Skills Needs Review in Manufacturing

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

towards full-scale industrialisation and inclusive growth
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The compilation of the Review of Skills Needs in Selected Sectors and Occupations in Manufacturing is the result of the contributions of a number of people from within and outside of the Department of Trade and Industry (**the dti**).

Chapters one to three are the result of internal research and analysis conducted by Chief Director Ms Jocelyn Vass and Deputy Director Mr Paul Raidani, who is currently employed as a labour market analyst in the Skills for the Economy Unit of **the dti**.

The technical research, upon which Chapter 4 is based, was conducted by independent research consulting company FEM Research. The original research reports are available on request from the Skills for the Economy Unit.

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List of Abbreviations and Acronyms

AGRISETA	Agriculture Sector Education and Training Authority
ANA	Annual National Assessment
APS	Admission Point Score
ATI	Artisan Training Institute
BRICS	Brazil-Russia-India-China-South Africa
BTech	Baccalaureus Technologiae
CAGR	Compound annual growth rate
CATHSSETA	Culture, Art, Tourism, Hospitality, Sport Sector Education and Training
CETA	Construction Education and Training Authority
CHIETA	Chemical Industries Education and Training Authority
CTL	Clothing, Textile and Leather
DBE	Department of Basic Education
DDG	Deputy Director-General
DHET	Department of Higher Education and Training
the dti	The Department of Trade and Industry
ECSA	Engineering Council of South Africa
EDD	Economic Development Department
ESETA	Energy Sector Education and Training Authority
ETDPSETA	Education, Training and Development Practices Sector Education and Training Authority
EU	European Union
FDI	Foreign Direct Investment
FET	Further Education and Training
FIETA	Forestry Industries Education and Training Authority
FOODBEV	Food and Beverages Sector Education and Training Authority
FPMSETA	Fibre Processing and Manufacturing Sector Education and Training
GDP	Gross domestic product
HEMIS	Higher Education Management Information System
HET	Higher Education and Training

HRDC SA	Human Resource Development Council of South Africa
HSRC	Human Sciences Research Council
HSRD	Human Sciences Research Council
HWSETA	Health and Welfare Sector Education and Training Authority
ICT	Information Communication Technology
IDC	Industrial Development Corporation
IDZs	Industrial Development Zones
IFR	International Federation of Robotics
ILO	International Labour Organisation
IoT	Internet of Things
IPAP	Industrial Policy Action Plan
ISETT	Information Systems, Electronics and Telecommunication Technologies Sector Education and Training Authority
LFS	Labour Force Survey
LGWSETA	Local Government Water and Related Services Sector Education and Training Authority
MERSETA	Manufacturing, Engineering and Related Services Sector Education and Training Authority
MNC	Multinational Companies
MQA	Mining Qualifications Authority
MTSF	Medium-Term Strategic Framework
NDP	National Development Plan
NGO	Non-governmental organisation
NIC	Newly industrialised countries
NSDS	National Skills Development Strategy
OECD	Organisation for Economic Co-operation and Development
PSETA	Public Service Sector Education and Training Authority
QLFS	Quarterly Labour Force Survey
R&D	Research and development
SA	South Africa
SACMEQ	Southern and East African Consortium for Monitoring Educational Quality

SASSETA	Safety and Security Sector Education and Training Authority
SET	Science, engineering and technology
SETAs	Sector Education and Training Authorities
SEIFSA	Steel and Engineering Industries Federation of Southern Africa
SEZs	Special Economic Zones
SIC	Standard Industrial Classification
SIPs	Strategic Integrated Programmes
SMMEs	Small, medium and micro enterprises
SOC	Standard Occupation Code
StatsSA	Statistics South Africa
TETA	Transport Education and Training Authority
TIMSS	Trends in International Mathematics and Science Study
TNC	Transnational companies
TVET	Technical Vocational Education and Training
UNISA	University of South Africa
UK	United Kingdom
UP	University of Pretoria
USA	United States
WEF	World Economic Forum
WRSETA	Wholesale and Retail Sector Education and Training Authority
WTP	Worker Training Programme

Executive Summary

The *Review of Skills Needs in Selected Sectors and Occupations in Manufacturing* is a mechanism through which **the dti** aims to identify skills needs in priority growth sectors and occupations in manufacturing. The review is based on research done in sectors and occupations, either in-house or via external consultants. The research and dissemination phases of the *Skills Review* form part of an interactive process between **the dti** and key actors in skills development.

The objective is to develop more responsive skills initiatives that complement and advance employment, industrialisation, economic participation, and trade and investment.

The review consists of four chapters, some of which are based on more extensive technical research reports that may be accessed from the Skills for the Economy Unit. The next section provides summaries of the key findings flowing from each chapter.

Chapter 1 – Trends in the Mathematics and Science performance of South African learners in schooling: Implications for manufacturing

The purpose of this chapter is to understand the trajectory of mathematics and, to a lesser extent, science performance in primary and secondary schooling, and the implications for technical skills requirements in the manufacturing sector, now and into the future.

South Africa has participated in the internationally comparative study Trends in International Mathematics and Science Studies (TIMSS), as well as the locally based Annual National Assessment (ANA). Mathematics and Physical Science are priority subjects in terms of the sector plan for the Department of Basic Education's Medium-Term Strategic Framework (MTSF) and the National Development Plan (NDP). Good teachers as well as methods and best practices remain in well-resourced schools, and the gap between the "mathematically advantaged and the disadvantaged" has widened. Over the years, South Africa has lagged behind and remained in the bottom five of all performers. While this is from a very low base, there has been a marked improvement in South Africa's performance in the TIMSS from 2003 to 2015, with its science and mathematics achievements among grade 9s increasing by 90 and 87 points on average respectively. There has been a general upward trend in the matric pass rate, however, there have been minimal improvements in the pass rates in mathematics and science. In the absence of significant and faster improvement, the relationship between the education system and its link to the labour market will remain problematic.

Chapter 2: Trends in the profile of artisans in manufacturing

The purpose of the chapter is to analyse one dimension of the so-called skills mismatch: the extent to which the qualification profile of those employed as artisans may be an indicator of what is regarded as a qualified artisan in manufacturing.

It does so through a trend analysis (2001–2016) of the employment, education or qualification and age profile of artisans in the industry. Manufacturing is the second-largest employer of artisans in the economy, but there has been little growth in the absolute number of artisans employed in the industry. Artisan employment has fluctuated more severely during the economic cycle, indicating vulnerability to changes in the economy.

Evidence of a skills mismatch is confirmed by the fact that the overwhelming majority of practising artisans have less than a matric qualification, while just below one-third has matric. It is estimated that only 6,4% of the workforce is qualified. Also, the artisan workforce is getting older and the shift to matric appears to have held no advantage for the improved entry of young people into the trades. There is little evidence of a skills pipeline to grow the number of those with matric (or the unqualified) to attain a trade test to become qualified.

A more nuanced approach is required to renew and revitalise the artisan workforce in a balanced manner, as a key cofactor in shifting manufacturing towards more value-added activities and beneficiation.

Chapter 3: Trends in the profile of engineers and technicians in manufacturing

The purpose of this chapter is to provide an updated trends analysis of the employment and demographic profile of engineers (professional engineers, technologists and technicians) in the South African economy and manufacturing specifically over the period 2002 to 2016.

Employment trends among the technical workforce are analysed by sub-sector and demographic indicators, including population group, age and gender. The chapter also looks at South Africa's competitiveness and readiness to adopt Industry 4.0. Engineers and technicians constitute the core of the technical workforce in the manufacturing sector, but growth in the absolute and relative number of engineers, technologists and technicians was uneven. There has been a decrease in growth in the absolute number of engineers employed across the economy, from 44 000 in 2002 to 41 231 in 2016, at a compounded annual growth rate (CAGR) of -0,4%. The absolute number of engineers in manufacturing has declined over the period 2002 to 2016. There have been major shifts in the gender profile in the engineering profession in manufacturing, as growth remained fairly high in black Africans and slow in whites.

The results indicate that the demand for engineers in manufacturing is decreasing, while university enrolments are increasing. However, major concerns remain at the capacity of the education system to produce qualified engineers in the numbers and quality required, given declining graduation rates.

Chapter 4: Itukise programme – monitoring and evaluation

The Itukise Internship for Unemployed Graduates programme (Itukise) is a graduate work placement programme aimed at providing relevant work experience to unemployed graduates. The programme's overall objective is to improve the employability of unemployed graduates through work experience placements in enterprises supported by **the dti** as well as other manufacturing and service enterprises.

The purpose of this chapter is to evaluate the success of the Itukise programme and identify areas for improvement.

The following emerged from interviews conducted with host companies, mentors and interns:

- 93, 5% of mentors, 84,1% of interns and 93,6% of host companies agreed (65,9% strongly) that interns were provided with the necessary work experience; and
- 78,3% of interns agreed that the programme was successful in assisting them with finding a job.

These results show that the project has met its target of relevance, and stakeholders have indicated they perceive the benefits in the project.

The following key results emerged from the analysis:

- 98,5% of host enterprises and 89,2% of mentors believe the Itukise programme should continue (which is a proxy for satisfaction); and
- 81,71% of interns believe their internship was successful.

Areas that need to be improved relate to intern support and the timely payment of stipends. Overall, it is very satisfying to note that the project was able to achieve this even though the economic environment was not a conducive one.

Chapter 1: Trends in twhe mathematics and science performance of South African learners in schooling: Implications for manufacturing

1.1. Introduction

"At Toyota, math is so foundational to all of our work – in machine maintenance, on the production floor, in the office – that it's inseparable from that work. Without effective math skills, one cannot be an effective Toyota worker." – Dennis Dio Parker, Toyota North American Production Support Centre (2013; Mathematics at work: Manufacturing)

The future of manufacturing lies in continuous upgrading with new technologies that are increasingly more knowledge-intensive. The quote above emphasises the fact that the industry requires a highly skilled and knowledgeable workforce, with specific requirements in mathematics and the sciences. The continued poor performance of South African learners in mathematics and science is worrying, particularly when compared to international standards, and poses a major constraint with regard to knowledge-intensive manufacturing. Mathematics and science are key requirements for a technical workforce that is internationally competitive and sufficiently able to adapt to critical changes as a result of robotisation and digitisation of work, and the Internet of Things (IoT). This chapter seeks to understand the trajectory of mathematics and, to a lesser extent, science performance in primary and secondary schooling, and the implications for technical skills requirements in the manufacturing sector, now and into the future.

As such, this chapter seeks to provide an overview of mathematics performance at grade 12 level for the period 2010 to 2016, as measured by the Department of Basic Education (DBE). Furthermore, trends will be derived from the performance of lower-level grades in the TIMSS study (HSRC, 2016) and international comparative study as per Global Competitiveness Report 2016/17. Studies on mathematics performance have shown that attainment and competence are cumulative. Attainment at lower grades is a vital indicator of prospective attainment at higher grades. South Africa has participated in the internationally comparative TIMSS studies as well as the locally based Annual National Assessment (ANA) studies. In 2015, however, the ANA was not conducted due to concerns expressed by some trade unions in the education sector.

1.2. Methodology

This chapter is based on the analysis of secondary data, including research reports and data from the DBE. The chapter provides an overview of key insights of the quantity and quality of mathematics learning in the country and its implications for progress in manufacturing and the reindustrialisation of the economy.

1.3. Scope and limitations of data

There is much controversy about the measurement of the quality of education in South Africa. Therefore, this chapter is, to a great extent, a first take on the secondary data that is available.

1.4. Competitive rankings: Mathematics and science and related indicators

It is globally accepted that the competitiveness of economies is closely linked to their ability to move up the value-added ladder, instead of competing solely on the basis of low wages. Thus, while the United States (US) is still the largest economy in the world, China, as a developing economy, is second in line, ahead of Japan and Germany (Colvin G, 2017). Furthermore, China has developed from an exporting economy based on low prices to one that is now increasingly competing on the basis of research and development (R&D) (OECD, 2015). This is a key differentiator for global competitiveness. R&D requires high-level knowledge workers with an excellent foundation in mathematics and science.

The World Economic Forum's (weF) Global Competitiveness Report provides an overview of the competitiveness performance of 138 economies in 2016/17 and 137 in 2017/18, and is considered the most comprehensive assessment of its kind globally. It contains a detailed profile for each of the economies included in the study, as well as an extensive section of data tables with global rankings covering more than 100 indicators.

Table 1: Global ranking of indicators

	Year	Availability of latest technologies	Quality of the education system	Quality of math and science education	Availability of scientists and engineers
China	2016	81	43	50	30
	2017	81	29	50	29
South Africa	2016	44	134	138	112
	2017	45	114	128	100
Brazil	2016	85	128	129	111
	2017	78	125	131	90
India	2016	78	29	44	36
	2017	72	26	37	32

Russia	2016	83	69	52	58
	2017	84	64	51	50
Turkey	2016	62	104	107	49
	2017	57	101	104	49
Chile	2016	32	88	108	23
	2017	28	86	99	22

Source: Global Competitiveness Report 2016/17 and 2017/18

According to Global Competitiveness data, South Africa ranked at 100 (less than 50% on average) out of 137 countries in 2017 with regard to the availability of scientists and engineers, an improvement on its position of 112 in 2016. South Africa has one engineer per 3 200 people, compared to 1:130 in China, 1:270 in Europe and 1:450 in Australia (Malan C, 2014). This means that the country does not have enough scientists and engineers, which could impact negatively on its levels of innovation and competitiveness.

The quality of mathematics and science education in South Africa is ranked at 128, while quality of the higher education system is ranked at 114, which is the second-lowest of all countries within the Brazil-Russia-India-China-South Africa (BRICS) grouping. South Africa is languishing at the bottom of the competitiveness of economies in terms of its education system and the quality of its mathematics and science education. Furthermore, it is not competitive compared to the rest of the BRICS countries, with the exception of Brazil. South Africa would need to improve the quality of its maths and science education for it to have any hope of becoming competitive with other countries in the BRICS grouping.

More optimistically though, other indicators related to manufacturing show that South Africa has the potential to develop its industrial base. For instance, the country is ranked 45 in terms of availability of the latest technology, which is better than the other BRICS countries, as indicated in Table 1. This is a paradox, however, in that while South Africa out-competes all other BRICS countries, as well as many other countries, in this regard, the shortcomings of the education system are an indication of the inequality within the development process.

Competitiveness remains an important contribution to the broader goal of human-centric economic progress by creating the resources needed for increased well-being, including better education, health, security and higher-per-capita income.

1.5. Importance of mathematics and science in the economy

This section provides an overview and analysis of the importance of mathematics and science in the local and global economies, and manufacturing in particular.

1.5.1. Relationship between mathematics and the global economy

Globalisation represents the end of geographical borders as products and services of better quality are provided faster and in larger quantities than ever before.

Young (2010:15) argues that there are definite elements to globalisation, including:

- shrinking of space and time
- new markets (globally interlinked financial and capital markets operating 24/7)
- new tools (internet, cellphones, global media networks)
- new institutions (transnational corporations, global non-governmental organisations)
- new rules (multilateral agreements on trade, services and intellectual property)

This implies that education has also been globalised, with local education systems influenced by global ones, and the standards and quality becoming more uniform. The importation of key knowledge workers from developing to developed economies is an indicator of the confluence of education systems.

Another factor to consider is what Young (2010:15) calls the massification of education, specifically mathematics. Larger groups of people in both developed and developing countries now have access to higher education. In post-apartheid South Africa, opportunities to access higher education have increased massively, but have not been accompanied by improvements in other parts of the education system. The secondary schooling and the TVET college systems specifically place great constraints on the higher education and training (HET) system, as illustrated by the recent #feesmustfall campaign.

1.5.2. Importance of mathematics education in South Africa

Mathematics and physical science are priority subjects in terms of the sector plan for the Department of Basic Education's Medium Term Strategic Framework (MTSF) and the National Development Plan (NDP). The cornerstone of the democratic era has been an "improving education system committed to the pursuit of quality basic education, the necessary raising

of standards and careful introspection of progress". The strategy of government to improve the quality of basic education has been articulated in the *National Development Plan Vision 2030: Our future – Make it Work*.

The NDP notes the disparity between the massive investment in education (about 5% of the budget) and the poor outcomes as a structural feature of South African society. General inequality in South African society has also had an impact on the mathematics education system. In the absence of significant and faster improvement, the relationship between the education system and its link to the labour market will remain problematic.

Thus, it is argued that mathematics education has not benefited from sufficient human and financial resources (Young, 2010:20). Young argues that those schools that are already well-resourced (including the private and former Model C schools) continue to have access to resources for mathematics education. Good teachers, as well as methods and best practices, therefore remain in well-resourced schools, and the gap between the "mathematically advantaged and the disadvantaged" has widened. These gaps are often caused by lack of access to technology (mathematics computer packages and applications), curriculum reform and mathematics teacher education and pedagogy (Young, 2010:210). South Africa has undergone major changes in all three elements, but the success rates have not been sufficient. There has been progress, but not at the pace required. In the next section, success rates in mathematics at Grades 3, 9 and Matric will be analysed, based on the latest evidence.

1.6. Trends in the enrolment and pass rates in mathematics and science in schooling

This section provides an analysis of post-apartheid trends in the enrolment and pass rates in mathematics, as illustrated in results from the ANAS for grade 3 and 9; then grade 12 or matric. It is generally accepted that while there has been improvement in the access to mathematics education, the poor outcomes and slow improvement have been an indictment of the quality of mathematics education in the country.

1.6.1. Trends in TIMSS performance at grade 9

The Trends in Mathematics and Science Study (TIMSS) is an international comparative study of the performance of learners in mathematics and science at Grade 3 and 9 respectively. South Africa has participated in this study every four years (in 1995, 1999, 2003, 2007, 2011 and 2015). It is an assessment of the mathematics and science knowledge of fourth and eighth grade learners in 59 countries. In 2015, 425 000 learners participated (HSRC, 2015:1).

This section provides an overview for Grade 9s only.

Over the years, South Africa has lagged behind in the bottom five of all performers. While this is from a very low base, there has been a marked improvement in the performance in TIMSS. South Africa showed the largest improvement from 2003 to 2015, increasing its science and mathematics achievements among grade 9s by 90 and 87 points on average respectively. The aggregate results, however, remain poor.

In mathematics, South Africa's grade 9 learners remained second-last out of 39 countries in 2015. In science, South Africa came last out of 39 countries. In general, South African learners performed below 400 points, the minimum level for competence (Farber T, 2017). The average mathematics score for South Africa's grade 9s was 372, while the science score was 358. Only, 20% of learners from public no-fee schools performed above the minimum level of competency. This, however, does show that pure talent also exists among the most disadvantaged.

The average mathematics score for Singapore was 621. Other countries in the top five included South Korea, Chinese Taipei, Hong Kong and Japan. These results should be seen in light of the advanced state of these economies' scale of development and industrialisation, and research and development (R&D). It is a clear indicator that in the absence of improvements, South Africa's plans for growth, and technical and R&D workforce development are at serious risk.

1.6.2. Mathematics and science advanced learners

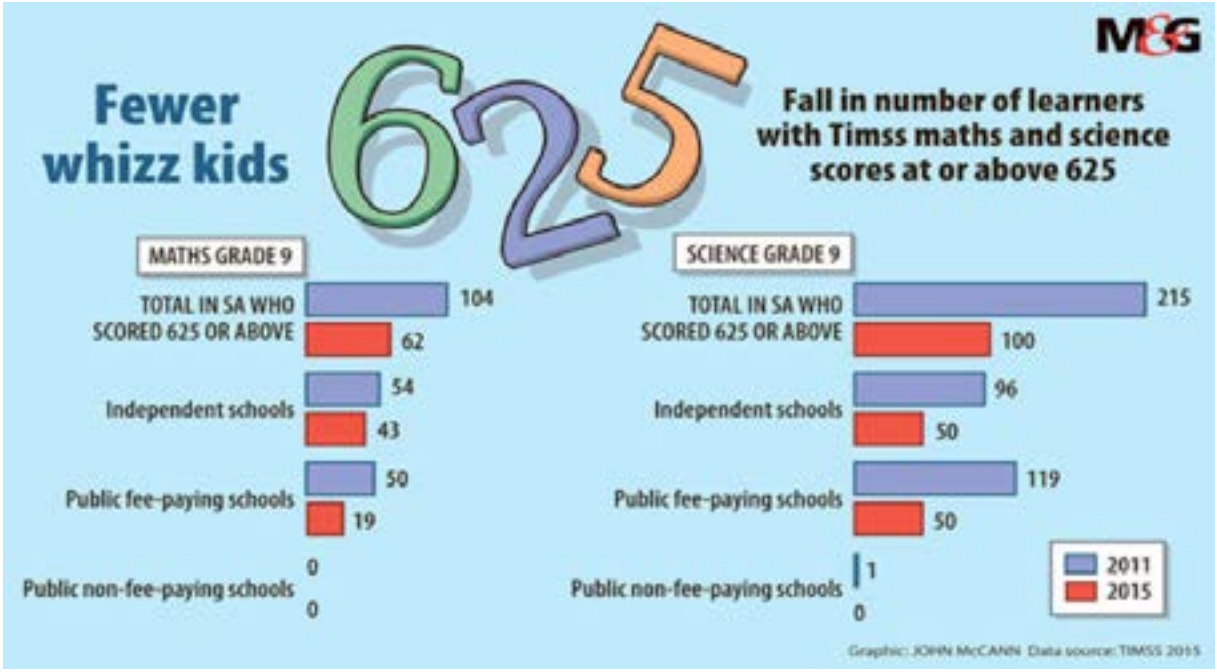
In the TIMSS project, advanced learners score 625 points or above. Figure 1 shows that the number of South African grade 9 "whizz kids" (excellent performers who score 625 points or above) has declined from 104 in 2011 to 62 in 2015. The researchers regard this drop in "mathematical boffins" as a red flag for thought leadership and to grow the economy (Govender, 2016). High-performing learners in mathematics and science are fundamental to a high-skill and knowledge-intensive economy. The reason for this decline is not yet clear, but is nonetheless worrying. The researchers note that high performers are more likely to be incentivised by overseas offers for higher education and lucrative career opportunities.

Furthermore, in 2015, while 5% of global learners scored more than 625 points, just one per cent of South African learners scored the same. Most of these learners came from private and former Model C schools. None of these advanced learners came from no-fee schools in 2011 or 2015. Thus, the dynamics of the mathematically advantaged and disadvantaged are clearly evident in our schooling system.

In science, the number of South African grade 9 learners scoring above 625 points declined by more than half, from 215 in 2011 to 100 in 2015. The majority also came from private and former Model C schools. Only one learner came from a no-fee school. It is a global trend that high-performing learners come from advantaged schools, both in terms of finances, teaching and technological capacity.

Research (Adler, 2016) suggests that there is an 80:20 divide, in that only 20% of learners have access to "fully functional, well-performing schools". Well-performing learners come from those schools by and large so the TIMSS reflects rather than contradicts the notion.

Figure 1: Trends in the number of learners in TIMSS mathematics and science scores at or above 625



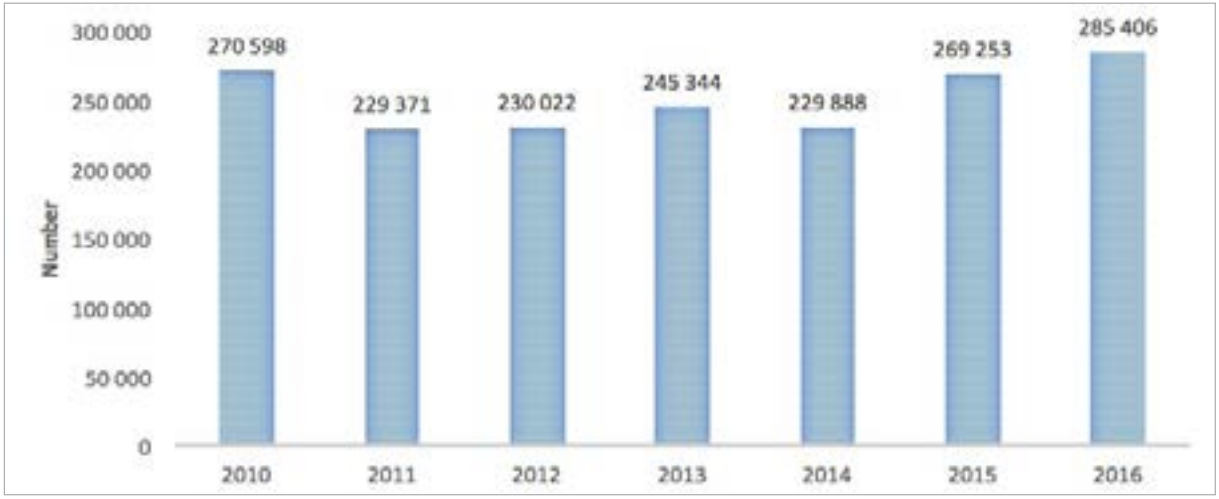
Source: Mail & Guardian, 2016

1.6.3. Trends in matric enrolment and pass rates

The national pass rates in matric released in January of every year are often regarded as a barometer of the health and quality of the secondary education system. This measurement may be a rather blunt instrument and researchers suggest other measures, including throughput, participation and subject performance rates (Reddy et al. 2017).

