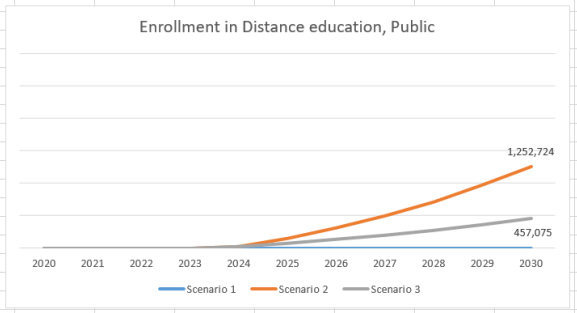


Figure A.5: Results from selected policy choices in the TVET expansion

Note that desired results are multifaceted and as such results from one parameter should not use to identify the scenario of choice. This determination is made when a reasonable balance between parameters is reached.

The costs of elements that will need to expansion can also be viewed from the results worksheet. The cost together with the outputs can help decision makers to determine which scenario of expansion is favourable.