Thus, while there has been general upward movement in the matric pass rate, there have been minimal improvements in the pass rates in mathematics and science. Even the introduction of mathematics literacy has not made a discernible difference. Figures 2 and 3 outline mathematics and physical science enrolments between 2010 and 2016. Mathematics and science are key subjects that provide a gateway for learners to enter career fields where currently there are skills shortages.

Figure 2: Grade 12 mathematics full-time enrolments, 2010 – 2016

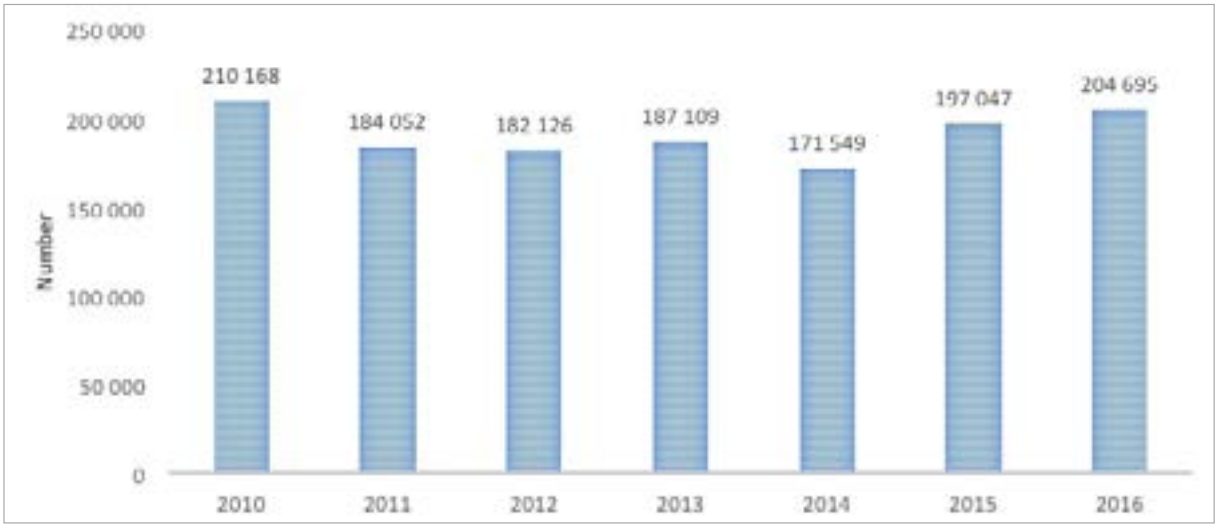


Source: DBE

Figure 2 shows that the enrolment for the mathematics examination increased by 16 153 candidates in 2016 and this substantiates the lower number in mathematical literacy, which declined by 2,4% to 389 163 in 2016. The increased enrolment in mathematics from 2014 to 2016 is encouraging. The total of 285 406 candidates in 2016 represents the largest number of learners enrolled for mathematics over the period 2010 to 2016, and an increase of 6% when compared to 2015.

The numbers enrolled in 2011 and 2012 were somewhat lower than in 2010 and 2013 (as indicated in Figures 2 and 3), and this was because of a change in the policy regarding the age of school-entry in 1999 and 2000. The second peculiarity was the large class that enrolled and wrote the National Senior Certificate (NSC) in 2015. This was largely because of the so-called progressed learner policy, which led to an increase in the numbers entering grade 12 in 2015 (DBE, 2016).

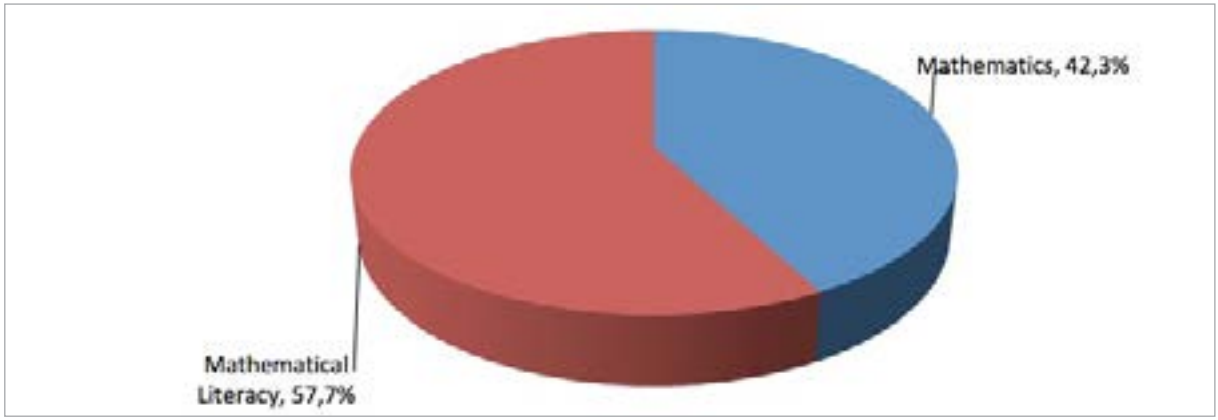
Figure 3: Grade 12 physical science full-time enrolments, 2010 – 2016



Source: DBE

The increased enrolment in physical sciences from 2014 to 2016, as indicated in Figure 3, is encouraging. The total of 204 695 candidates in 2016 represents the largest number of learners enrolled for physical sciences since 2010, and an increase of 4% when compared to 2015.

Figure 4: Percentage share of grade 12 mathematics candidates' enrolments, 2016



Source: DBE

Figure 4 compares the percentage of candidates who enrolled for grade 12 mathematics and mathematical literacy in 2016. Mathematical literacy claimed a bigger share of candidates at 57,7% than mathematics at 42,3%.

The results of recent international studies such as the TIMSS and the Southern and East African Consortium for Monitoring Educational Quality (SACMEQ) show that the performance of South African learners is on an upward trajectory. This was affirmed by the preliminary SACMEQ IV study results, which for the first time showed that South African learners at grade 6 level achieved mathematics scores above the significant centre of 500 points.

Table 2: Candidates' performance at 30% and above in grade 12 mathematics and science subjects, 2015-2016

Subject (Full-Time)	2015			2016		
	Wrote	Achieved 30% & Above	% Achieved	Wrote	Achieved 30% & Above	% Achieved
Mathematical Literacy	388 845	277 594	71.4%	361 865	257 881	71.3%
Mathematics	263 903	129 481	49.1%	265 810	135 958	51.1%
Physical Science	193 189	113 121	58.6%	192 618	119 427	62.0%

Source: DBE

According to the Department of Basic Education (DBE), the number of full-time grade 12 candidates who achieved 60% or more in physical science was higher in 2016 than in any other year since 2008 when the NSC was introduced. In mathematics, 33 511 learners achieved a mark of 60% or more in the 2016 examinations, an increase from 30 287 in 2014 and 31 811 in 2015. By far, the improvement has been highest among black African learners, who comprised 77% of the increase of 1 700 learners achieving a mark of 60% or more in mathematics between 2015 and 2016 (DBE, 2016).

The international TIMSS results confirm that South Africa's grade 9 learners have improved substantially in mathematics and science since 2002, implying that learners may be entering grade 12 better prepared than before. Table 2 is in line with the positive trends seen in South Africa's TIMSS results, which indicates that the percentage of candidates who achieved 30% and above in physical science and mathematics have increased from 58,6%

and 49,1% in 2015 to 62,0% and 51,1% in 2016 respectively. However, the annual pass growth rate of 1,1% for mathematics and 3,6% for physical science does not bode well with regard to the NDP targets (*Mail & Guardian*, 2017).

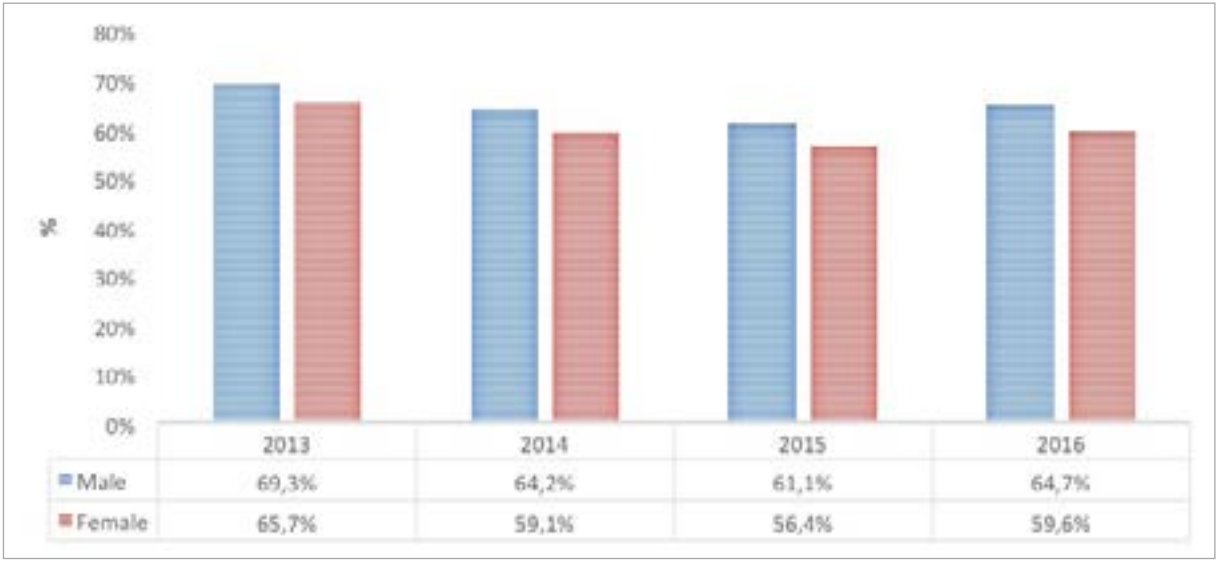
Figure 5: Candidates' performance (full-time, 30% and above) in grade 12 mathematics by gender, 2013-2016

	2013	2014	2015	2016
Male	64,9%	59,3%	54,9%	57,0%
Female	54,3%	48,6%	44,2%	46,4%

Source: DBE

Figures 5 and 6 show that at the highest levels of achievement in mathematics and physical science there were similar numbers of males and females, which bodes well for gender equality in traditionally male-dominated areas of work. There was a positive relationship between the achievements of males and females in both mathematics and physical science from 2013 to 2016.

Figure 6: Candidates' performance (full-time, 30% and above) in physical science by gender, 2013-2016



Source: DBE

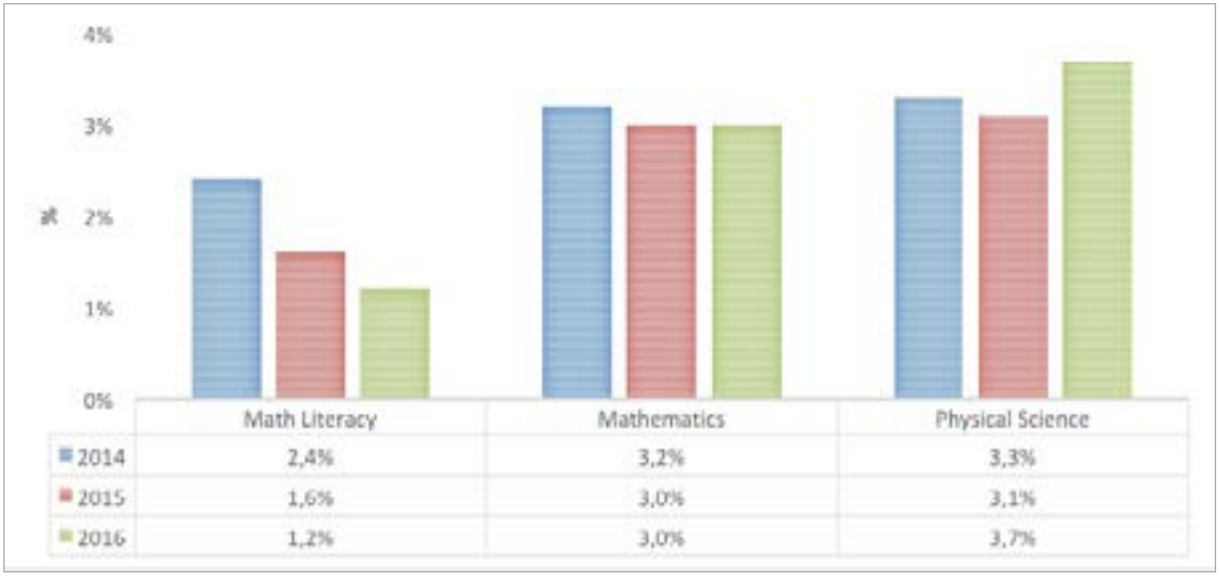
Table 3: Number and percentage of distinctions per grade 12 subject (80%-100%)

Subject	2015			2016		
	Wrote	Achieved with distinctions	% with distinctions	Wrote	Achieved with distinctions	% with distinctions
Mathematical Literacy	388 845	6 130	1,6%	361 865	4 364	1,2%
Mathematics	263 903	7 791	3,0%	265 810	8 070	3,0%
Physical Sciences	193 189	5 903	3,1%	192 618	7 043	3,7%

Source: DBE

The marks that learners obtain in their NSC are still low. Table 3 indicates that only 3,7% of physical science candidates achieved distinctions in 2016, an increase of 0,6% from 2015. The percentage of candidates who passed mathematics with distinctions was stable at 3,0% in 2015 and 2016, as indicated in Table 3 and Figure 7.

Figure 7: Distinction percentages in grade 12 subjects, 2014-2016



Source: DBE

Building on the upward trajectory patterns observed in TIMSS and SACMEQ, the achievement rates of grade 12 mathematics and physical science candidates increased from 49,1% and 58,6% in 2015 to 51,1% and 62,0% in 2016 respectively. This indicates that systemic gains at lower levels of the system (e.g. grades 6 and 9) are being carried through to grade 12. In both mathematics and physical science, the number of learners achieving 40% and above increased between 2014 and 2016 (DBE, 2016).

1.7. Conclusions

In terms of the targets of the NDP, by 2024 there should be 350 000 passes in mathematics and 320 000 in science. Given the annual pass growth rate of 1,1% for mathematics and 3,6% for science, the NDP targets remain out of reach. The shortages of skilled technical workforce and knowledge-based workers is a worldwide phenomenon, and a lacking mathematics and science education is a major constraint in building this skills pipeline. The path to the re-industrialisation of the South African economy, with a focus on value-added manufacturing and services, is complicated by this constraint. An effort at all levels of the education and training system to improve access to quality mathematics and science education beyond the DBE is required, for the long-term competitiveness of the South African economy.

1.8. References

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1.9. Annexures

Annexure A: 85 Things Mathematicians Have Been Hired to Do in Industry

(For details, see job profiles from the American Mathematical Society.)

1. Apply graph theory to problems in the telecommunications industry at AT&T Bell Labs.
2. Model the shape and chemical constitution of a region of land under the sea given only the depth and composition at a few specific points in that region for Exxon-Mobil Corporation.
3. Use optimization techniques (learned in calculus class!) to predict the most lucrative places to drill for oil for Exxon-Mobil Corporation.
4. Perform research for risk management and derivatives pricing in Foreign Exchange, equity and interest rate markets at NatWest Global Financial Markets in London.
5. Use mathematics to study cell cycle regulation, tumor growth, and regeneration of the Epithelial after irradiation at M.D. Anderson Cancer Center.
6. Monitor the operation of the space shuttle onboard data processing system, both hardware and software, from the Mission Control Center during Space Shuttle missions at NASA.
7. Teach various Space Shuttle crews the operation of both the Data Processing and Navigation systems on the Shuttle Mission Simulator at NASA.
8. Use numerical analysis to solve complex heat transfer problems for IBM.
9. Work on problems aimed at improving the Navy's ability to collect, transmit, and process information essential to its operations.
10. Develop ways to make computers more responsive to the user at Microsoft Corporation.
11. Provide technical support for systems sold to the Federal Government, including reworking mathematical algorithms to optimize code run times.
12. Develop software for engineering, medical, and scientific applications at Elements Research.
13. Develop technical computing and data standards for the oil industry at Petrotechnical Open Software Corporation.
14. Prepare cost estimates for Navy shipbuilding construction.
15. Mathematical modeling of aerospace vehicles for NASA.

16. Provide statistical support for environmental restoration projects at a Department of Energy site in Oak Ridge, where wastes such as nuclear material are stored, for Lockheed Martin.
17. Combine topology, geometry, and mechanics to work on problems related to DNA structure for Mount Sinai School of Medicine.
18. Mathematical and statistical analysis of experimental data in the discovery development and manufacture of protein pharmaceuticals for Genentech, Inc.
19. Develop mathematical models to describe chemical and biological phenomena for Agouron Pharmaceuticals, Inc.
20. Develop numerical methods for space vehicle trajectory simulation tools at The Aerospace Corporation.
21. Use stochastic processes to help determine launch schedules at an aerospace corporation.
22. Perform probabilistic modeling for waste tank safety analysis at Battelle Pacific Northwest National Laboratory.
23. Work with troubled companies by helping them develop and implement financial plans that allow them to continue in business at Gordion Group, L.P.
24. Develop and implement an office risk-management system used primarily by investment banks at Summit Systems Inc.
25. Work with engineers, scientists, managers, and shop floor operators to improve manufacturing processes at Eastman Kodak.
26. Develop algorithms to effectively represent geometric objects at Silicon Graphics.
27. Work on interplanetary mission analysis problems with Viking Lander Program at McDonnell Douglas.
28. Develop methods to schedule computer applications of a network of distributed processors at the Naval Research Laboratory.
29. Work in derivatives pricing in the energy and commodity markets at Enron in London.
30. Use non-linear dynamical systems to try to develop a mathematical model of how cellular proteins regulate cell-cycle progression at M.D. Anderson Cancer Centre.
31. Develop software and perform general research for the textile industry at Clemson Apparel Research.
32. Perform statistical analysis and administrative support for programs providing safeguards for the assembly and dismantling of nuclear weapons at Mason & Hanger.
33. Develop new algorithms for the efficient numerical solution of partial differential equations for Los Alamos National Laboratory.

34. As media specialist, help support the curriculum and provide resources and instruction in information processing skills at DeMasi Middle School.
35. Develop models of interactions between macromolecules at the National Cancer Institute.
36. Help develop monetary policy at the Federal Reserve System in Washington DC.
37. Build a model that will be used to price medical malpractice business for doctor groups at Ernst & Young LLP.
38. Oversee a company's asset and liability management processes as an actuary at Westfield Companies.
39. Analyze data pertaining to HIV prevention and acute infection at Fred Hutchinson Cancer Research Center.
40. Use numerical linear algebra and optimization to address problems associated with a model for fiber optics at Bell Labs.
41. Work with a data security company in the areas of cryptography and information security at RSA Data Security.
42. Develop mathematical models to simulate flow of air in the respiratory tract at the Chemical Industry Institute of Toxicology.
43. Lead a project that implements and optimizes speech compression algorithms for use in Intel's ProShare video conferencing system.
44. Work on an Air Force project producing computer models and simulations to help address the environmental clean-up of sites around the world contaminated with spilled jet fuel at Ecodynamics Research Associates, Inc.
45. Develop data hiding methods for IBM Japan.
46. Work in the area of interest rate derivatives at J.P. Morgan Securities.
47. Act as Senior Editor of the Mathematics Division of the textbook company Springer Verlag.
48. Develop models for simulations and perform statistical analyses of experimental data for anti-cancer projects at Aguoron Pharmaceuticals, Inc.
49. Define and lead research and development efforts in the areas of computational linguistics, information science, and artificial intelligence at PRC Inc.
50. Work as part of a team of UNIX system administrators for the Army.
51. Consult for the Management Analytics Division for Price Waterhouse.

52. Analyze human genome data for SmithKline Beecham Pharmaceuticals.
53. Design and analyze algorithms for enciphering vulnerable communications for the National Security Agency.
54. Work for Daniel H. Wagner Associates, a mathematical consulting firm, on a variety of topics, including financial and military applications.
55. Test new software for the US Postal service to modernize customer service.
56. Develop mathematical model looking at an aspect of kidney function for the National Institute of Health.
57. Use statistical methods to determine insurance risk for CNA Insurance Companies.
58. Perform analysis and modeling in the area of nuclear medicine, at Park Medical Systems Inc.
59. Help develop telerobotics for NASA.
60. Help engineers and physicists translate physical problems into a mathematical formulation and helping them to solve it, at Vista Research Inc.
61. Engage in research to do automatic speech recognition for IBM.
62. Be responsible for product and marketing strategies at Macsysma.
63. Engage in applied research and high level mathematical support within Boeing.
64. Work on a project to incorporate data from a new weather satellite earth station into models used to forecast atmospheric conditions, for the Texas Natural Resources Conservation Commission.
65. Incorporate your interest in both mathematics and business as an actuary at American Equity Insurance Company.
66. Provide support to business people in a non-technical environment; communicate technical information to other employees and customers in a way they can understand for CIGNA Corporation.
67. Build models for researching new manufacturing techniques and products at Eastman Kodak.
68. Work in the area of signal processing and image processing on defense-related and commercial projects at Science Applications International Corporation.
69. Develop mathematical models that are used to create and analyze hardware and software designs for Raytheon.
70. Develop products that exploit new 3M material technology.

71. Help large truck, air, and railroad shippers solve their transportation logistic problems by contributing to the development and optimization of decision support software at PTGG, Inc.
72. Perform modeling and analysis to evaluate competing fighter aircraft designs at Lockheed Martin Tactical Aircraft Systems.
73. As a manager, oversee people with degrees in mathematics, computer science, operations research, physics, and engineering who perform the modeling and analysis to evaluate competing fighter aircraft designs above.
74. Develop numerical wavelet methods for computational chemistry at Battelle Pacific Northwest National Laboratory.
75. Provide engineering analyses and simulation studies in support of problems arising in satellite telecommunications as a consultant for GORCA Systems, Inc.
76. Work as a contractor for Motorola to help them to place 66 satellites into low earth orbit in order to provide remote telecommunications access for cellular telephone subscribers.
77. Develop a problem solving environment for numerically solving partial differential equations for SciComp, Inc.
78. Develop new business for and monitor the financial operations of Metron, Inc.
79. Develop algorithms to solve large problems on massively parallel computers at Sandia National Laboratories.
80. Apply methods and codes developed at Sandia to track a comet which hit Jupiter.
81. Develop mathematical models of the immune system at Fred Hutchinson Cancer Research Center.
82. Monitor the development and testing of new weapon systems at the Institute for Defense Analyses.
83. Develop new trading models that are part of the automated trading strategies used by D.E. Shaw & Co.
84. Collect data and perform analysis that will result in the improvement of the production process at Ford Motor Company.
85. Develop and code a mortgage prepayment model in the area of mortgage research at Salomon Brothers.

Source: https://home.sandiego.edu/~dhoffoss/careers/cando.html; 03/27/2017

Chapter 2: Trends in the Profile of Artisans in Manufacturing

2.1. Introduction

Over the last two decades, South Africa has accomplished enormous social progress by bringing to millions of its citizens access to key public services, most notably education, health, housing and electricity. Almost 90% of households have access to piped water and 84% to electricity (Statistics South Africa, 2016). The advanced banking system and financial markets have made South Africa a regional hub for financial services.

Nevertheless, growth has trended markedly downward since 2011 due to constraints on the supply side, in particular electricity shortages and falling commodity prices as well as policy uncertainty (OECD, 2017). Unemployment rose from 25% to 27%, with the youth particularly hard hit at an unemployment rate of 53% in 2016.

Artisan training and development has been identified as a critical area to address the challenges of economic growth and redress as well as the growing youth unemployment in the country (NSDS III).

In this chapter, we look at both the artisan demand (in terms of employment trends) as well as the current supply response (to industry and wider economic priorities). As part of our theme on artisan employment trends, the chapter seeks to analyse one dimension of the so-called skills mismatch, which is the extent to which the qualification profile of those employed as artisans may be an indicator of what is regarded as a qualified artisan in manufacturing. It does so by providing a detailed trend analysis (2002-2016) of the employment, educational qualification and age profile of artisans in manufacturing.

Intermediate-level artisans remain crucial to the future because multi-technical systems need maintenance, servicing and repairs (Rasool H, 2016). Artisans constitute the core of the technical workforce, ensuring innovation and efficiency of the production process through the optimal use, design and maintenance of materials, equipment, capital and personnel.

2.2. Methodology

This chapter is based on analysis of secondary data, including research reports and data from Statistics South Africa (StatsSA), the Department of Higher Education and Training (DHET) and so forth. The chapter provides an overview of key insights of the quantity and quality of artisans and the implications for progress in manufacturing and the economy.

This chapter adopts the Human Sciences Research Council's (HSRC) definition of qualified artisans as outlined in its 2008 research for the Department of Labour (Du Toit et al.). The qualifications are grouped as follows:

Table 1: Definition of sub-groups of artisans in analysis

Definition	Highest level of education
Qualified	Certificate with Grade 12/Standard 10
	Diploma with Grade 12/Standard 10
	Bachelor's degree and diploma
	Honours degree
	Higher degree (Master's, Doctorate)
Under-qualified	NTC I – NTC III
	Certificate with less than Grade 12/Standard 10
Unqualified	No schooling
	Grade R/0
	Grade 1 – Grade 11/Standard 9/Form 4

Source: HSRC, 2008

The implication of this definition is that the absolute numbers of artisans captured in the Standard Occupation Code (SOC) description as "craft and trade workers" may not necessarily be the same as the sub-group of artisans used as the basis for the analysis in this report.

2.3. Scope and limitations of data

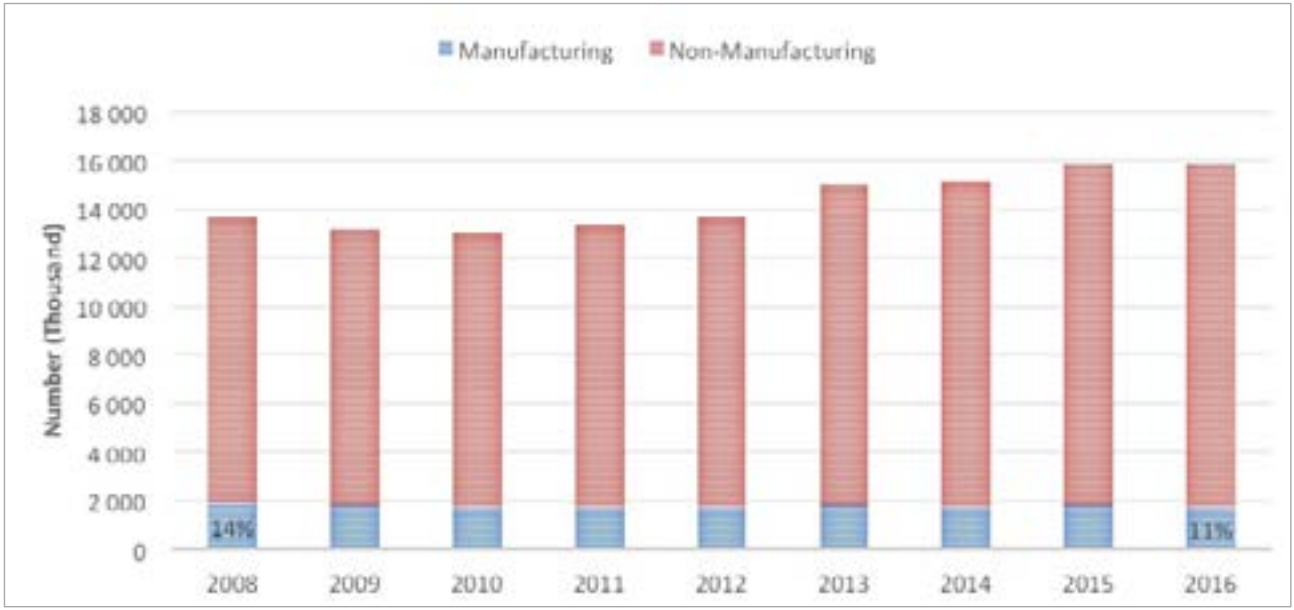
There is not much research about the measurement of the quantity and quality of artisans in the manufacturing industry. This chapter provides analysis of the artisan employment trends in manufacturing using the secondary data that is available. About 1% (or 5 000) of the artisans employed within the manufacturing industry did not have data on the "highest qualification level", which might have an adverse effect on the quality of the available data.

2.4. Manufacturing employment, value-added and gross domestic product

This section considers growth trends in the manufacturing sector, its share of gross domestic product (GDP) and impact on the trends in employment between 2002 and 2016. The research shows that the manufacturing sector is currently 15% bigger (in terms of value addition) than it was 10 years ago, 51% bigger than 20 years ago, and 64% bigger than 30 years ago (Langenhoven H, 2016). The same research shows that employment numbers have declined alarmingly: 14% fewer

people are employed today than in 2005 and 23% fewer than in 1995. Changes in manufacturing technologies have led to a decline in employment in the sector, but there was still improvement and strong linkages and multipliers to the service sectors that sustain jobs in the economy. **(the dti** Newsflash, 2017).

Figure 1: Manufacturing share of total employment, 2008-2016



Source: StatsSA, QLFS: Q3

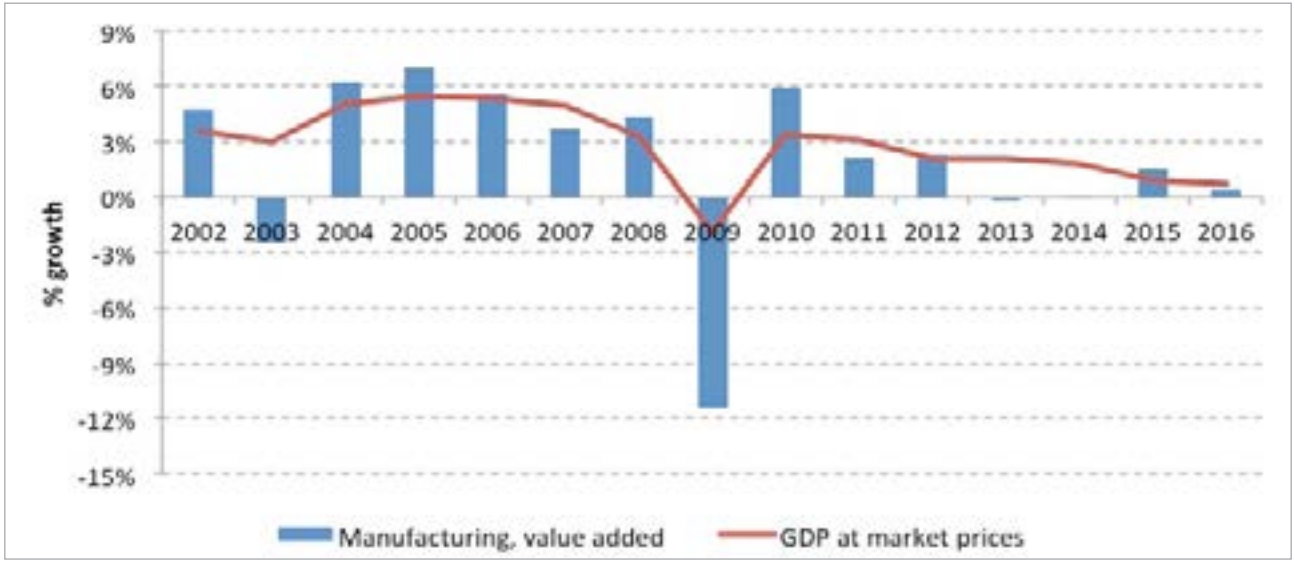
Manufacturing accounts for about 11% of South Africa's total workforce, down from 14% in 2008, as indicated in Figure 1. Manufacturing constitutes a diminishing share of the economy simply because other sectors, primarily services, have been growing faster over the same period (Langenhoven H, 2016). According to the South African Reserve Bank, manufacturing's contribution to the economy has declined from 19,7 percent in 1995 to 13,7 percent in 2015. In nominal values, manufacturing employment declined from 1,9 million in 2008 to 1,7 million in 2016. Manufacturing employment has been declining at an annual rate of 1,6%, while non-manufacturing employment has been increasing at an annual rate of 1,9% over the period 2008 to 2016. Manufacturing production was up 0,8% in January 2017, but this is still below levels of production recorded before the global financial market crisis (StatsSA, 2017). This might have been the cause for the declining employment figures in manufacturing.

The government recognises that manufacturing can play a pivotal role in reducing unemployment, poverty and inequality, and has highlighted the urgency of promoting increased labour-intensive forms of manufacturing in a number of policy documents, including the NDP and the Industrial Policy Action Plan (IPAP).

Despite this recognition, the manufacturing sector has continued to decline, both in terms of its contribution to economic growth and employment, as shown in Figures 1 and 2. Though the sector has many challenges and the economy is not performing well, it is still doing a lot better than it would have without the intervention of **the dti** over the last few years, particularly in the automotive, clothing and textile, agro-processing, film and business process outsourcing sectors (**the dti** Newsflash, 2017).

The declining share of manufacturing, however, is not only confined to developing economies. The US, for example, has for more than two decades witnessed a decline in manufacturing (Martin NB and Barry PB, 2014). The Trump administration's "America First" foreign policy is based on the idea of reshoring. Instead of off-shoring manufacturing jobs to China, India or Indonesia, for example, there is an effort to bring American manufacturing jobs back to the US. The success of this strategy is yet to be seen. The approach of reshoring has implications for developing economies such as South Africa, which may potentially lose manufacturing jobs that return to their original economies.

Figure 2: Manufacturing and GDP growth rates at constant 2010 prices, 2002-2016



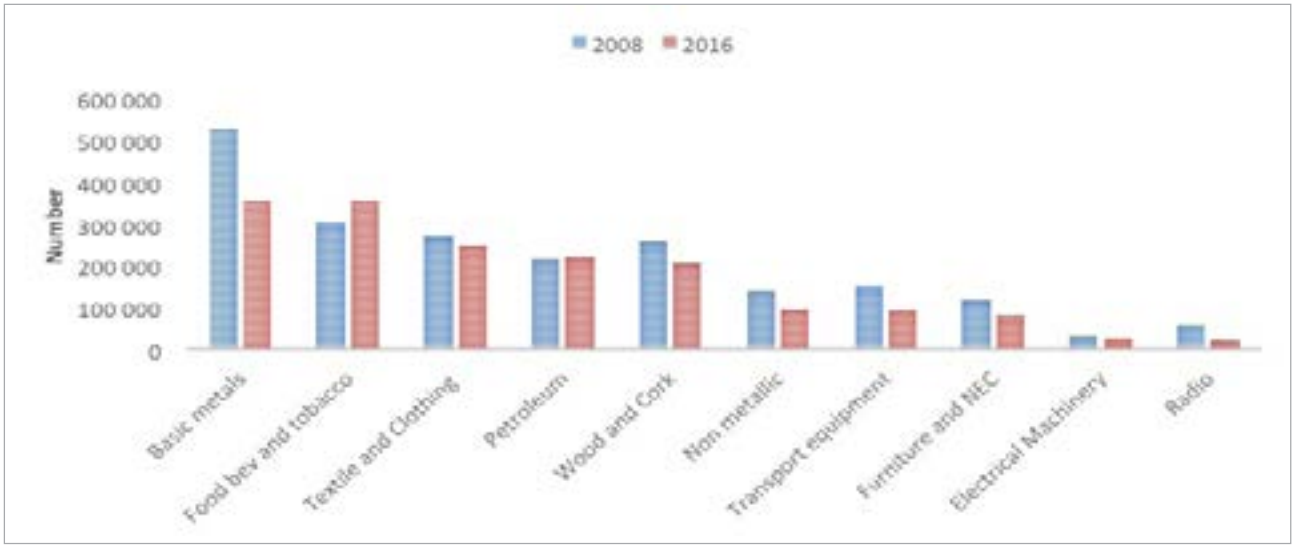
Source: StatsSA GDP: Q3

GDP and manufacturing growth has disappointed over the last few years, as shown in Figure 2. Weak consumer demand, persistently falling business investment, policy uncertainty and the prolonged drought weighed on activity (OECD, 2017). There is a strong positive link between the growth of manufacturing and growth of GDP, as depicted in Figure 2. Manufacturing has declined by about 20% since 2002 (StatsSA, 2017).

There has been a shift away from tradable sectors such as agriculture, mining and manufacturing towards non-tradable sectors and, in particular, financial services. Between 2002 and 2016, the size of financial services increased by more than 24% (StatsSA, 2016) – by far the biggest increase in any sector. Government services and retail and wholesale trade experienced more moderate growth.

Seventy percent of GDP is concentrated in only five sectors: trade, transport, financial services, government services and personal services (StatsSA, 2017) and it is fair to assume that this number will only increase in the future. South Africa's manufacturing is essentially made up of five large industrial groups, including agro-processing (24%), metals and engineering (23%), chemicals (22%), wood, paper and printing (13%) and the automotive sector (7%) (Langenhoven H, 2016). Weak GDP growth trends since 2008 further support the recommendations in the NDP that a broad programme of reform needs to be implemented, with skills development as one of its key features.

Figure 3: Manufacturing employment by subsector, 2008 − 2016



Source: StatsSA QLFS (Q3)

The basic metals subsector has remained the largest employer in the manufacturing industry for 2008 and 2016, as indicated in Figure 3. This is followed by the food, beverages and tobacco, and the clothing and textiles subsectors.

Manufacturing covers a broad range of subsectors, each with its own set of unique challenges and opportunities. The biggest challenge facing tobacco companies is the increasingly stringent regulations regarding the consumption, sale and advertising of tobacco products (Bhorat H, 2017). Employment in the food, beverages and tobacco sector, however, has increased from 2008 to 2016.

Local steelmakers continue to struggle to make ends meet in an environment of reduced domestic demand due to the significant increase in cheap imports and poor international selling prices. Evraz Highveld Steel and Vanadium closed its doors in February 2016 following a failed attempt at business rescue; about 2 200 employees were sent home without retrenchment packages (*Mail & Guardian*, April 2016). Employment in the basic metals subsector declined by an annual rate of 4,7% over the period. There have been a number of interventions, including an agreement of a developmental price for steel that could improve the relative competitiveness of downstream steel producers. In addition, **the dti** approved a 10% hike in trade tariffs on 10 primary steel products in 2015 to protect South Africa's steel-producing capacity against cheap Chinese imports (*Financial Mail*, September 2016). Rising electricity and transport have also had a negative impact on the competitiveness of steelmakers as they use large amounts of energy for production; the end result is that many retrench staff and close down.

The biggest challenge in the textiles, clothing and leather sector is competition from abroad, particularly South-East Asia (Bhorat H, 2017). The sector has experienced a decrease in employment over the period. Crucially, these challenges differ in their effect on GDP and the employment of artisans and technicians, as shown in Figure 3. All other subsectors experienced a decrease in employment over the period, with the exception of food, beverages and tobacco, and petroleum.

2.5. Current state of employed artisans

The number of artisans employed across the economy increased from 1,5 million in 2001 to 1,9 million in 2016. In fact, there was a net increase of 358 000 across the period at a CAGR of 1,4%. This is in support of the NDP, which highlights that South Africa would require 30 000 artisans by 2030. It is also in support of Commitment 1 of the National Skills Accord, which emphasises the need to increase the number of artisans and other scarce skills through the national training system (Economic Development Department, 2011).

As illustrated in Table 3, there were a number of peaks and troughs during the period. Significant employment growth was last recorded in 2014 (7,5%) and 2015 (10,2%) when two-million artisans were employed. A steady decline was recorded in 2016, peaking at -2,7% (-54 artisans) year-on-year (Table 3). All the growth experienced from 2005 to 2006 was wiped out during the recession in 2008. However, there were signs of recovery from 2011. The growth rates have been positive since 2011, at 10,2% in 2015.

Despite claims of a shortage of artisans in the economy, the economic data still indicates a low increase in demand (using employment patterns as a proxy for demand). In fact, there are indications that the so-called “hourglass” phenomenon is at play here. The demand for mid-level skills is declining, whereas the demand for high- and low-level skills is increasing. Bhorat et al. (2013) refer to this phenomenon as well as the continued decline in mid-level skilled jobs. Their study (2013) found that a contributory factor could be the outsourcing of mid-level work, particularly that of artisans, through labour broking. A preliminary analysis found that a significant portion of non-financial categories of employees are found in the financial intermediation sector. Given the quality of the data, however, further verification may be necessary. Nevertheless, it remains a concern that there has been a low increase in the number of employed artisans across the economy, as shown in Table 3.

Table 3: Trends in the number of employed artisans in the economy (2001-2016)

Year	Number of Artisans '000	Actual Change '000	Y/Y % Change
2001	1589		
2002	1584	-5	-0,3%
2003	1535	-49	-3,1%
2004	1629	94	6,1%
2005	1869	240	14,7%
2006	2070	201	10,8%
2007	1984	-86	-4,2%
2008	1881	-103	-5,2%
2009	1619	-262	-13,9%
2010	1607	-12	-0,7%
2011	1655	48	3,0%

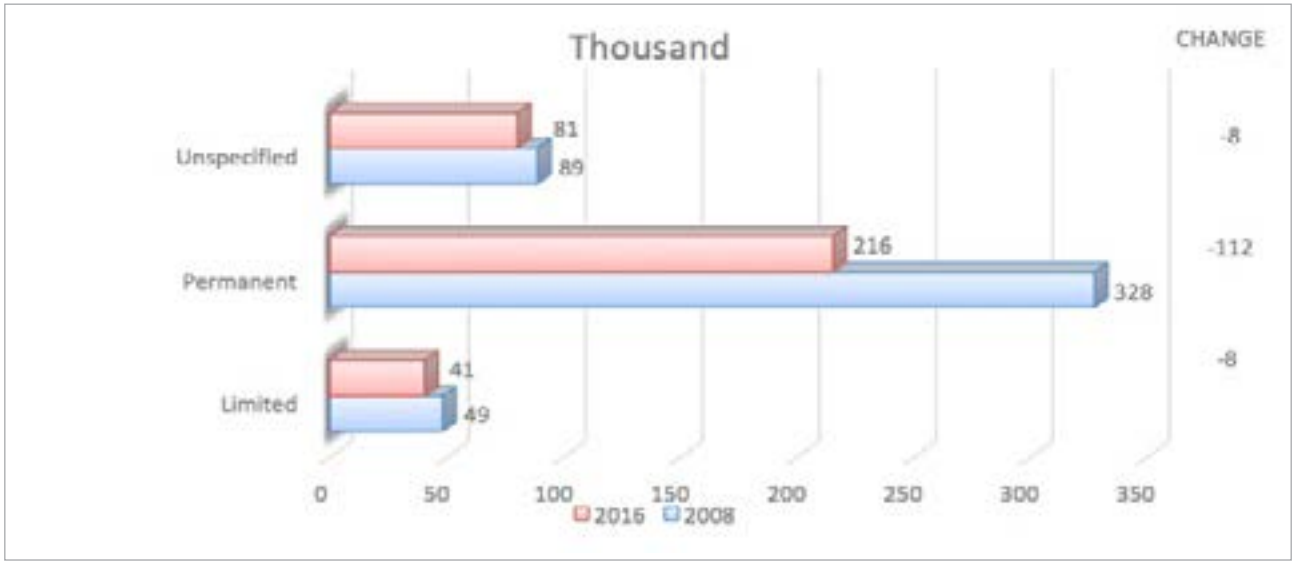
2012	1662	7	0,4%
2013	1690	28	1,7%
2014	1816	126	7,5%
2015	2001	185	10,2%
2016	1947	-54	-2,7%
Total		358	

Source: StatsSA LFS, 2001 – 2016

2.6. Demographic profile of artisan employment in manufacturing

This section provides an analysis of artisan employment by employment contract, age group, gender and population group.

Figure 4: Year-on-year changes in nature of artisan employment contract, 2008 and 2016



Source: StatsSA, QLFS, 2016 and own calculations

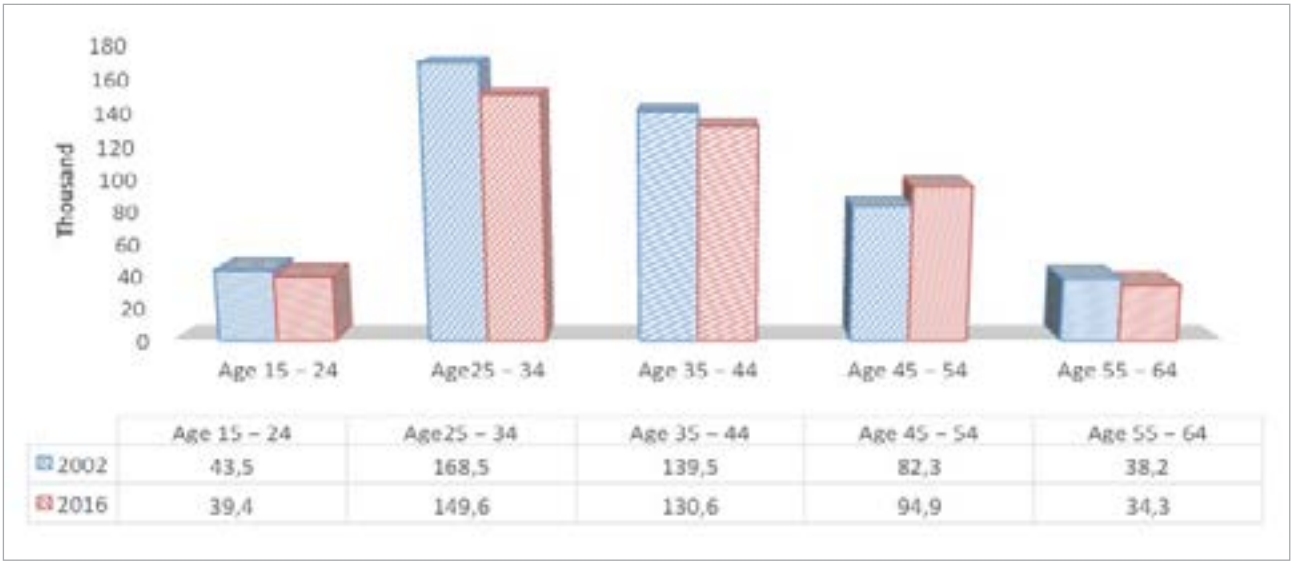
The majority of artisans (216 000) in the manufacturing sector are employed on a permanent basis, compared to the 41 000 employed for a limited duration, as shown in Figure 4. Limited-duration artisans declined by 2,2% per annum over the period 2008 to 2016, just below half of the annual growth of permanent artisans in manufacturing, which was -5,1%. The

artisans who had unspecified contracts declined by 1,2% per annum over the period. The International Labour Organisation (ILO) in a study of 180 countries estimates that in 2015 stable, full-time employment represented less than one in four jobs.

In South Africa, between 25% and 50% of workers are estimated not to have permanent contracts. But the trend is global, with about 90% of Chinese workers not having permanent contracts (Theron J, 2015). The ILO's research also indicates that so-called advanced economies, such as the US and those in Europe, are showing the same trend of standard employment less likely to be found.

There is no short answer to why permanent work is increasingly scarce, but the restructuring of the workplace to the benefit of the top echelons of society has eroded the base of organised labour, that is the permanent worker (Jan Theron, October 2015). It is also good that artisans and technicians in permanent employment are more likely to receive training, which contributes to skills upgrading.

Figure 5: Employment of artisans by age group (thousand) (2002 and 2016)



	Age 15 – 24	Age25 – 34	Age 35 – 44	Age 45 – 54	Age 55 – 64
2002	43,5	168,5	139,5	82,3	38,2
2016	39,4	149,6	130,6	94,9	34,3

Source: StatsSA, QLFS, 2016 and own calculations

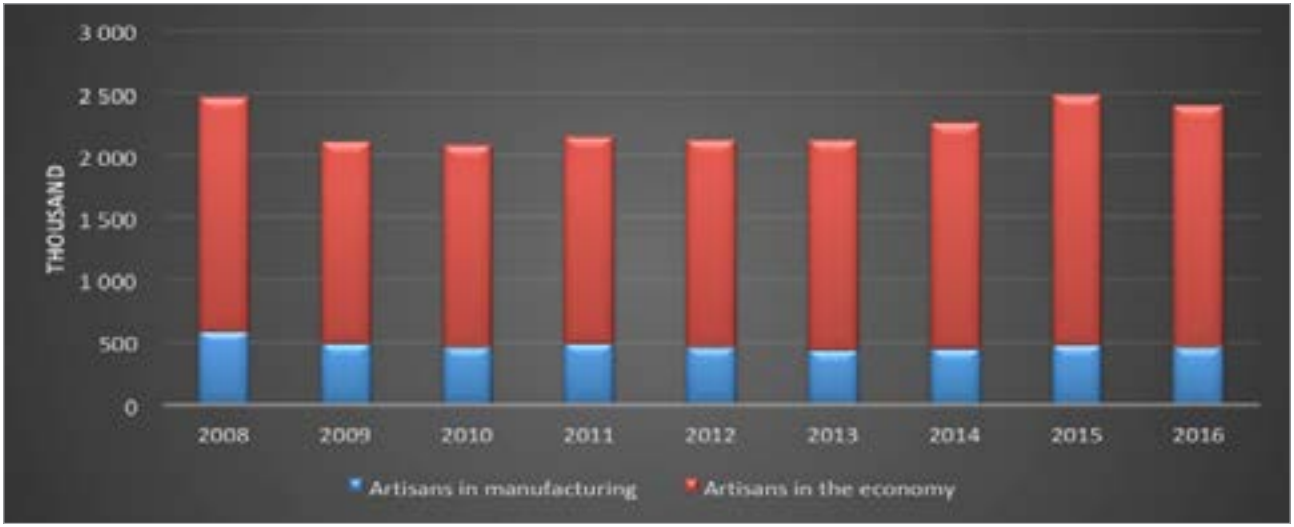
The age profile presented in Figure 5 suggests that there is a balanced mix of youth and experienced artisans, with 42% in the age group 15 to 34 years, 29% between the ages of 35 and 44, and 29% aged 45 to 64. The decline in the number of artisans from 168 000 to 150 000 (-0,8% per annum) in their prime productive years (25 to 34 years) is worrying. The

number of employed artisans in the age groups 45 to 54 increased by 1,0% per annum over the period. There were much weaker gains in all age groups.

Availability of experience may be suggested by the relatively high share of artisans older than 35 years. Furthermore, the relative growth in the number of artisans older than 45 years bodes well for the sector, as more experienced artisans remain in the system. This may positively affect the transfer of skills from older to younger artisans and the availability of experienced mentors in manufacturing.

Artisan retention is particularly important, not only because the country is facing a critical shortage of artisans but also because the average age of artisans was 54 years (CDE, 2007). This means that 29% of the artisans who were employed in 2007 would have exited the labour force within the following seven to eight years, which would only aggravate the current shortage of artisans and intensify the competition for talent.

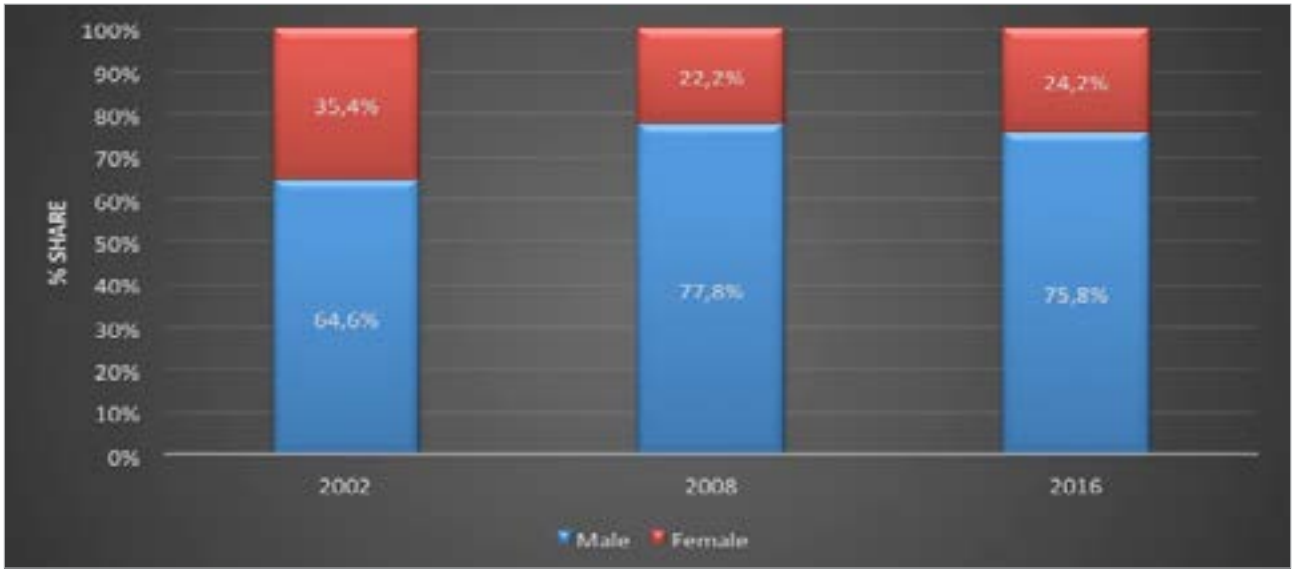
Figure 6: Share of artisans in the manufacturing industry and the economy, 2008 − 2016



Source: StatsSA, QLFS, 2016 and own calculations

The relationship between the two trends has been positive since 2008, as shown in Figure 6. Manufacturing accounts for about 23% in 2016 of the total South African artisans, down from 31% in 2008. The growth in the number of artisans has been unstable over the period 2008 to 2016. This might have been due to the manufacturing sector, which has been struggling since 2009.

Weak growth in household spending impacted on the producers of consumer goods. Declining growth in the sector shows it continues to drag down the overall performance of the economy (Lings K, 2017). In 2011, the sector experienced significant disruptions due to strikes and rose by only 2,8%. In 2012, growth averaged 2,3%, given a weaker global economy and extensive mining strikes (StatsSA, 2017).

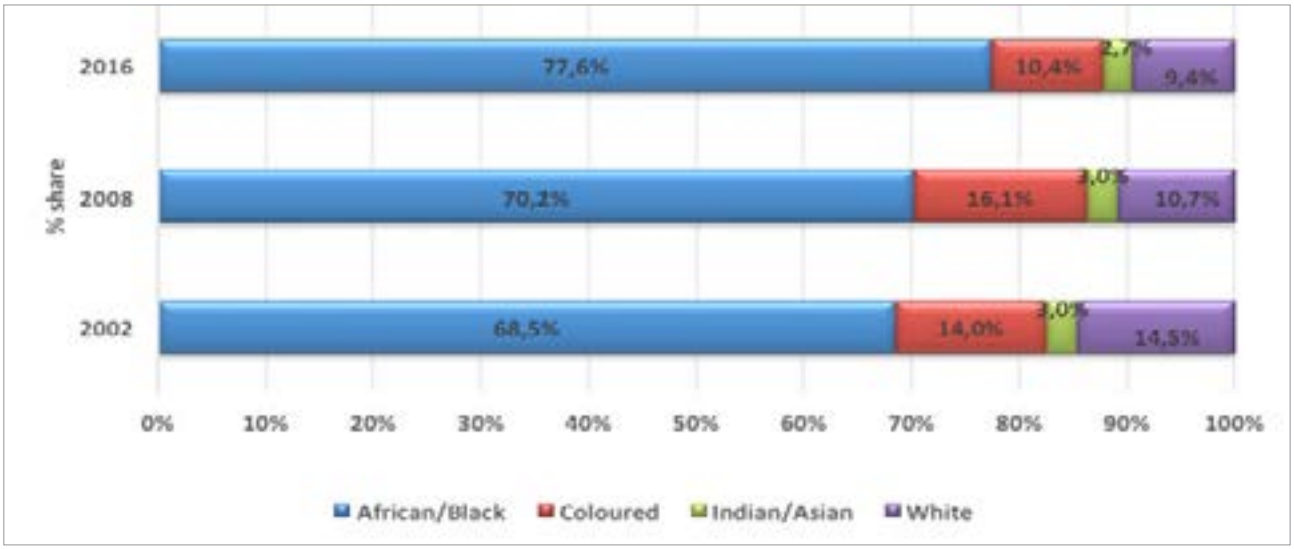


Source: StatsSA, QLFS, 2016 and own calculations

In South Africa, where women represent about 52% of the population, the percentage of women in crafts and trades positions in the manufacturing sector in 2016 was about 24%, a decrease from 35% in 2002. In both years, women were far less likely than men to be working as artisans, as shown in Figure 7. The percentage share of male artisans increased by 11,2% between 2002 and 2016. The proportion of women in artisan employment as compared to men increased from 22,2% in 2008 to 24,2% in 2016. This represents a significant step towards closing the gender gap in this occupation.

The TVET colleges are reporting an increase in female students in fitting and turning, and electrical and motor trades. False Bay TVET College for instance has experienced a year-on-year average growth of 200% since 2014 in females studying for qualifications in motor trades, electrical and civil engineering (News24, 2016). Many of its top achievers in these subjects in 2015 were women. More women graduated (20% in 2016) in engineering than men (18% in 2016) from universities of technology (DHET, 2017).

Figure 8: Employment share of artisans by race, 2002 − 2016



Source: StatsSA, QLFS, 2016 and own calculations

Figure 8 shows the employment of artisans by population group. Black African artisans outnumbered those from other racial categories, about 69% of blacks worked as artisans in 2002, but this figure increased to 78% in 2016. The percentage share of white artisans declined from 15% in 2002 to 9% in 2016.

The share of African artisans (albeit male) is reflective of the share of Africans in the economically active population. This picture contradicts the public perception that the average artisan is white and male (usually more than 50 years of age). The data shows that there has been a substantive turnaround in the demographic profile of the employed artisan population, which more closely mirrors the economically active population. The proportion of black African workers in the labour force has also increased since 2002 (StatsSA, 2016).

2.7. Employment of artisans by sub-sector

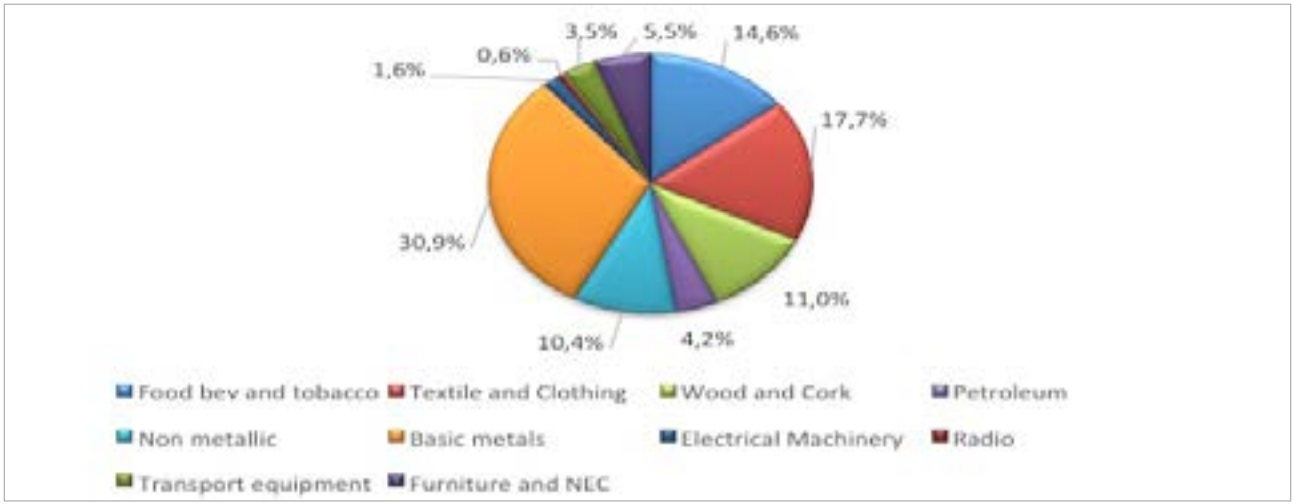
Manufacturing covers a broad range of sub-sectors, each with its own set of unique challenges and opportunities. The basic metals sector has remained the largest employer of artisans in the manufacturing industry, followed by textiles and clothing, and food, beverages and tobacco sub-sectors.

Tobacco companies' biggest challenge would be the increasingly stringent regulations regarding the consumption, sale and advertising of tobacco products. On the other hand, the biggest challenge in the textiles, clothing and leather sub-sector is competition from abroad, particularly South-East Asia (Bhorat H, 2017).

The plastics sector also faces a skills shortage and slow technological upgrading as well as high competition from imports. Similarly, at an operations level, mould-setters and plant operators are in short supply owing to new competency demands arising from innovation and technological development (Mosai S, 2017).

Crucially, these challenges differ in their effect on GDP and the employment of artisans in various manufacturing sub-sectors, as shown in Figure 9.

Figure 9: Percentage share of artisan employment by manufacturing sub-sector, 2016

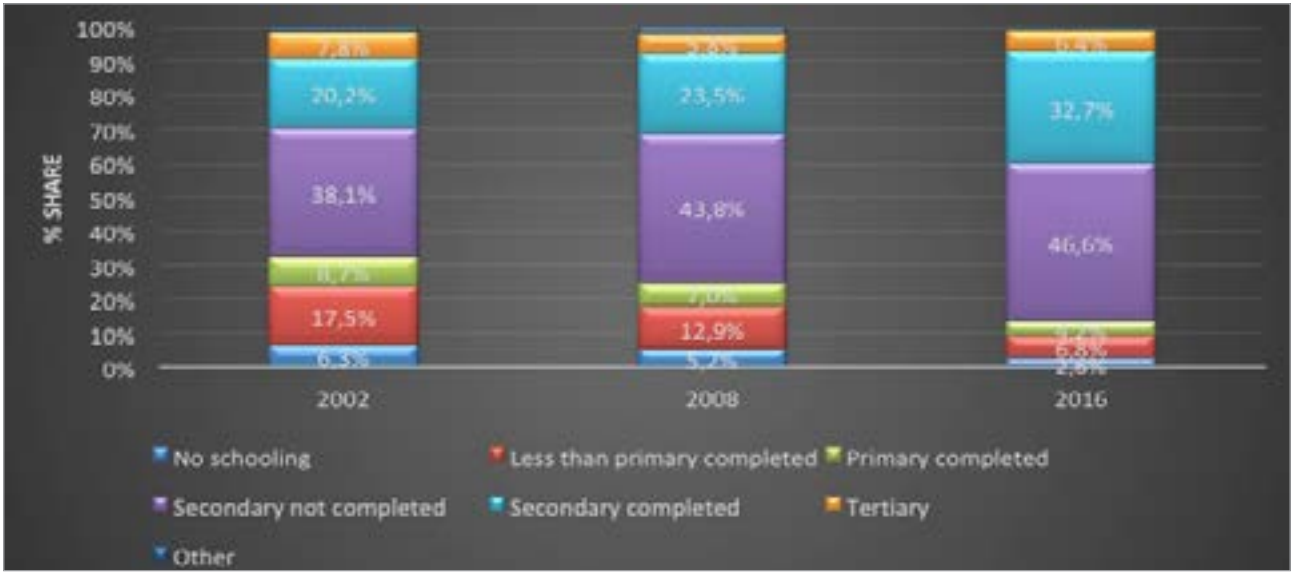


Source: StatsSA, QLFS, 2016 and own calculations

2.8. Employment of artisans by education and skills level

One of the key constraints to economic growth is the mismatch between the demand and supply of skills. The extent to which workers are appropriately qualified in line with the requirements of the job is a key indicator of the skills mismatch. Historically, most artisans had less than grade 12 (at least grade 9) and a post-school qualification, NTC 1-3, attained at a TVET college. However, given the oversupply of grade 12s, recently trained artisans have a minimum of grade 12 plus a TVET engineering qualification.

Figure 10: Share of employed artisans by education, 2002 − 2016



Source: Statistics SA, QLFS, 2002 − 2016 and own calculations

Note: 'Tertiary' includes post-matric certificate and diploma, post-higher diploma, bachelor's degree, post-graduate diploma, honours degree and higher degree. Values for 'other' are not shown on the graph.

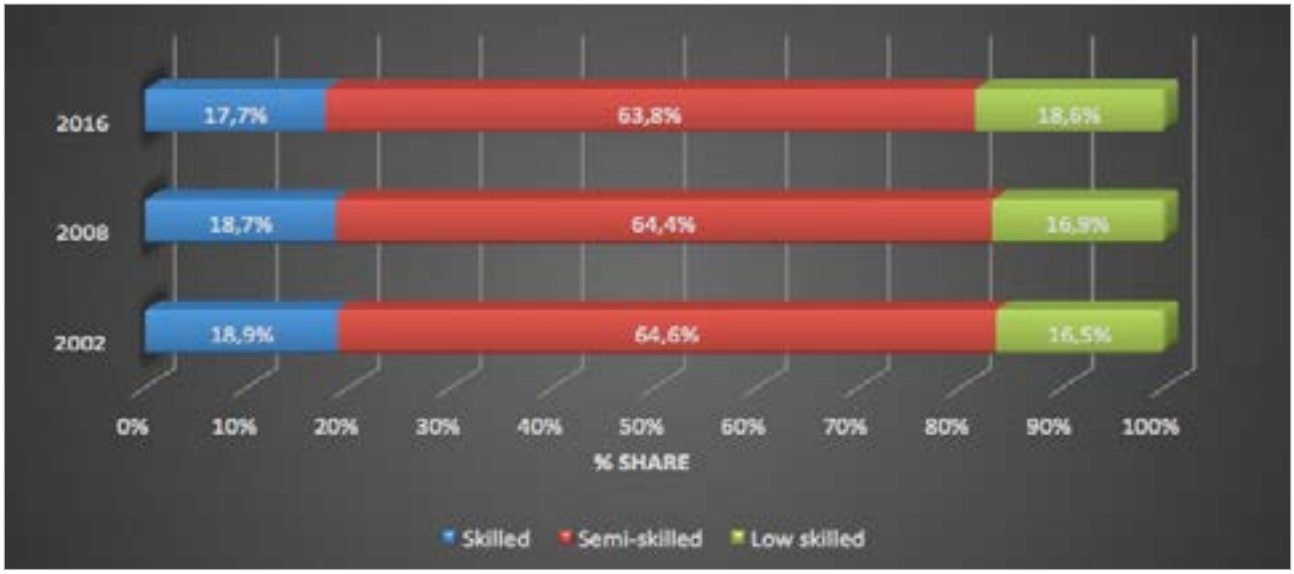
Figure 10 shows that the majority of artisans are unqualified, with 46,6% having less than grade 12 (with no additional qualification) and 32,7% with grade 12 in 2016. What is of concern is that only 6,4% had a tertiary qualification. The latter may be the result of the more recent phenomenon of grade 12 being the entry requirement. That is also supported by the share of those artisans with matric as the highest qualification, which has been increasing since 2002. While those who are unqualified probably have significant experience, it is clear that not enough effort is being made to provide a form of certification through Recognition of Prior Learning (RPL). The share of employed artisans with less than primary completed has been decreasing since 2002, while the share with tertiary qualifications (graduates and other tertiary) was low.

There is a dissonance between the baseline qualification required (Grade 12) and the actual qualifications attained among employed artisans. This is worrying. These results echo similar findings for the period 1996 to 2005 (Du Toit and Roodt, 2008). The authors argued that the lack of experiential training in the workplace, as required by the National Diploma qualification, may be a contributory factor to the degree of under-qualification. According to the CEO of the Artisan Training

Institute (ATI), artisan training has seen a sharp decline over the last 24 months as a result of contractions in the mining, engineering and agricultural sectors due to companies experiencing cash flow and budget constraints (Fin24, March 2016).

This apparent mismatch represents challenges in manufacturing. Skill mismatches and shortages can have important adverse economic consequences and have become a growing concern among policymakers. At the individual level, skills mismatch has a negative impact on job satisfaction and wages. At the enterprise level, it may reduce productivity, and increase on-the-job search, while shortages increase the cost of hiring.

Figure 11: Share of employed persons by occupation in manufacturing, 2002 to 2016



Source: StatsSA, QLFS, 2016 and own calculations

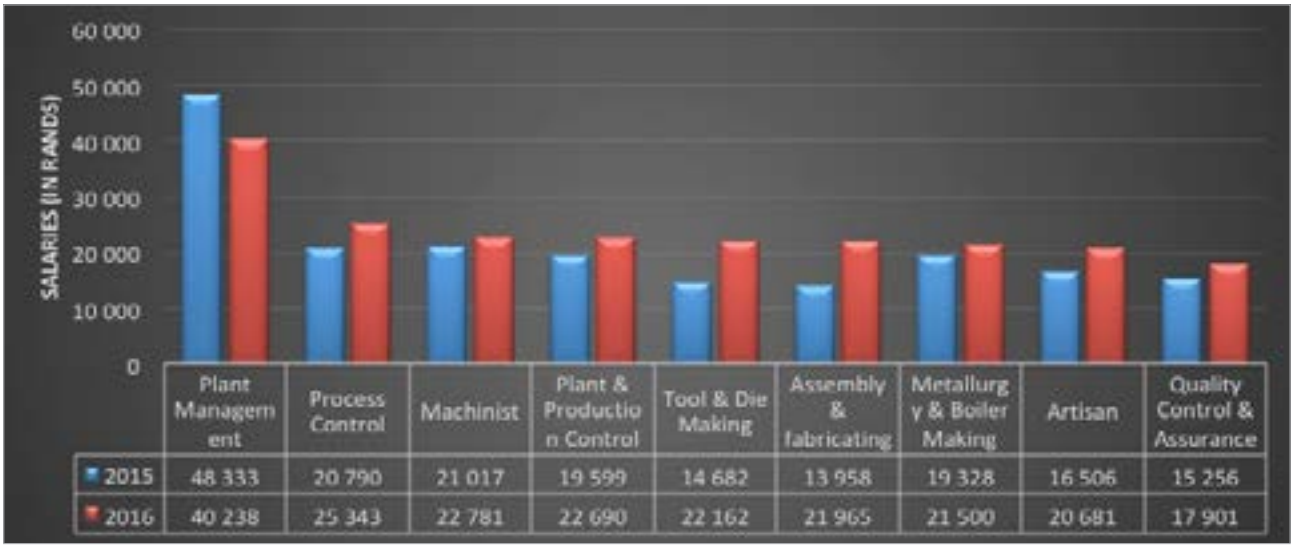
Since 2002 there has been a shift to low-skilled employment. The share of skilled employment declined by 1,2 percentage points to 17,7% in 2016 and semi-skilled by 0,8 percentage points to 63,8% in 2016, as shown in Figure 11. The majority of manufacturing employment is semi-skilled occupations (63,8%), followed by low skilled (18,6%) and skilled (17,7%).

South Africa's manufacturing sector faces low growth, characterised by a poor skills profile and weak competition for goods and services (StatsSA, 2015).

2.9. Salaries of artisans in South Africa

This section analyses trends in income (salaries and wages) in the manufacturing sector.

Figure 12: Manufacturing and assembly salaries in South Africa



	Plant Management	Process Control	Machinist	Plant & Production Control	Tool & Die Making	Assembly & fabricating	Metallurgy & Boiler Making	Artisan	Quality Control & Assurance
2015	48 333	20 790	21 017	19 599	14 682	13 958	19 328	16 506	15 256
2016	40 238	25 343	22 781	22 690	22 162	21 965	21 500	20 681	17 901

Source: Career Junction's salary index 2016

Figure 12 shows the average manufacturing and assembly salaries in South Africa as published by Career Junction. Plant managers earn much more than other occupations in the manufacturing and assembly fields, followed by process controllers and machinists. Average salaries for artisans are higher than in 2015, this might be due to the changes in the supply and demand of artisans in South Africa. Salaries may also be determined by qualifications and the number of years of work experience in a particular field.

According to Sean Jones, CEO of the Artisan Training Institute (ATI), artisans are almost guaranteed formal employment and upon graduation can earn between R20 000 and R25 000 a month, more than most university graduates would earn (Sean J, 2016).

2.10. Supply of artisans

The supply of artisans in this paper will be analysed using artisans trade test results, i.e. the number of people who enrolled and who passed the artisan trade test, as released by Indlela, based on Sector Education and Training Authorities (SETA) data. SETAs have been established to manage the skills development needs in South Africa. Each SETA coordinates skills development in its particular sector. For purposes of planning and managing the delivery of training, the economy has been divided into 23 sectors, each of which has its own SETA.

Table 4: Artisan enrolments and completion by manufacturing SETAs, 2016 − 2017

Manufacturing SETAs	Actual Enrolled Learners			Actual Certificated Learners		
	2015/16	2016/17	y/y growth rate	2015/16	2016/17	y/y growth rate
CHIETA	3 359	4 263	27%	743	936	26%
FOODBEV	45	178	296%	0	13	-
FP&M	454	419	-8%	101	124	23%
MERSETA	8 121	8 038	-1%	8 352	9 661	16%
Total Manufacturing	11 979	12 898	8%	9 196	10 734	**17%**

Source: DHET, 2017

Table 4 shows the number of enrolled and certificated artisan learners in manufacturing SETAs, i.e. Chieta, merSETAseta, Food Bev and FP & M) for the financial years 2015/16 and 2016/17. The number of artisan enrolments in manufacturing SETAs stood at 12 898 in 2016/17, an increase from 11 979 in the previous year. The number of artisans who passed the trade test in manufacturing SETAs also increased by 17% over the period. The actual certificated artisan learners at merSETA increased by 16%, while Chieta rose 26% over the period. This is in support of the NSDS, which highlights the need to increase the numbers of artisans in South Africa.

Table 5: Registered and competent artisan trade test learners, 2015/16 – 2016/17

IPAP Clusters	2015/16		2016/17		y/y growth rates	
	Registered	Competent	Registered	Competent	Registered	Competent
Plastics, pharmaceuticals and chemicals	3 372	743	4 263	936	26%	26%
Clothing, textiles, footwear and leather	459	101	419	124	-9%	23%
Green and energy-saving industries	1 378	470	1 287	697	-7%	48%
Agro-processing	45	0	178	13	296%	-
Tourism, arts and culture, hospitality, sports	514	0	683	0	33%	-
Metal fabrication, capital and transport equipment	8 130	8 352	8 038	9 661	-1%	16%
Business processing services	1 127	550	1 416	1 247	26%	127%
Non-SETA candidates (INDLELA)	5 734	2 952	7 311	3 224	28%	9%
Not in IPAP	7 881	2 946	7 222	5 296	-8%	80%
Total	28 640	16 114	30 817	21 198	8%	**32%**

Source: DHET, 2017

Table 5 shows registered and competent artisan learners in SETAs and Indlela by IPAP cluster from 2015 to 2017. According to the Department of Higher Education and Training (DHET), 30 817 students were enrolled in 2016/17 in South Africa, an increase from 28 640 enrolled in 2015/16. Most of the students in 2016/17 were registered in the metal fabrication, capital and transport equipment cluster (8 038), followed by the plastics, pharmaceuticals and chemicals cluster (4 263). In

2016/17, 7 311 artisan learners registered at Indlela in 2016/17. The table further indicates that the agro-processing cluster recorded the fewest enrolments (178), followed by clothing, textiles, footwear and leather sectors with 419.

In contrast, the business processing services sector was successful in the number of registered and competent learners, with growth rates of 26% for those taking the test and 127% for those passing the test. The clothing, textiles, footwear and leather cluster fared the worst in registered learners, and so the sector will continue to have problems training artisans given these poor registration trends. The plastics, pharmaceuticals and chemicals cluster also performed well, with both numbers of registered and certificated learners growing by 26% over the period.

2.11. Recommendations

- Align education system to industry needs.
- Improve the current throughput and pass rates in artisan qualifications.
- Identify instruments and models of best practice to improve the delivery of artisans.

2.12. Conclusion

The continued decline in artisan employment across the economy is a concern, specifically in the manufacturing sector. It illustrates that even where efforts to improve the supply of artisans are successful, the newly qualified candidates may not find full-time employment. It is often argued that the "real" skills shortage does not lie in the numerical gap between supply and demand, but in the quality of skill and expertise the employee acquires. In light of the number of under- and unqualified practising as artisans, it might be relevant to upgrade the skills and expertise of existing employed artisans.

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2.14. Annexures

Annexure 1: Shortened sector names from the LFS (according to SIC)

Shortened sector name	Industry
Basic metals sector	Basic metals, fabricated metal products machinery and equipment and of office and accounting and computing machinery
Textile, clothing and leather sector	Textile, Clothing and Leather
Wood and cork sector	Wood and Wood products
Food bev and tobacco sector	Food, Beverages and Tobacco

Non-metallic minerals products sector	Non-metallic mineral products
Furniture and NEC sector	Furniture and manufacturing NEC
Transport equipment sector	Transport equipment
Chemicals and petroleum sector	Petroleum products, chemicals, rubber and plastic
Radio, TV, communication and medical equipment sector	Radio, TV, communication equipment and apparatus and of medical, precision, optical, instruments, watches and locks
Electrical machinery and apparatus sector	Electrical machinery and apparatus

Annexure 2: Comparison of employment trends in artisans, technicians and manufacturing in South Africa (2002 - 2016)

Year	Artisans '000	Y/Y % change	Total Manufacturing employment '000
2002	481		1647
2003	453	-5.8%	1560
2004	464	2.4%	1724
2005	545	17.5%	1742
2006	547	0.4%	1757
2007	525	-4.0%	1776
2008	546	4.0%	1917
2009	458	-16.1%	1771
2010	445	-2.8%	1713
2011	471	5.8%	1737
2012	430	-8.7%	1727
2013	404	-6.1%	1667
2014	441	9.2%	1741
2015	475	7.7%	1774
2016	455	-4.2%	1683
CAGR	-0.4%		**0.2%**

Chapter 3: Trends in the profile of engineers, technologists and technicians in manufacturing

3.1. Introduction

At the end of the second quarter of 2016, renewed weakness was evident in the manufacturing, metals and engineering sectors. Incidentally, the latter is 6% and 53% larger than in 2005 and 1995 respectively. However, the sector is still producing at 30% below the 2007 peak, with grave concern that it has entered a renewed downward cycle (Langenhoven H, July 2016).

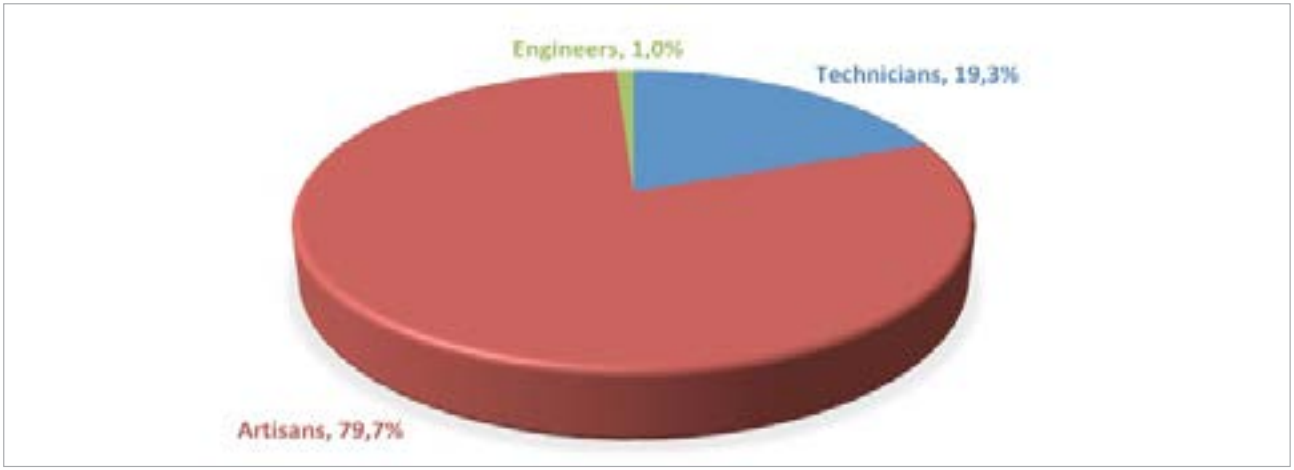
According to SEIFSA Chief Economist Michael Ade, the metals and engineering sector has been in decline for three consecutive years (Ade M, 2018). The local producers' share of the market shrunk from 68% in 2002 to 48% in 2016, which is a staggering R114-billion worth of production forfeited or 70 000 job opportunities lost (Langenhoven H, July 2016).

This chapter uses the quantitative method to analyse the employment trends of engineers, technologists and technicians in the manufacturing sector from 2002 to 2016. It also gives an overview of Industry 4.0 in South Africa. The main data sources are StatsSA and the Department of Higher Education and Training (DHET).

3.2. Employment share of technical workforce in manufacturing

The overwhelming majority of the technical workforce in the manufacturing sector is represented by artisans (79,7%) and technicians (19,3%), while engineers and technologists constitute only 1,0%, as shown in Figure 1. South Africa has one engineer per 3 200 people, compared to 1:130 in China, 1:270 in Europe and 1:450 in Australia (Malan C, 2014). South Africa produces 1 400 engineering graduates per year, against a demand for 2 400 per year (Furter, 2013).

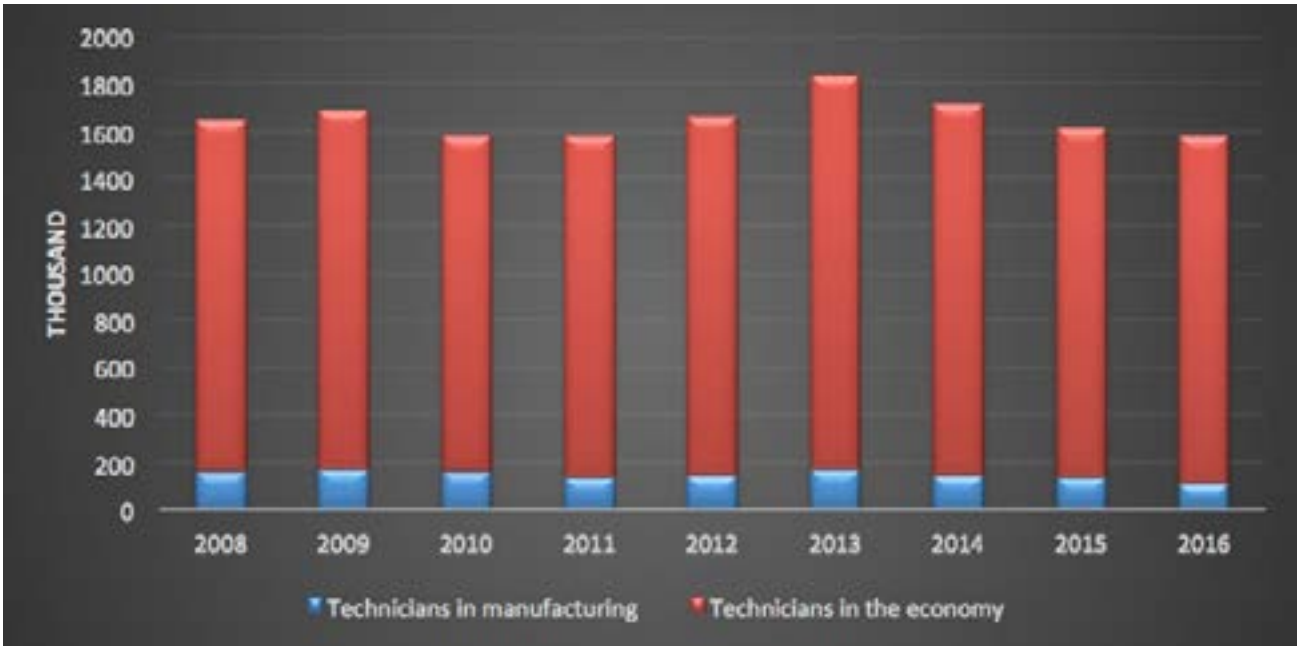
Figure 1: Distribution of engineering professionals and artisans in manufacturing, 2016



Source: StatsSA, Quarterly Labour Force Survey 2016 and own calculations

Over the period, total manufacturing employment grew by about 0,2%, as compared to the annual growth of employment in the economy, which was 2,4%. By comparison, the CAGR varied widely in technical occupations in manufacturing, ranging from -7,1% for engineers and technologists to -2,3% for technicians and -0,4% for artisans (2002 to 2016) (Annexure 3.1). Employment of technical workforce in manufacturing is therefore shrinking.

Figure 2: Share of technicians in the manufacturing industry and the economy, 2008-2016



Source: StatsSA, Quarterly Labour Force Survey 2016 and own calculations

Figure 2 shows that about 1.5 million technicians are employed in South Africa, with 110 000 in the manufacturing sector specifically, a decrease from 158 000 in 2008. StatsSA data shows that about 7% of employed technicians in South Africa are in the manufacturing sector. The number of technicians has been decreasing since 2014, with the highest number recorded in 2013.

3.3. Fourth Industrial Revolution

Industrial robots are machines that can be programmed to perform production-related tasks without the need of a human controller. An industrial robot is designed in such a way that it helps to move materials, parts and tools, and performs other tasks related to production and manufacturing. Industrial robots are ideal for situations that require high-quality production with consistent accuracy.

Manufacturing is a critical component of South Africa's economic policy and is important in creating and ensuring jobs in the economy. The rapidly growing adoption of robots in various industries has the potential to increase productivity and

throughput and reduce labour costs, which is one of the major drivers for the growth of the industrial robotics market. The production of digital and changes in manufacturing technologies has led to an employment decline in the sector (**the dti** Newsflash, Nov 2017).

3.3.1. Current status of adoption of Industry 4.0 in South Africa and the BRIC countries

Rapid advances in innovation and technology have resulted in countries using automation and robotics for their production, particularly in manufacturing. Figures from the International Federation of Robotics (IFR) show that sales of robots are increasing year-on-year, with a 15% increase in 2015 over the previous year (International Federation of Robotics, 2017). The speed in which the use of robots is increasing differs from country to another, depending on whether the country is developed or still emerging. At present, each nation is working on improving the readiness for Industry 4.0 and driving quicker adoption. This section will discuss that in detail.

Table 1: Comparison of South Africa, other BRICS and Developed Economies

	Robot Density[1]			Industry 4.0 related patents[2]	M2M Connection[3]	
	2002	2014	CAGR	2014	2014	Global share
Brazil	2	10	14%	19	10	4.0%
Russia	-	2	-	43	9	3.4%
India	0	2	-	35	3	1.2%
China	1	36	35%	2721	69	27.6%
South Africa	2	22	22%	10	5	2.0%
Korea	126	478	12%	476	3	1.2%
Japan	328	323	0%	1724	11	4.4%
Germany	172	282	4%	953	6	2.3%
USA	46	155	11%	3120	45	17.8%

Source: International Federation for Robotics; Ministry of Economy, Trade and Industry (Japan); WIPO; USPTO; GSMA Intelligence.

1 *Robot density is defined as the number of industrial robots per 10 000 employ*

2 *Industry 4.0 related patents have been assumed to be registered in 4 major patent categories – H04L (Transmission of Digital Information), B25J (Industrial Robotics), B29C (Shaping or Joining of Plastics) and G05B (Control and Monitoring Systems). 3. M2M Connections are defined as SIM connections that enable mobile data transmission between machines. It does not include SIMs used computing devices in consumer electronics such as smartphones, dongles, tablets, e-readers, routers or hotspots.*

Table 1 shows the readiness and current status of adoption for Industry 4.0, for 2002 to 2014. The demand for industrial robots has accelerated considerably in recent years as a result of continued technological advancements in automation systems and artificial intelligence (ILO, 2016). With the expected reduction in cost arbitrage and the increasing need for flexibility (e.g. mass customisation), it is important for BRICS nations to adopt advanced manufacturing technologies to remain competitive in the global market (BRICS Business Council, 2016). According to the latest World Economic Forum (WEF) Global Competitiveness Report 2017-2018, South Africa is ranked 61 globally (out of 137 countries) and third overall in the Sub-Saharan Africa (SSA) region, behind Mauritius and Rwanda in first and second place respectively. This means that South Africa lost 14 places from its ranking of 47 a year ago. The WEF report revealed that the top five most problematic factors hampering South Africa's competitiveness, particularly with regard to doing business, include corruption, crime and theft, government instability/coups, tax rates and inefficient government bureaucracy.

South Africa trails its BRICS counterparts with respect to competitiveness, sitting at fourth position within the BRICS. China ranks first, with a global ranking of 27 (up from 28th place in 2016-2017), followed by Russia (with a global ranking of 38, up from 43rd place in 2016-2017) and India (with a global ranking of 40, down from 39 in 2016-2017). Brazil is the lowest-ranked BRICS economy in terms of global competitiveness, behind South Africa in 2017/18.

The adoption of robots in developed countries is occurring fast as those countries have high levels of industrial automation and high numbers of Industry 4.0-related patent applications. Consequently, robot density in South Africa (measured as the number of industrial robots per 10 000 people employed) increased from two in 2002 to 22 in 2014, while Industry 4.0-related patents stood at 10 in 2014, as shown in Table 1.

South Africa (22) is placed second with respect to levels of industrial automation within the BRICS, behind China with 36 in 2014. On the other hand, South Africa is only better than India with respect to machine-to-machine connections within the BRICS, behind China (69), Brazil (10) and Russia (nine). China has the highest growth rate (35%) per annum within the BRICS, followed by South Africa with 22%. BRICS nations, other than China, have low levels of industrial automation (robot density), low numbers of Industry 4.0-related patent applications, low numbers of machine-to-machine connections, and limited activities in robotics and additive manufacturing by companies, as shown in Table 1. This is an indication of low levels of Industry 4.0 readiness. In South Africa, the public sector invests in research on additive manufacturing in order to support Industry 4.0.

3.3.2. The impact of robots and automation on skills and employment in South Africa

The manufacturing industry is a cornerstone for most economies, South Africa included. It has become increasingly important not only to produce high-quality products at affordable prices, but also to have the necessary highly trained labour force to increase production and create much-needed job opportunities. Manufacturers rely on skilled people to operate advanced technology, which is a basic requirement of the sector.

Research shows that the future will be robots and humans working together, i.e. robots complementing and augmenting labour. Automation provides the opportunity for humans to focus on higher-skilled, higher-quality and higher-paid tasks. Meanwhile, there is ample evidence that automation does not lead to job substitution, but rather to a reallocation of both jobs and tasks in which robots complement and augment human labour by performing routine or dangerous tasks (IFR, 2017).

The rapidly growing adoption of industrial robots may shift skills requirements to higher-skilled labour in the sectors in which automation has substituted for labour, but may also create new lower-skilled jobs in other sectors due to spill-over effects. According to the BRICS White Paper on Skills Development for Industry 4.0, the adoption of Industry 4.0 will result in the elimination of lower-skilled jobs through automation.

The manufacture of robots requires high investment in hardware and software and introduces other ongoing expenses such as maintenance, which can hinder market growth. This in turn will lead to the development of new forms of work, notably telework and ICT-mobile work. The focus will increasingly be placed on higher-end skills as technology will transform the manufacturing environment into a programmable system. There is a risk of job displacement through robotisation, which is particularly high in developing countries.

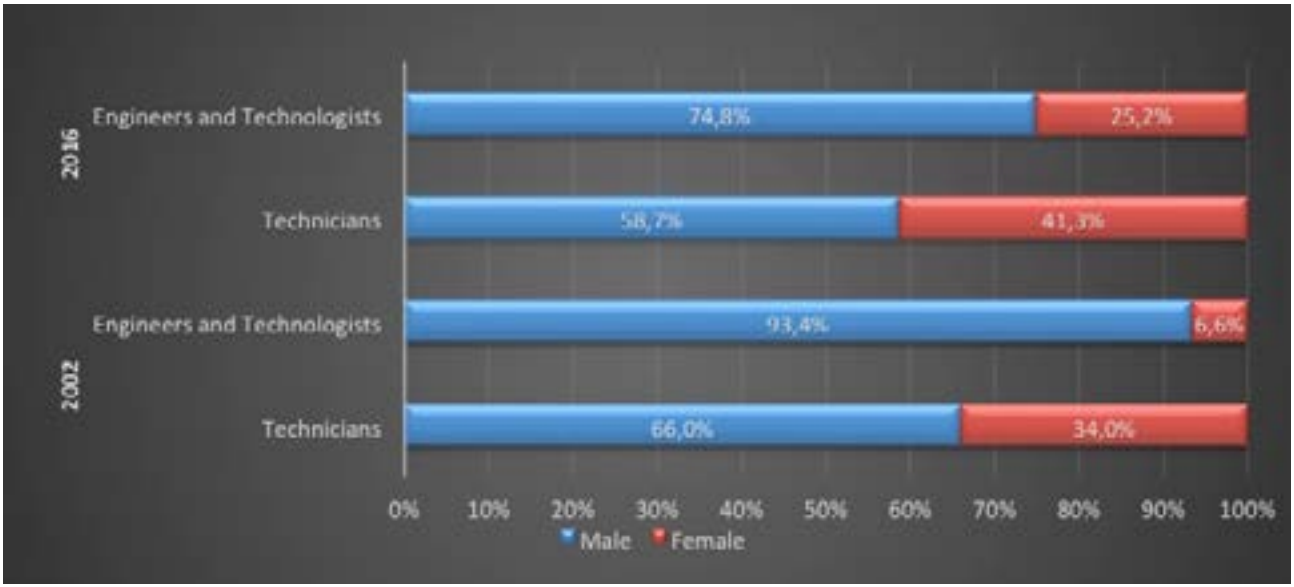
Many occupations involve a combination of tasks, and different manual and routine tasks have been mechanised for centuries, with new technologies, including robots, predominantly replacing labour in routine tasks (UNCTAD, 2017). A more recent study found that routine-based tasks dominate in manufacturing. As a result, some jobs will be replaced by robots and there will be the development of new forms of work in the sector. The same study found that robots are not yet suitable for a range of labour-intensive industries, leaving the door open for developing countries to enter industrialisation processes along traditional lines (UNCTAD, 2017).

South Africa has set itself the goals of eradicating poverty, reducing inequality, growing the economy by an average of 5,4%, and cutting the unemployment rate to 6% by 2030. Education, training and innovation are critical to the attainment of these goals (NDP: 296-7).

3.4. Demographic profile of engineers and technicians in manufacturing sector

The South African engineering sector has evolved to become more gender-balanced, as employment equity measures increasingly ensure equal opportunities for both men and women. However, further transformation is required. It is still a man's world in African engineering and science. The marginalisation of women in engineering and science is not unique though to the continent. It is a pattern around the globe. It has been estimated that, on average, only 30% of science roles throughout the world are held by women (Butler-Adam J, 2015).

Figure 3: Employment share of engineers and technicians by gender, 2002 and 2016



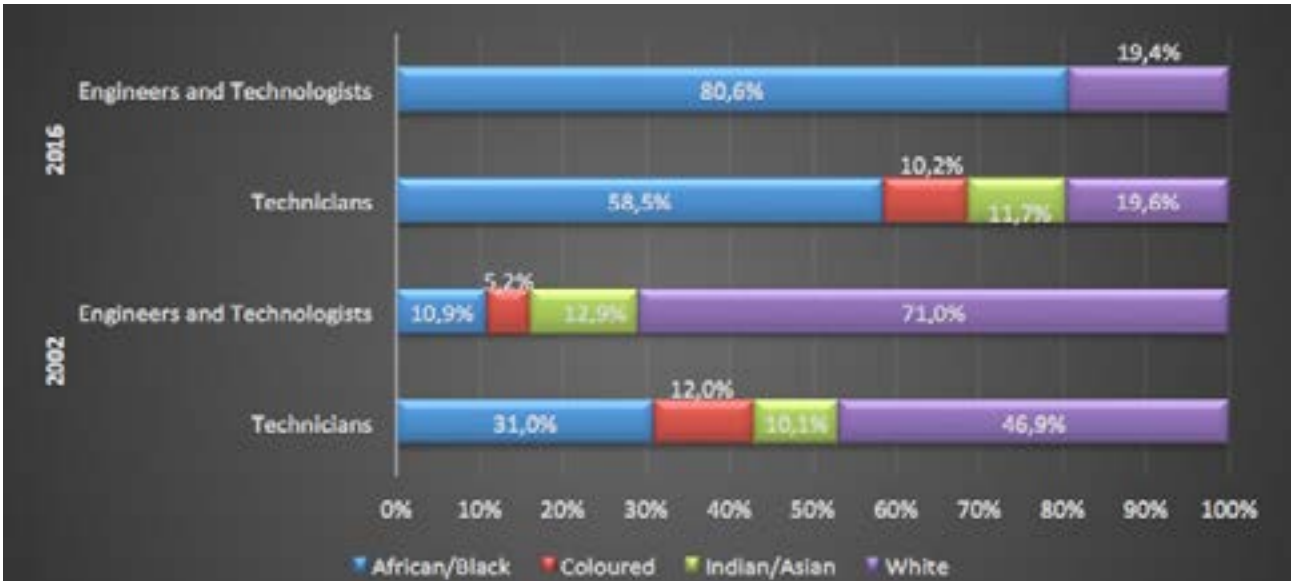
Source: StatsSA, Quarterly Labour Force Survey 2016 and own calculations

In South Africa, women represent about 52% of the population, but only 25,2% are in engineering positions in the manufacturing sector, an increase of 18,6% from 6,6% in 2002. Unemployment across all categories is rising. However, women remain the more vulnerable group, and young women the most vulnerable group (StatsSA, 2017). Shocking statistics from the Engineering Council of South Africa in 2015 showed that 70% of women who graduated with engineering degrees left the sector after starting their careers because they felt isolated in their jobs. Research at Network Engineering reveals that professional South African women engineers continue to battle old stigmas in this male-dominated industry (Thompson M, 2015).

The proportion of women employed as technicians increased from 34,0% in 2002 to 41,3% in 2016, a significant step towards closing the gender gap. The TVET colleges are reporting an increase in female students in the fitting and turning as well as electrical and motor trades. False Bay TVET College, for instance, has experienced a year-on-year average growth of 200% since 2014 in females studying for qualifications in the motor trades, and electrical and civil engineering (False Bay TVET College, News24, 2016). Many of its top achievers in these subjects in 2015 were women. More women are graduating (20% in 2016) in engineering than men (18% in 2016) at universities of technology (DHET, 2017). In 2002 and 2016, women were far less likely than men to be working as artisans and technicians. A higher proportion of women (41,3%) are more likely to be technicians than engineers (25,2%), as shown in Figure 3.

With industries actively recruiting women for training as technicians, statistics are beginning to reflect that women are making inroads into formerly male occupations (False Bay TVET College, News24, 2016).

Figure 4: Employment share of engineers and technicians by race, 2002 and 2016

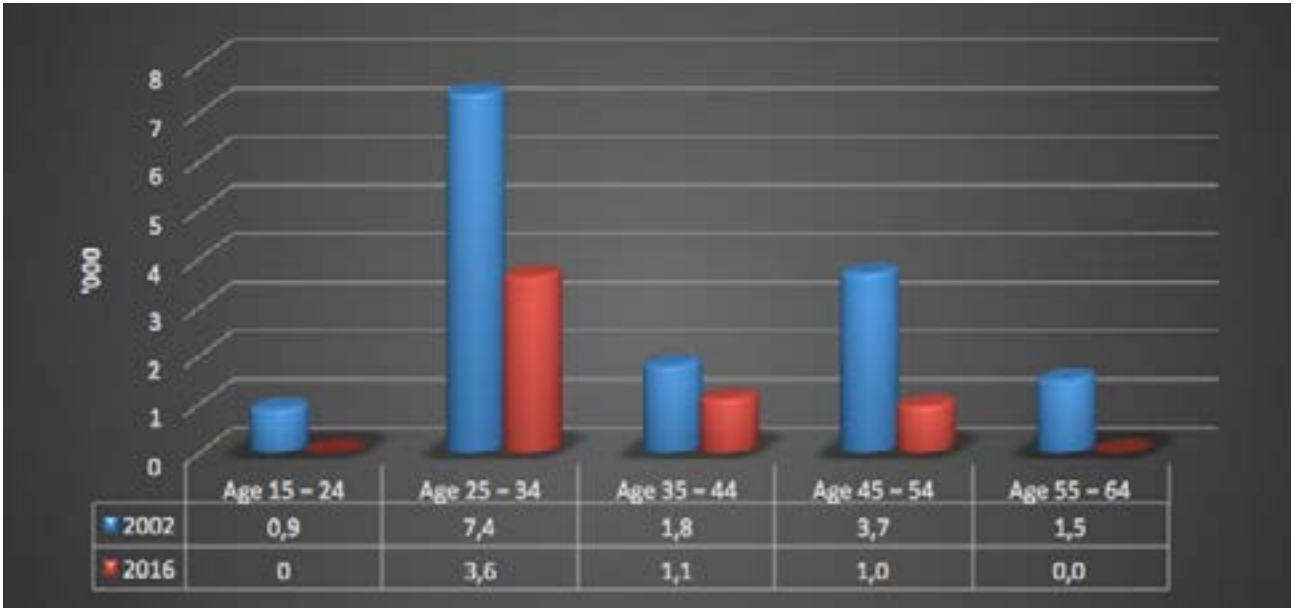


Source: StatsSA, Quarterly Labour Force Survey 2016 and own calculations

Figure 4 shows that the continuing decrease in white engineers and the increase in black African engineers has continued apace. Du Toit and Roodt (2008) show there was a doubling in the number of black (African, coloured and Indian) engineers and technologists, from 15,5% (1996-1999) to 30,5% (2000-2005). Over the same period, black technicians increased from 31,0% in 2002 to 58,5% in 2016.

About 46,9% of employed technicians were white in 2002, decreasing to 19,6% in 2016. The share of Indian engineers and technologists decreased from 12,9% in 2002 to 0% in 2016. The share of white engineers and technologists decreased from 71,0% in 2002 to 19,4% in 2016.

Figure 5: Number of employed engineers by age group, 2002 and 2016

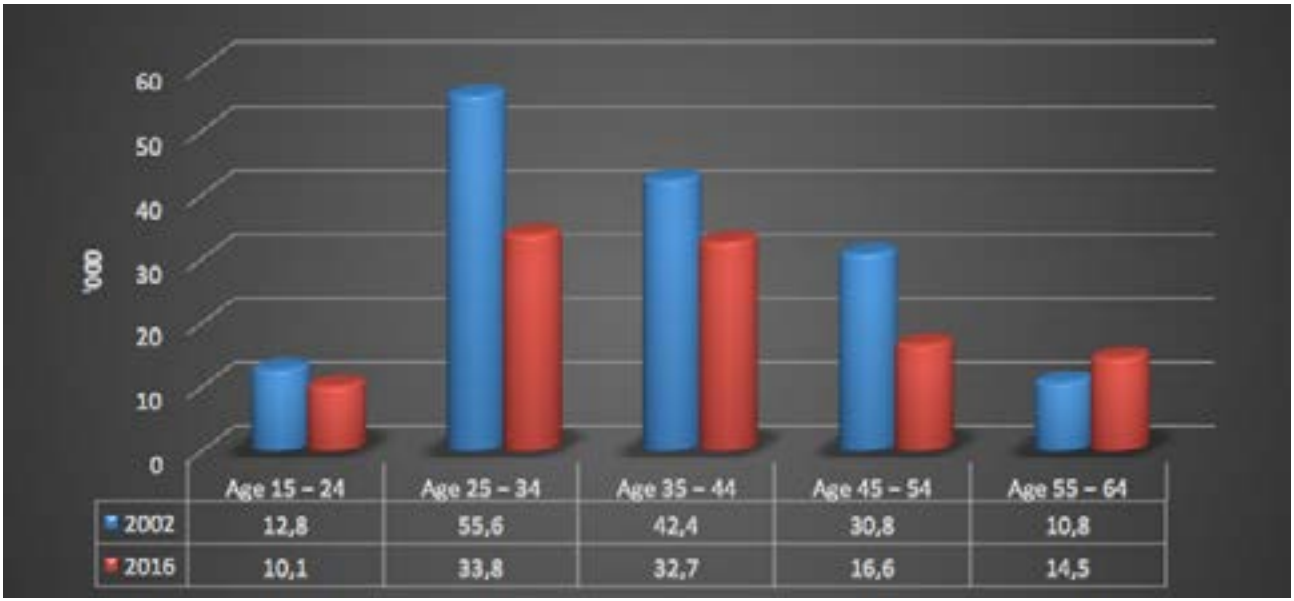


Source: StatsSA, Quarterly Labour Force Survey 2016 and own calculations

The age profile presented in Figure 5 suggests that engineers and technologists are relatively young, with 44,2% in the age group 25 to 34. There is a suggestion of a decreasing engineering skills pipeline, as the number of newly qualified engineers and technologists (15 to 24 years) decreased significantly from 900 to 0 in 2016. All the age group figures for 2016 are low as compared to the 2002 figures.

Taken together, these results suggest there is a lower retention rate of experienced engineers and a decreasing pipeline into the profession. The low numbers of the age groups 15 to 24 and 55 to 64 may have negative effects in the long run on the growth and innovation capability requirements that are necessary to ensure greater competitiveness in the manufacturing sector, given the centrality of the engineering profession in the production process.

Figure 6: Number of employed technicians by age group, 2002 and 2016



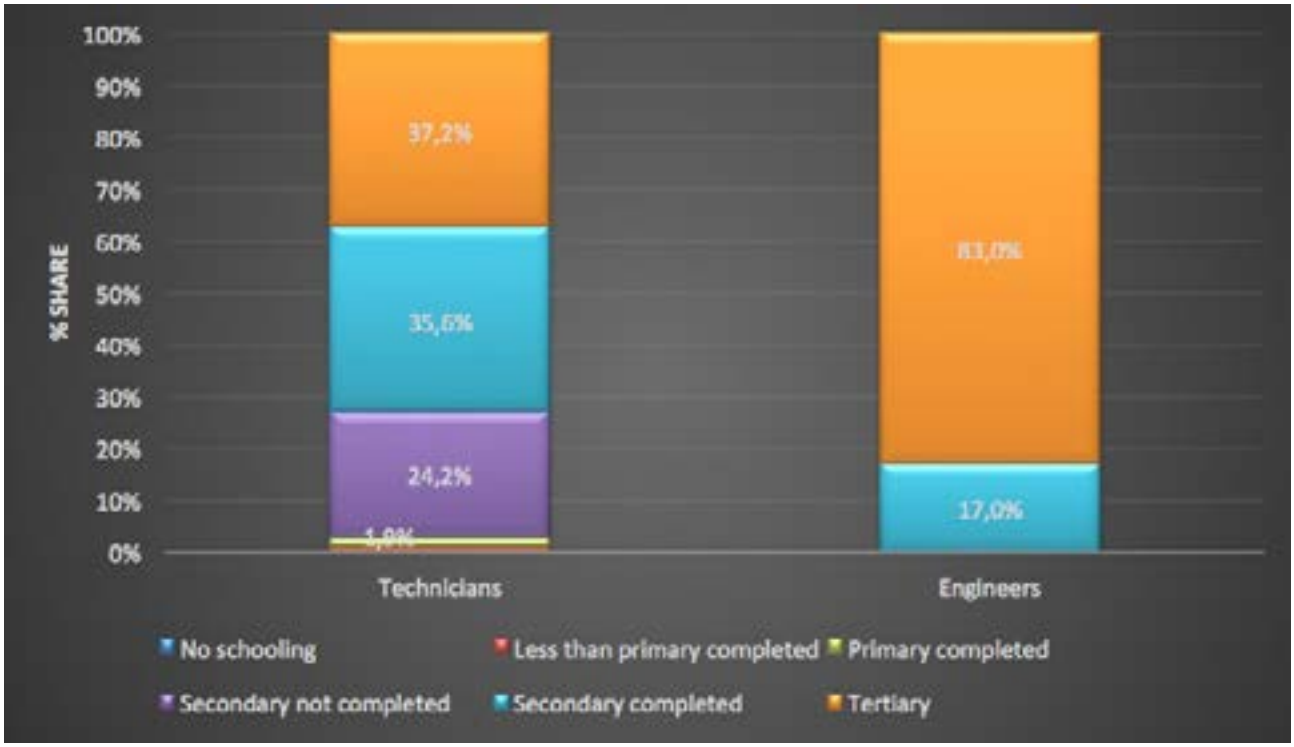
Source: StatsSA, Quarterly Labour Force Survey 2016 and own calculations

There appears to be a more balanced mix of youth and experience among technicians, compared to the age profile of engineers, with 40,8% in the age group 15 to 34 years; 30,3% in 35 to 44 and 29,0% in 45 to 64. The decline in the number of technicians in all age groups (except 55 to 64) is worrying, as shown in Figure 6. The decline in the number of entry-level technicians aged 15 to 24 suggests a slowdown of entry into the skills pipeline. The number of employed technicians in the age group 55 to 64 increased by 2,1% per annum over the period, as technicians of pensionable age exit the system. Alternatively, they may also enter into business ventures, as research shows that owners of manufacturing enterprises generally have a technical qualification. The availability of experienced technicians older than 35 years may positively affect the transfer of skills from older to younger technicians.

3.5. Employment of engineers, technologists and technicians by education

Quality engineers and technologists are essential for innovation, which leads to the competitiveness and growth of the economy. These technical skills are also essential for manufacturing as a sector.

Figure 7: Highest education completed among employed engineers and technicians, 2016



Source: StatsSA, Quarterly Labour Force Survey 2016 and own calculations

Note: 'Tertiary' includes post-matric certificate and diploma, post-higher diploma, bachelor's degree, post-graduate diploma, honours degree and higher degree. Values for 'No schooling' are not shown on the graph.

A key constraint to economic growth is the mismatch between the demand and supply of skills. The extent to which workers are qualified in line with the requirements of the job is a key indicator of the skills mismatch.

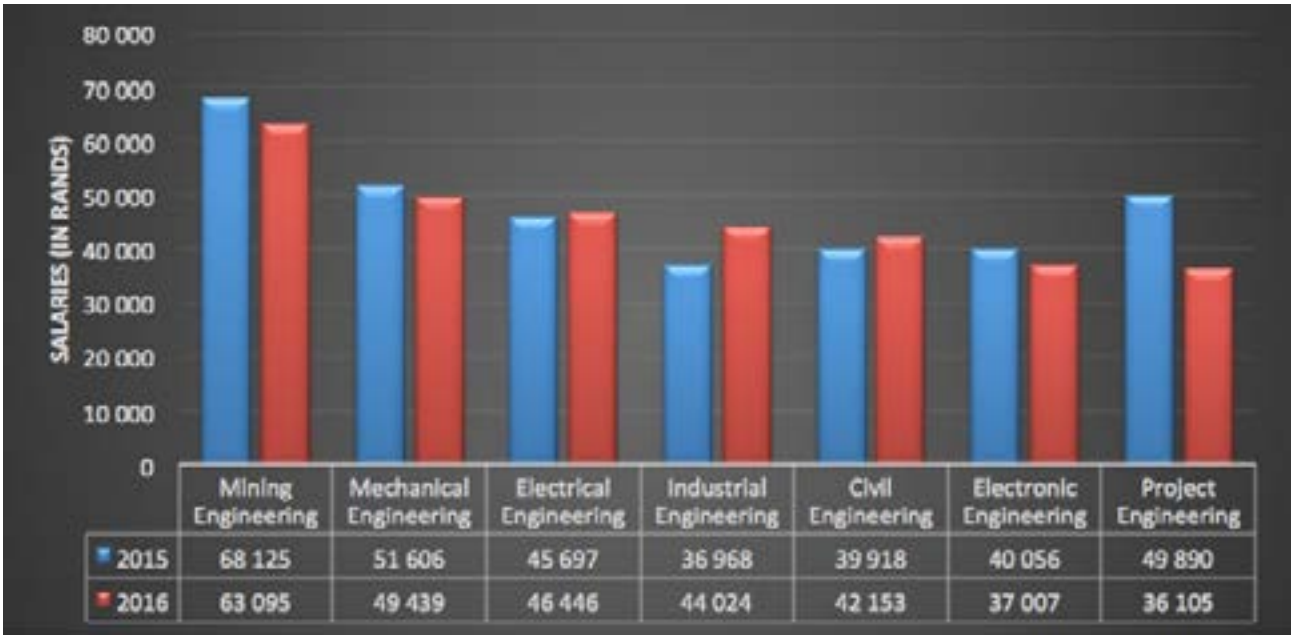
Figure 7 shows that the overwhelming majority of engineers have a post-matric qualification; indicating high levels of compliance with the basic requirements of an engineering degree.

In terms of employed technicians, there is a dissonance between the baseline qualification required (National Diploma from a University of Technology) and the actual qualifications attained. This is worrying. As a result, only 37,2% of technicians in the manufacturing sector had tertiary qualifications, implying that the majority did not have the right qualifications. The findings suggest that 62,7% of employed technicians have either a Grade 12 (35,6%) or less (27,1%). These results echo

similar findings for the period 1996 to 2005 (Du Toit and Roodt, 2008). The authors argued that the lack of experiential training in the workplace, as required by the National Diploma qualification, may be a contributory factor to the degree of under-qualification.

3.6. Salaries and wages of engineers in South Africa

Figure 8: Engineering salaries in South Africa



	Mining Engineering	Mechanical Engineering	Electrical Engineering	Industrial Engineering	Civil Engineering	Electronic Engineering	Project Engineering
2015	68 125	51 606	45 697	36 968	39 918	40 056	49 890
2016	63 095	49 439	46 446	44 024	42 153	37 007	36 105

Source: Career Junction's salary index

Figure 8 shows the average salaries of engineers in South Africa as published by Career Junction. South African mining engineers get paid the most in the engineering fields, followed by mechanical engineers. Data on average salaries, after tax, within the major fields of mechanical, electrical, chemical and civil engineering show that engineers in South Africa earn much more than their counterparts in the traditional South African immigration meccas of Australia (Auks), the United Kingdom (aUKs) and the United States (aUkS) – or AUKS countries (News24, 22 February 2016).

From the above figure, it is clear that project engineers are paid the least in the engineering fields. The data shows that the average salary in this field declined from R49 890.00 in 2015 to R36 105.00 in 2016. Figure 8 shows that there were

some changes to average salaries in the engineering fields between 2015 and 2016, which might be a result of changes in the demand and supply of engineers. Generally, the pay-scale trends indicate that South Africa and the US are the top two countries in terms of earning potential for engineers (SA beating the US marginally), with Australia a distant third and the UK by far the worst country for engineers to generate wealth (News24, 22 February 2016).

Equipped with a basic understanding of the economic law of supply and demand, it is easy to see why the US and South Africa have such high relative engineering salaries. Their demand for engineers far outweigh their supply, as indicated by their respective unemployment rates of 3% and less than 1% (News24, February 2016).

The latter unemployment figure might seem contradictory in a country that has one of the highest national unemployment rates in world at 27,1% as published by StatsSA in the third quarter of 2016, but what tends to be forgotten is that it is largely the unskilled labour force that is unable to find work.

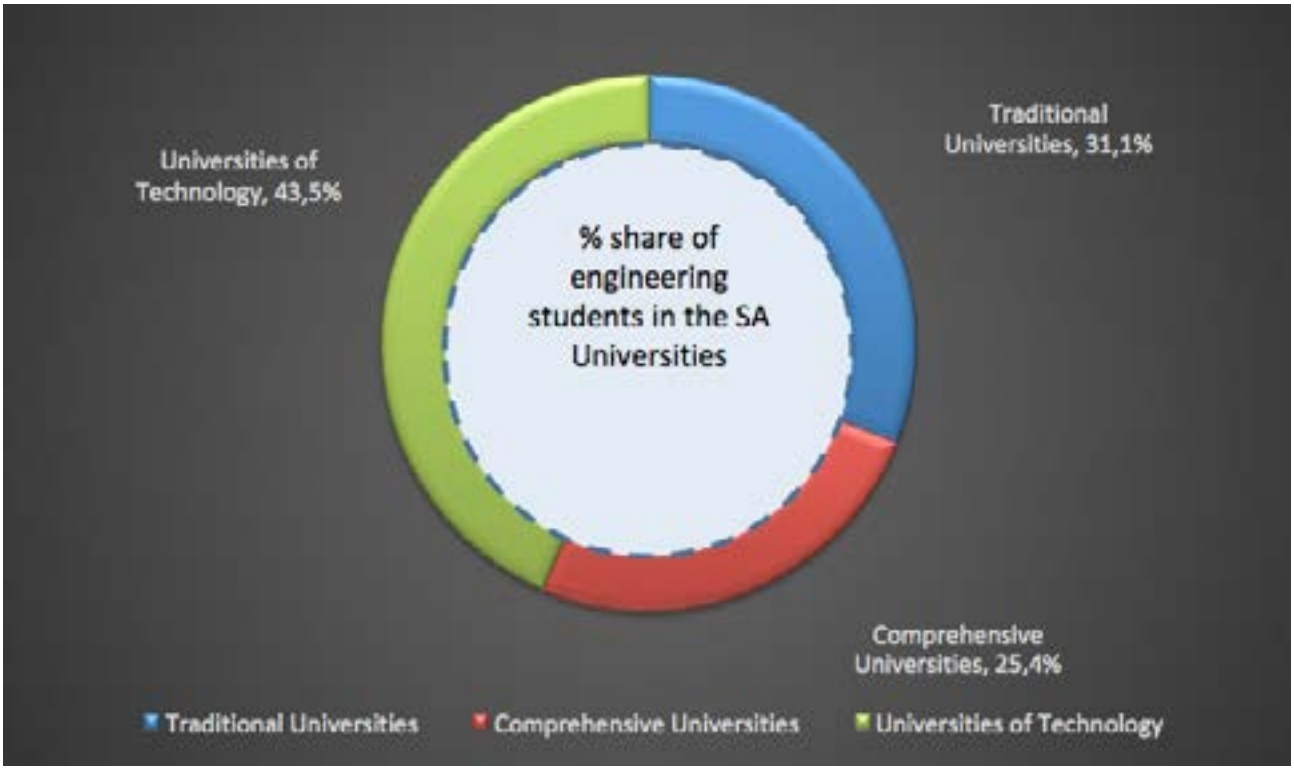
Although engineers in South African earn much more than their counterparts, more than 300 qualified engineers leave South Africa every year (News24, 22 February 2016).

3.7. Enrolment and graduation of engineers, technologists and technicians at universities

The ratio of enrolment to graduation of engineering students provides insight into the profession's skills pipeline. There are three types of universities in South Africa: traditional, comprehensive and technological. The country's 25 public higher education institutions offer a range of study and research options for local and international students.

Figure 9 shows that the overwhelming majority of engineering students are at universities of technology (43,5%), followed by traditional universities (31,1%) and comprehensive universities (25,4%).

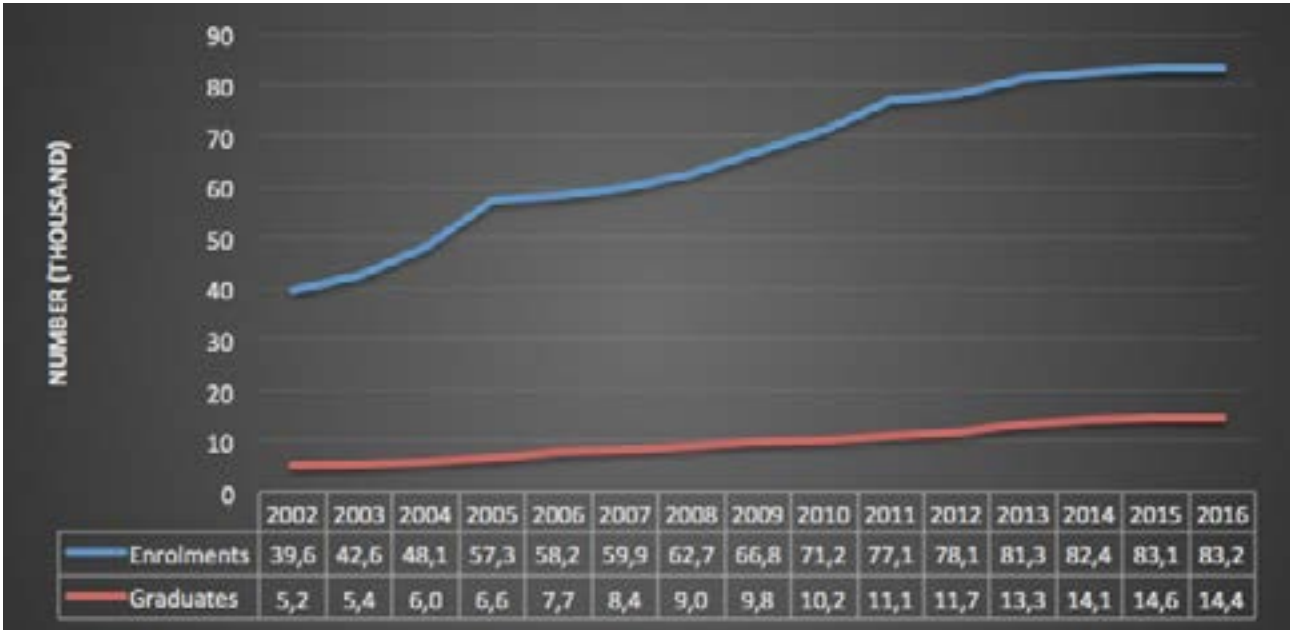
Figure 9: Engineering students (enrolments) by types of universities in South Africa, 2016



Source: DHET, 2016

The number of university enrolments improved incrementally over the period after a dip from 2005 to 2006. Figure 10 shows that while there was steady growth in university enrolments in 2016, graduation rates declined by 1% from a low base. There is a big gap between the number of enrolments and the number of graduates, and it is broadening.

Figure 10: Trends in universities engineering enrolments and graduates (2002-2016)

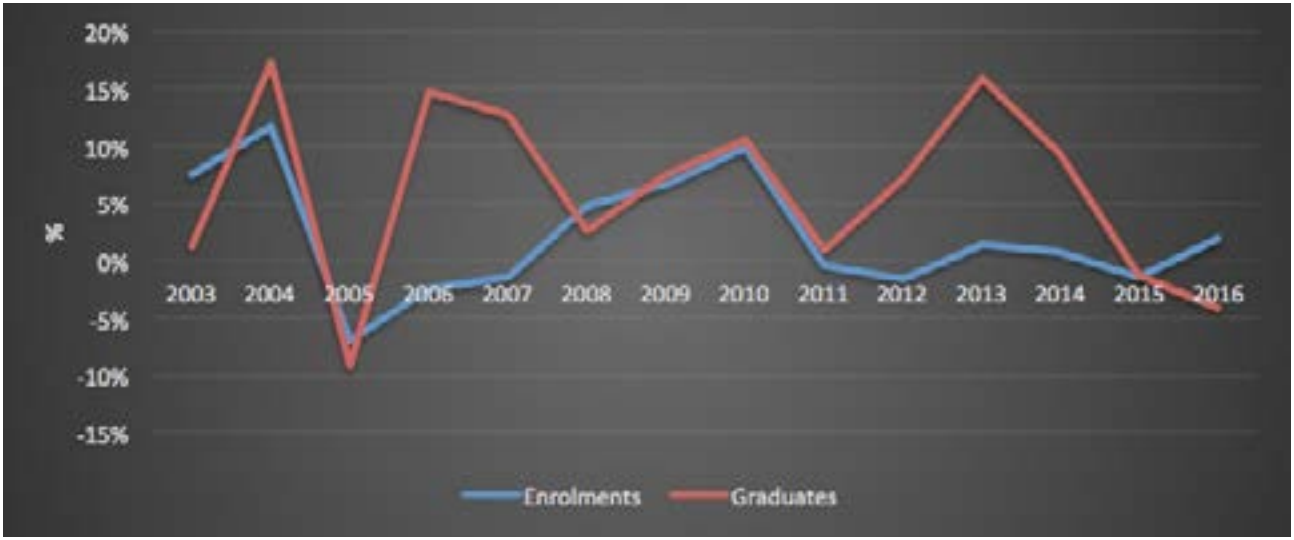


	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Enrolments	39,6	42,6	48,1	57,3	58,2	59,9	62,7	66,8	71,2	77,1	78,1	81,3	82,4	83,1	83,2
Graduates	5,2	5,4	6,0	6,6	7,7	8,4	9,0	9,8	10,2	11,1	11,7	13,3	14,1	14,6	14,4

Source: DHET, 2016

There is a positive relationship between enrolments and graduates at universities of technology. Figure 11 suggests that in 2005, the number of engineering enrolments at these institutions decreased by almost 8% and the number of graduates decreased by 9%. Despite some significant fluctuations over the period, the ratio of enrolments to graduates was almost 1:1 between 2008 and 2011. The number of graduates began to far outweigh the number of enrolments, starting from 2012 to 2014.

Figure 11: Annual growth in the universities of technology engineering enrolments and graduates (2003-2016)



Source: DHET, 2016

South Africa began restructuring its higher education system in 2003 to widen access to tertiary education. Smaller universities and technikons (polytechnics) were incorporated into larger institutions to form comprehensive universities.

A comparative analysis suggests there may have been a substitution effect (crossover of students from one kind of institution to the other) at play between the comprehensive, traditional and technology universities in 2005. In 2006, however, the number of graduates at universities of technology increased by 14,8%, but slowly decreased to align with enrolments, then grew at 10% per year until 2011. In 2016, graduates at these universities declined by 4% while enrolments were increasing by 2%, as depicted in Figure 11.

Table 2: Gender distribution of engineering students' enrolments and graduates at the Universities (2016)

	Enrolments	% Share	Graduates	% share
Male	61 160	73%	10 236	71%
Female	22 067	27%	4 183	29%
Total	83 227	100%	14 419	100%

Source: DHET, 2016

According to the DHET-HEMIS data, one of the areas with the greatest gender imbalances in the universities of technology is engineering, where only 27% of students are women. The engineering enrolments are still dominated by males, with 73%, as depicted in Table 1. Government statistics (HEMIS) also show that the percentage of engineering women who graduated (19%) from the universities were more than the percentage of men (17%) in 2016. According to Sean Jones, the CEO of the Artisan Training Institute (ATI), more women are graduating as electricians, fitters and turners, and measurement, control and instrumentation technicians (ATI, 2016).

3.8. Conclusion

Manufacturing is a critical component of South African economic policy and also important in creating and ensuring that there are jobs in the economy. The development of skilled engineers, technologists and technicians is vital to backup many of the country's developmental plans. The majority of employed engineers (83%) have tertiary qualifications, as compared to technicians. A shortage of technical skills is one of the key problems undermining the competitiveness of the South African manufacturing sector.

Competitiveness remains an important contributor to the broader goal of human-centric economic progress. In South Africa, the public sector invests in research on additive manufacturing, in order to support Industry 4.0. South Africa, however, still has low levels of Industry 4.0 readiness. The average age of both engineers and technicians was between 25 and 54 years of age. The low throughput and pass rates for qualifications are also an issue, which has implications for the manufacturing industry and continued growth in the economy. There is therefore a need for more coordinated and responsive skills planning.

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3.10. Annexure 3.1

Comparison of employment trends in artisans, technicians and manufacturing in South Africa (2002-2016)

Year	Artisans and technicians employment in manufacturing				Total manufacturing employment '000
	Technicians '000	Y/Y % change	Artisans '000	Y/Y % change	
2002	153		481		1647
2003	141	-7.9%	453	-5.8%	1560
2004	120	-14.6%	464	2.4%	1724
2005	110	-8.1%	545	17.5%	1742
2006	120	8.4%	547	0.4%	1757
2007	109	-9.1%	525	-4.0%	1776
2008	158	45.1%	546	4.0%	1917
2009	168	6.5%	458	-16.1%	1771
2010	163	-2.9%	445	-2.8%	1713

2011	135	-17.6%	471	5.8%	1737
2012	143	5.9%	430	-8.7%	1727
2013	166	16.3%	404	-6.1%	1667
2014	145	-12.5%	441	9.2%	1741
2015	137	-5.4%	475	7.7%	1774
2016	110	-19.7%	455	-4.2%	1683
CAGR	**-2.3%**		**-0.4%**		**0.2%**

Source: StatsSa, QLFS 2016

Chapter 4: Itukise Monitoring and Evaluation

4.1. Introduction

The vision of **the dti** is "to create a dynamic industrial, globally competitive South African economy, characterised by inclusive growth and development, decent employment and equity, built on the full potential of all citizens". As reported by StatsSA in the National and Provincial Labour Market: Youth study, youth (aged 15 to 34) have over the last five years been marginalised within the South African workforce. These statistics show that the number of unemployed youth is almost double that of the adults, even though youth make up 55% of the workforce and adults 45%.

the dti has implemented initiatives such as the Itukise Internship for Unemployed Graduates to create opportunities for youth. Itukise is a graduate work placement programme aimed at providing relevant work experience to 1 200 unemployed graduates. Graduates in various fields were placed in 244 enterprises to gain work experience over a period of 12 months. Itukise also provided in-service training for those whose graduate programmes have the requirement of a practicum in order to obtain the qualification. The purpose of this study is to evaluate the success of the Itukise programme as well as areas where improvements can be made.

The first section of the report outlines the specific aims and objectives of the study as well as the methodology employed. This is followed by a review of similar international and national programmes, as well as input from participants in the programme, including host companies, mentors and interns. This data is then used to draw conclusions and recommendations, and provide an analysis of the strengths, weaknesses, opportunities and threats (SWOT) associated with Itukise.

4.2. Overview of Itukise

The Itukise programme aimed to provide relevant work experience to 1 200 unemployed graduates at eligible enterprises. Initially, this was only open to beneficiary enterprises of **the dti** incentives, but was then extended to include any eligible host company because of the diverse sectors in which the interns had to be placed. The provision of work experience placement focuses on increasing the employability of young graduates. The lack of relevant work experience has been identified as a key constraint to the employability of young unemployed graduates.

The programme had a national footprint. The envisaged composition of the interns was 70% unemployed graduates, 20% degree or diploma pre-graduates at Universities of Technology who required 12 months' work experience to graduate, and 10% students from FET Colleges who required a practicum for their tertiary programmes.

The programme's overall objective is to improve the employability of unemployed graduates through work experience placements in enterprises in support of the National Skills Development Strategy 3 (NSDS 3) and key government policies.

The NSDS 3 identifies the inadequate alignment between institutional and workplace learning, which results in low employability and workplace readiness of graduates from FET and HET institutions. Itukise aimed to bridge the gap through the provision of access to an employer network and the opportunity to improve work-readiness through real work experience.

4.3. Objectives and outcomes of the evaluation study

The terms of reference of the study identifies three objectives. In total, there are three objectives as well as six outcomes. Table 1 outlines how these objectives and outcomes tie together.

Table 1: Aims and objectives of study

OBJECTIVE OF THE STUDY		PROCESSES
1	To evaluate the relevance and impact of the programme on participating interns, in-service trainees and companies	To evaluate the overall relevance of the programme to the planned objectives of the project. This part of the assessment focuses on how relevant stakeholders and programme participants perceive the programme to be.
2	To evaluate the relevance and impact of the programme on participating interns, in-service trainees and companies	To evaluate stakeholder satisfaction – the views of the two main stakeholder groups, i.e. the participating companies (including mentors) and interns and in-service trainees must be canvassed to assess their experience of the operational aspects of the programme, such as 'ease of use', and the level of support provided to them by the project team, among other indicators
3	To propose recommendations for the improvement of the programme in the future	To evaluate the strengths and weaknesses of the programme and to make recommendations. This part of the report will include a SWOT analysis and feasibility recommendations.

4.4. Methodology

A mixed research methodology was used to achieve all the objectives outlined in Table 1.

The qualitative aspects of the research used were:

- meetings and discussion with the programme implementing partner (PIP),
- face-to-face interviews conducted with host enterprises, mentors and interns (both graduates as well as in-service trainees)

The quantitative aspects of the research were derived from the data collection phase of the evaluation, which entailed interviewing host enterprises, mentors and interns. Questionnaires were developed for each of these stakeholder groups.

4.4.1. Data collection

The data collected represents respondents that participated in the programme at both a company and intern level. A probability proportional to size sampling methodology was used (i.e. a sampling procedure whereby each unit in the universe has a probability of selection proportional to the size of some known relevant variable). In the case of establishments, size is usually defined in terms of employment or output, while in terms of populations, size can be determined by aspects such as race, gender and age. The basis for the proportionality was the geographic spread of the interns and the host enterprises. This was critical as it ensures that the study results may be used to estimate the views of all participants.

Both face-to-face and telephonic interviews took place. A sample size of 30% of the total interns and companies was agreed upon due to the fact that this was the first time that a study on the programme was being conducted. Fieldwork entailed contacting the 450 students and 56 companies preselected from the contact lists provided. However, many were either non-contactable (their contact details had changed) or chose not to participate in the interview process (in the case of companies, this group accounted for 65,3% of the entire population). For this reason, the sample sizes were increased:

- 100% of companies were contacted and 66 agreed to participate
- 94,4% of interns were contacted and 432 agreed to participate

Almost the entire population was contacted and so the study no longer employed a sample-based approach but rather a census approach. Table 2 shows the number of host enterprises per region, the number contacted and the

number that chose to participate in the interview process. Sixty-six companies agreed to be surveyed out of the total of 190.

Table 2: Host company sample breakdown by province

NUMBER OF HOST COMPANIES PER PROVINCE					
REGION	**PARTICIPANTS**	**ORIGINAL SAMPLE**	**TOTAL CONTACTED**	**TOTAL PARTICIPATED**	**% OF TOTAL PARTICIPANTS**
Gauteng	109	33	109	30	57,4%
Western Cape	16	5	16	5	8,4%
Eastern Cape	17	5	17	7	8,9%
KwaZulu-Natal	30	9	30	13	15,8%
North West	2	1	2	2	1,1%
Northern Cape	7	2	7	6	3,7%
Free State	3	1	3	1	1,6%
Mpumalanga	4	1	4	1	2,1%
Limpopo	2	1	2	1	1,1%
Total	190	57	190	66	100%

Table 3 details the number of interns per region as well as the number that agreed to participate in the interview process. In total, 1 451 interns that participated in the programme, of which 1 251 were contacted and 432 agreed to participate in the survey. Multiple efforts were made to contact respondents, however, 547 did not answer, 276 went to voicemail and 115 were the wrong number.

Table 3: Intern sample breakdown by province

NUMBER OF INTERNS PER PROVINCE						
PROVINCE	**INTERNS PER PROVINCE**	**ORIGINAL SAMPLE**	**TOTAL CONTACTED**	**TOTAL PARTICIPATED IN SURVEY**	**PROPTION OF SAMPLE**	**PROPORTION OF TOTAL POPULATION**
Eastern Cape	56	17	54	31	7,2%	2,2%
Free State	31	9	30	4	0,9%	>1%
Gauteng	920	276	883	264	61,1%	19%
KwaZulu-Natal	171	51	164	51	11,8%	3,7%
Limpopo	59	18	57	27	6,3%	1,9%
Mpumalanga	32	10	31	15	3,5%	1,1%
North West	31	9	30	4	0,9%	>1%
Northern Cape	29	9	28	10	2,3%	>1%
Western Cape	122	37	117	26	6%	1,9%
TOTAL	**1 451**	435	1 393	**432**	100%	31%

A total of 64 mentors were interviewed, with the majority (45,3% or 29) from Gauteng, followed by KwaZulu-Natal (20,3% or 13). These numbers correlated with the geographic spread of the companies.

4.4.2. Limitations

There were two limitations to the study. The first was with regard to making contact with host enterprises and interns. Five-hundred and forty-seven interns did not answer their phones, 276 telephone numbers went straight to voicemail and a further 115 were incorrect numbers. In addition, 132 companies chose not to participate in the survey process. As outlined in the methodology above, this limitation had two effects: Firstly, the normal sampling frame could not be used and so more time had to be spent on fieldwork as a census-based study was then implemented; and, secondly, the fact that these individuals and host enterprises chose not to participate means that the current results could possibly be skewed, i.e. with their input the outcomes of this report could change. The second limitation was with regard to the service provider. While the service provider did provide responses to the questions posed, it took more than two months for it to provide all the necessary information in order to complete the assessment. This delayed the delivery and completion of the project.

4.5. Literature review

4.5.1. Introduction

Unemployment in general and youth unemployment in particular constitute one of the major challenges facing South Africa at present. The unemployment rate stood at 26,4% at the end of 2015, with about two-thirds of all unemployed falling below the age of 35 years. Unemployed young people tend to be unskilled and inexperienced. Inexperience is a particular drag on employment prospects and can explain some of the implicit age discrimination in the labour market. With such high unemployment rates in South Africa, competition for employment is fierce among young adults. An important reason why unemployment is so high among the youth is that they struggle to gain work experience, which is an important indication of ability to potential employers. This could explain the large number of young South Africans who are unemployed or spend significant periods without a job following higher education.

Policies and programmes have been put in place to bridge the gap between school and work. These interventions are critical for improved skills development and entry into the labour market. The National Skills Development Strategy for South Africa has led to an increase in the use of internships as an effective approach to further the education and training of young adults, thereby enhancing their employability and career development. Through internship programmes, young adults who have gained theoretical knowledge from higher education institutions get an opportunity to enhance and develop these skills through vocational or practical training in the workplace, thereby giving effect to the notion of lifelong learning.

4.5.2. Transitioning graduates to the workplace

Training programmes are aimed at alleviating skills shortages in an economy. They are intended to enhance the productivity and employability of participants as well as human capital through the improvement of skills, while simultaneously fulfilling the needs of labour demand[3]. Internationally, these programmes are the most widely used labour-market intervention and are often split into those designed to develop basic skills necessary for job readiness (such as numeracy and literacy, language courses, basic computer courses) and sector- or industry-specific vocational training (including advanced computer courses or technical training).

Training interventions in other countries tend to be supported by the public sector and are often directly provided by government. Private-sector participation is also common, particularly in Latin America. Close cooperation and dialogue between the public and private sectors helps ensure that training needs are demand-driven.

3 National Treasury. 2011. A discussion paper on confronting youth employment. Available: http://www.treasury.gov.za (17 February 2012).

The most common of these training interventions is the internship, which is defined as a programme aimed at assisting students to bridge the gap between the academic world and the workplace in a practical and meaningful way[4]. Internships are aimed at providing students with workplace experience or an opportunity to practise the skills they have acquired through the education system. Scholars state that one objective of the internship programmes is to help the student bridge the gap between academic theory and practical application. The knowledge that interns gain at tertiary institutions only becomes valuable if they get the opportunity to apply that theory in actual practical situations because experience enriches the lessons students learned and grounds them in reality.

Internship programmes are supposed to be planned, structured and managed training projects that provide work experience for a specific timeframe. During the course of the training programme, a designated mentor is a prerequisite to support an intern's learning and nurture his or her development in the workplace[5]. According to scholars, intensive and rigorous mentoring and monitoring of interns is a critical factor for the success of a training programme.

4.5.3. Employer and intern perceptions of internships

In essence, while the obvious benefits for interns might be the enhancement of technical skills and career opportunities, the modern workplace also emphasises the importance of generic skills such as communication, quantitative analysis, problem-solving, information technology and the ability to work with others[6]. The lack of these generic work-attraction skills has been identified as one of the factors attributing to the high rate of unemployment among black graduates in South Africa.

Studies have revealed reduced payrolls due to cheaper labour (as the salaries of the interns are often subsidised by external organisations) and higher retention rates, since interns who are offered full-time positions stay at the companies for longer periods of time. Internships are therefore often seen as a "win-win" proposition. They play a role in providing organisations and prospective applicants with ample opportunities to get to know and impress each other in a more natural setting. It is also a screening process for both the intern and the organisation, allowing them to achieve a better match between the skills of the intern and the requirements of the workplace.

Internships are, however, not without their challenges. The most common challenges interns face are that work tasks can either be monotonous or the workload too little or too much. Interns complain about the lack of monitoring and supervision from mentors, the fear of asking questions, their work being overlooked and competitiveness between

4 Merrit, AD. 2005.Internships help students, CPA firms alike in tax season. Philadelphia Business Journal 39(57): 1 – 5.
5 Cord, B & Clement, M. 2010. Pathway for student self-development a learning oriented internship approach. Australian Journal of Adult learning. 50(2): 287 – 307.
6 National Youth Development Agency (NYDA). 2014. Final report on the internship baseline study 2013. NYDA.

interns. Moreover, internships, as is the case with temporary positions, tend to offer few or no benefits (since they are 'peripheral', they receive little commitment from the employer and less attention from organisational policies and programmes). Furthermore, their temporary status tends to be characterised by limited autonomy and decision-making, and less co-worker support as compared to permanent employees (NYDA, 2014).

4.5.4. Conclusion

The literature review has outlined the development and implementation of internship programmes as a strategy for promoting the inclusion of the youth in the economy of South Africa. It concludes that even though there are clear indications that the youth find it hard to be absorbed into the labour market, internships are a useful strategy that enhances and equips young graduates or those in the process of graduating with proper workplace experience so that they are able to find employment in their fields of expertise.

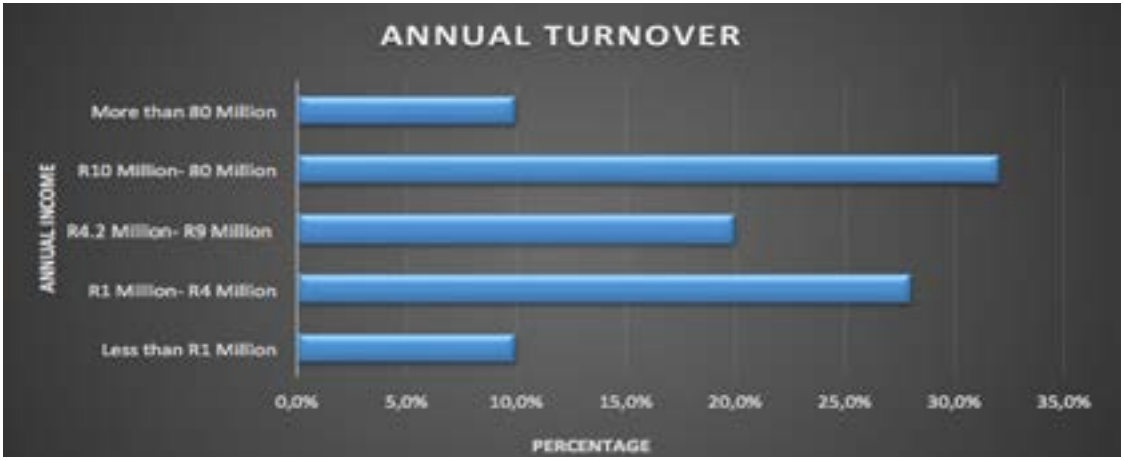
4.6. Host company, intern and mentor evaluation

4.6.1. Host company

4.6.1.1. Host company profile

The following section looks at the profile of host companies that participated in the Itukise programme. Host company representatives were asked to provide information regarding annual turnover and total number of employees for the last financial year.

Figure 1: Annual turnover profile of host enterprises



The data in Figure 1 above shows that 32% of host enterprises had an annual turnover of between R10 million and R80 million in the last financial, followed by 28% with an average turnover of between R1 million and R4 million. Only 10% of the surveyed host companies had an annual turnover of more than R80 million. No statistical link could be found between the size of the company and its ability to take on interns.

Figure 2: Enterprise size and share of employees

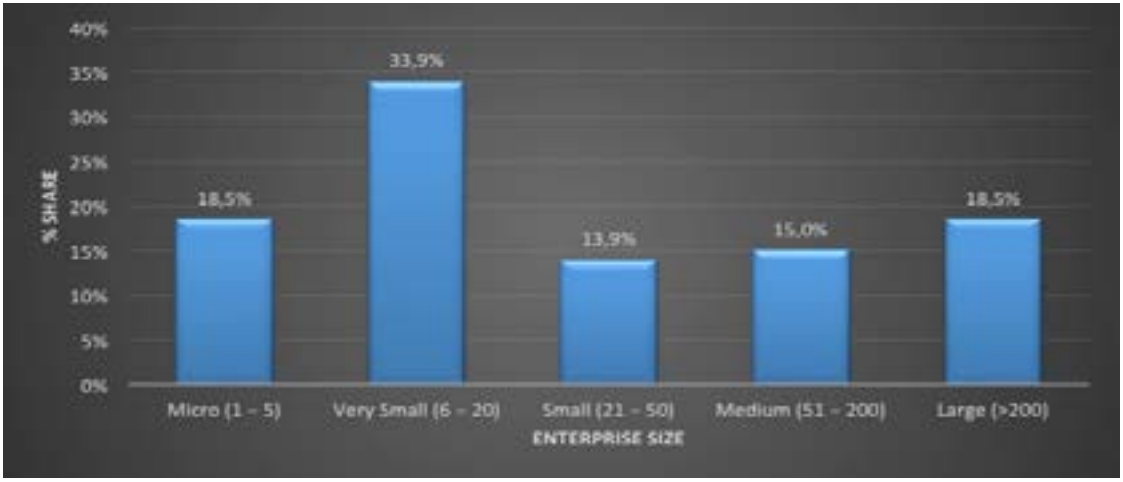


Figure 2 illustrates the employment categories of host companies, depending on their employment patterns over the last year. The majority of companies (33,9%) can be categorised as very small companies, employing between six and 20 workers, followed by micro companies (between one and five employees) and large companies (more than 200 employees). This shows that the Itukise programme attracted both large and small companies.

4.6.1.2. Programme experience

Respondents were asked to indicate whether their companies operated in-house training centres. Figure 3 shows the percentage, while Table 9 shows the number of years such facilities have been in operation. The results show that the majority of host companies (63,6%) do not operate in-house training centres, a potential reason for the low rates of graduate employment, since the existence of such centres would make it easier to ensure that new employees have the necessary skills.

Figure 3: Companies operating in-house training centres

Table 4 shows that 30,4% of the companies operating in-house training centres have done so for a period of between one and five years, followed by 26,1% for a period of between six and 10 years. Two companies reported that they had operated in-house training centres for between 56 and 60 years. Twenty-three companies that operate such facilities have decided to partner with Itukise.

Table 4: Number of years operating in-house training centre

IF YES, FOR HOW MANY YEARS?		
NUMBER OF YEARS	**NUMBER**	**PERCENTAGE**
1-5	7	30,4%
6-10	6	26,1%
11-15	2	8,7%
16-20	2	8,7%
21-25	1	4,4%
26-30	3	13,0%
56-60	2	8,7%
TOTAL	23	100,0%

Respondents were asked to indicate whether they had taken part in a graduate recruitment programme prior to Itukise: 31,3% had participated in prior programmes; 66,7% of these companies had participated between one and five times, three more than 25 times, and two between six and 10 times. Eighteen companies that operate graduate recruitment programmes have decided to partner with Itukise, indicating the importance of the project even for companies already doing similar activities.

Respondents were asked to indicate the number of interns the host companies had enrolled into the Itukise programme: 76,9% of the 65 companies took between one and five interns, followed by 10,8% taking in between six and 10. One of the companies indicated that it had 26 interns under the programme. In general, it was found that companies that already ran graduate recruitment programmes and were large in size took on more interns.

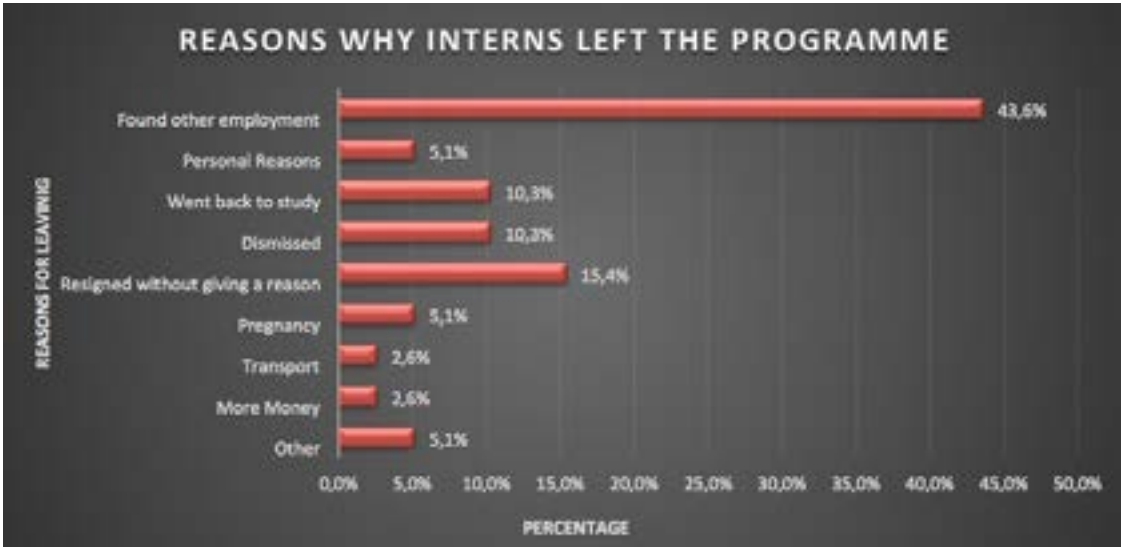
Respondents were asked to indicate the total number of interns that remained for the duration of the Itukise programme: Fifty-eight of the host companies indicated that 238 interns completed the programme; 34,5% reported that at least one of their interns completed the programme, while 25,9% indicated that at least two completed the programme. Two companies reported that a minimum of 19 interns completed the Itukise programme.

Figure 4 looks at the number of interns offered employment by the host companies following completion of the Itukise programme: 52,6% of the companies offered employment to at least one; 21,1% offered employment to at least two; and four companies offered employment to at least 10 interns.

Figure 4: Number of interns offered employment

Respondents were then asked to indicate the main reasons why some interns left the programme prematurely. Figure 5 illustrates that the majority of interns (43,6%) found employment elsewhere; 15,4% left without a reason; and 10,3% were either dismissed or went back to study.

Figure 5: Reasons why interns did not complete the Itukise Programme



Respondents were asked to indicate whether interns attended the Work Readiness Programme provided by Itukise: 69,4% reported that interns did participate, while 30,7% indicated that they had not.

Respondents were then asked to indicate whether host companies had organised an induction for the interns at the workplace: 96,9% had done so, while 3% had not. The majority of those companies that offered induction (84,1%) conducted the induction within the first fortnight of the programme, while 14,3% did so within the first month of the programme.

This section of the report focuses on the types of training in which interns participated during the programme. The data illustrates that approximately 84% of the interns were offered the opportunity to attend workshops, training or courses during the programme.

More than half of the respondents (54,7%) indicated that host companies offered interns on-the-job training, as shown in Table 5. Other host companies registered their interns for formal SAQA-accredited courses (16%) and external workshops (16%). Approximately 11% of the host companies provided internal workshops. These results tie in with the earlier results showing that only one-third of the companies ran in-house training programmes, i.e. the majority of companies only provided on-the-job training.

Table 5: Nature of the training

NATURE OF THE TRAINING	NUMBER	PERCENTAGE
Formal SAQA-accredited courses	9	17,0%
External (outside of the company) workshops	9	17,0%
Internal (inside of the company) workshops	6	11,3%
On-the-job training	29	54,7%
TOTAL	53	100,0%

Respondents were asked to indicate whether their respective host companies had participated in graduate recruitment programmes prior to Itukise. The majority (77,3%) had not, while 22,7% had participated. Host companies that had participated in such programmes were then asked to indicate whether the Itukise programme was kept separate from their normal graduate programme. Twelve of the 13 companies that responded stated that the programmes were kept separate, while one indicated that Itukise was consolidated into its in-house graduate programme. This finding goes against the required outputs of the service-level agreement between Deloitte and **the dti**, and further comment on this is provided later in the report.

4.6.2. Mentor report

The following section outlines the input provided by mentors appointed by host companies. In many instances, these individuals were different from the company representative who provided the information in the previous section. In the case where they were not, the individual was required to answer both questionnaires. A total of 64 mentors were surveyed in various companies across South Africa's nine provinces. Mentors were contacted using a database of 190 companies received from **the dti**. The majority of mentors surveyed were from Gauteng (45,3%), followed by KwaZulu-Natal (20,3%). While efforts were made to contact all host company mentors, not all were available to participate in the evaluation process.

4.6.2.1. Programme experience

The first section looks at the overall details of the Itukise Internship Programme from the perspective of the mentors. The section starts by looking at the number of interns allocated to each mentor, followed by the number of interns that remained throughout the duration of the programme, as well as the number of interns that were offered employment by host companies following completion of the programme.

The majority of mentors (45,3%) had one intern to mentor, while 26,6% mentored more than two. Four reported they had more than seven interns to mentor, one of which mentored 19 during the programme.

Approximately 40% of the mentors reported that at least one of their interns completed the programme; 19,4% indicated that at least two of their interns completed the programme. It is pleasing to note that the 19 interns allocated to the one mentor mentioned above all completed the programme. Eight mentors (12,9%) reported that none of their interns completed the programme.

Figure 6 illustrates the number of interns offered employment by host companies following the completion of the Itukise programme. Twenty-two mentors (39,3%) indicated that none of the interns were offered employment by host companies, while 32,1% indicated that at least one was offered employment. Four mentors reported that employment was offered to at least 10 interns at each company, while the company with the 19 interns mentioned above offered employment to all 19.

Figure 6: Number of interns offered employment by host companies

4.6.2.2. Induction and training

In this section, mentors were asked to comment on the type of induction and the nature of training interns received for the duration of the Itukise Programme. Mentors were asked to indicate whether interns had participated in the Work Readiness Programme offered by Itukise, and whether induction had been organised in the first two weeks, first month or within two months of the enrolment of the interns into the programme.

The majority of the mentors (76,7%) indicated that their interns had attended the Work Readiness Programme, while 23,3% said they had not. This is in line with the findings in the host company section above and will be further ratified in the intern section that appears later in the report.

Respondents were asked about the number of interns offered induction by the host companies: 93,8% of the mentors reported that their interns had been provided induction, while 6,2% said their interns had not.

4.6.2.3. Mentor experience

Respondents were asked to indicate whether this was their first time mentoring interns and, if not, the number of years or months that they had acted as mentors prior to the Itukise programme: 50,8% indicated that they did not have prior experience, while 49,2% had mentored before.

4.6.2.4. Levels of satisfaction

The last section of the report looks at the overall satisfaction levels of mentors in terms of both the quality of interns received by host companies and the Itukise programme as a whole. Mentors were required to rate the interns and the programme on a scale of one to four, with one being “strongly disagree” and four “strongly agree”.

The mentors all agreed that they had a clear understanding of the role the interns had to play in the host company; 95,3% agreed that the Itukise programme should continue; and 93,5% agreed that the programme was effective in providing interns with the necessary work experience.

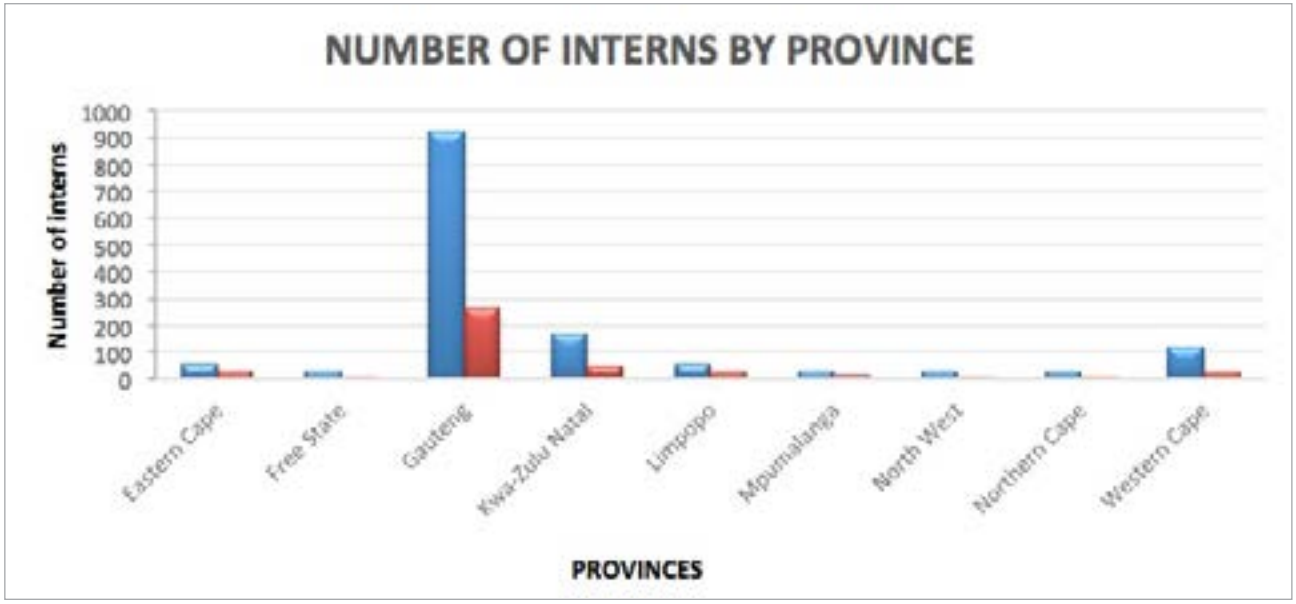
The following results emerged with regard to their interaction with Deloitte: 94,7% of the mentors agreed that communication was good; 89,7% were satisfied with the quality of services received; 30,4% disagreed that Deloitte had provided adequate resources (such as manuals and information) during implementation

of the project; and 16,7% disagreed that Deloitte had provided the necessary administrative support during the course of the programme. These findings are in line with the results from company representatives and point to problems around stipend payments.

4.6.3. Intern report

The final part of this section assesses the input provided by the interns who participated in the programme. A total of 432 interns were surveyed from various host companies across South Africa's nine provinces. Interns were contacted using a database of 1 451 contacts received from **the dti.** The majority of interns surveyed were from Gauteng (61,1%), followed by KwaZulu-Natal with 11,8% and the Eastern Cape with 7,2% (as shown in Figure 7). Efforts were made to contact all interns, but not all were available to participate in the evaluation process.

Figure 7: Sample breakdown by province



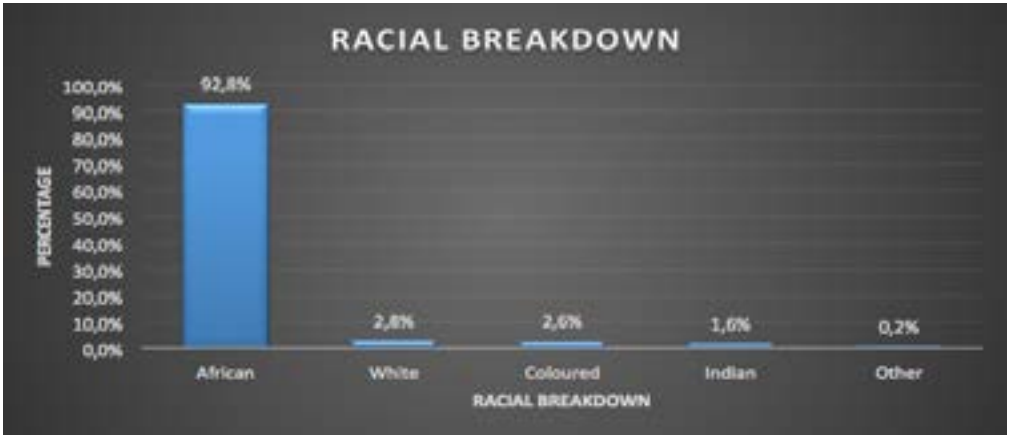
4.6.3.1. Intern details

The first section looks at the overall demographics and education levels of the respondents. Respondents were asked to indicate their gender, racial group and age, level of education, the type of higher education institutions they attended, and areas of specialisation.

4.6.3.1.1. Demographics

The data illustrates that 51,9% of the respondents were female and 48,1% male. Figure 8 shows the racial breakdown of interns surveyed: 92,8% classified themselves as African, 2,8% white and 2,6% coloured. The least represented racial groups were Indians (1,6%) and those classified as Other (0,2%).

Figure 8: Racial breakdown



The majority of respondents (90%) that participated in the internship programme were between the ages of 22 and 30, 19,2% of which were 25 this year and 16,9% 24. These findings reinforce the need for programmes such as Itukise since it is clear that young graduates are finding it difficult to gain employment.

4.6.3.1.2. Higher education

Interns were asked to indicate which higher education institution/university they attended, as well as their highest level of qualification achieved and area of specialisation.

Table 6 provides an outline of institutions attended by respondents. Higher education institutions were classified as college, university of technology and university. The findings show that 36,8% of the respondents obtained their qualifications from a university of technology, 35,4% from a university and 27,8% from a college. Interns were therefore drawn from various skills pools and hence the problem of youth unemployment cuts across all types of higher education institutions.

Table 6: Type of higher education institution

HIGHER EDUCATION INSTITUTION	NUMBER	PERCENTAGE
College	121	27,8%
University of Technology	160	36,8%
University	154	35,4%
TOTAL	435	**100,0%**

Table 7 shows that more than 50% of the Itukise interns who participated in the evaluation process held a diploma, followed by 33,3% with a degree. Only 2,1% had obtained a post-graduate qualification (Honours).

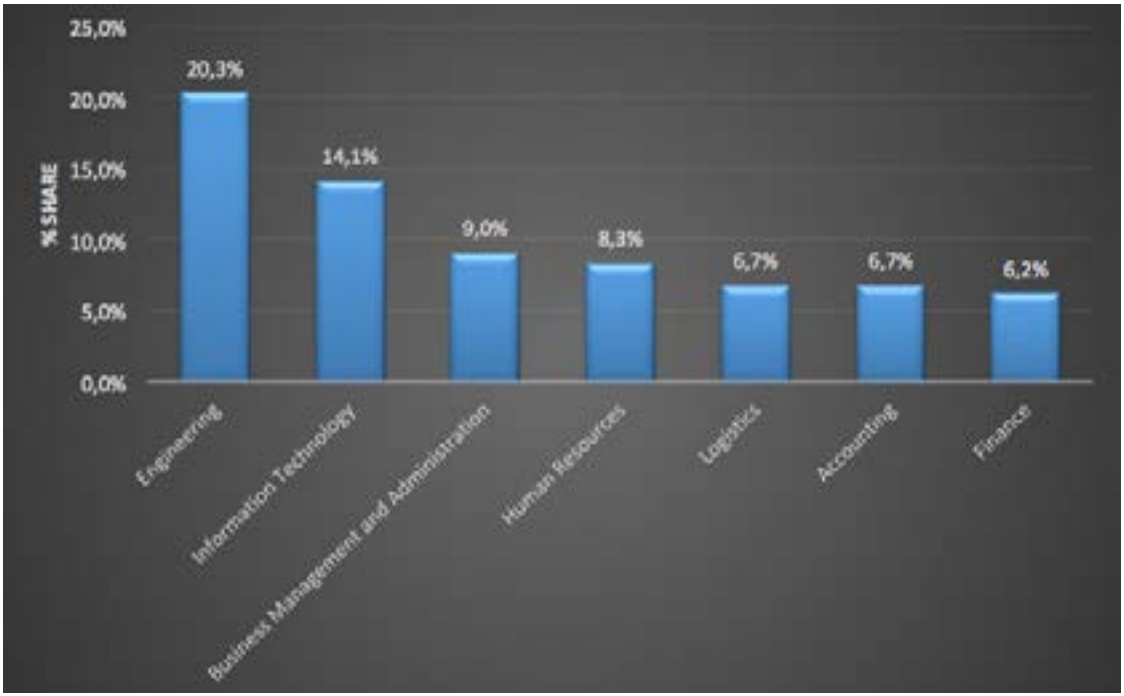
Table 7: Highest completed qualification

QUALIFICATION	NUMBER	PERCENTAGE
Certificate	53	12,2%
Diploma	228	52,4%
Degree	145	33,3%
Honours	9	2,1%
TOTAL	435	**100,0%**

Figure 9 provides a detailed outline of the qualification type that interns studied towards at higher education level. The majority of interns (20,3%) specialised in the field of Engineering. Of the 88 interns with an engineering qualification, 37 specialised in Electrical Engineering, 11 in Metallurgical Engineering, 10 in Mechanical Engineering and the rest in unspecified engineering fields. Of the interns in the study, 14,1% specialised in Information Technology (IT) and 8,3% had a qualification in Human Resources (HR). These qualifications were in the form of degrees and diplomas.

As noted earlier, these findings reinforce the need for programmes such as Itukise since it is clear from the results that young graduates are finding it difficult to find employment, irrespective of their area of specialisation and type of qualification. It is also clear that interns have skills that span various sectors, indicating that the problem of youth unemployment cuts across qualifications from all types of higher education institutions.

Figure 9: Areas of specialisation



4.6.3.2. Programme experience

The section looks at the type of induction processes followed by host companies and the implementing agent (Deloitte) to facilitate the introduction of interns into the workplace. The report goes on to outline the types of training received by interns during the programme, including opportunities such as formal SAQA-accredited courses, external and internal workshops, and formal non-accredited courses that may have been provided by host companies.

Respondents were asked to indicate whether they attended the Work Readiness Programme provided by Itukise to facilitate their introduction into the workplace. Approximately 60% of the respondents attended the programme, while the remaining 40% indicated that they were not aware of such training.

The data shows that 36,5% of the interns who attended the Work Readiness Programme indicated that they did so after two months of placement, while 28,6% attended within the first month of placement in the

Itukise programme. Approximately 17% of the interns indicated that the Work Readiness Programme was conducted within the first two weeks of their placement. Ninety-one per cent of the interns that attended the programme found it useful.

Interns were asked to indicate whether their respective host companies conducted an induction workshop at the workplace. The majority (72,5%) indicated that their host companies had done so, while the remaining 27,5% indicated that they were not offered induction training. Similar to the results regarding the Work Readiness Programme, a pleasing proportion of the interns (93,4%) found the induction workshops to be useful.

Table 8: Was the induction useful?

WAS THE INDUCTION USEFUL?	NUMBER	PERCENTAGE
Yes	267	93,4%
No	19	6,6%
TOTAL	286	**100,0%**

Interns were asked if their host companies provided them with ongoing training during the course of the internship: 58,1% reported that they were, while 41,9% said they did not receive such training. These results are in line with earlier results that indicated that majority of companies did not have a formal training process and hence most of the training that took place was on-the-job.

Of the interns that received ongoing training, 34,8% received “on-the-job training, while 23,4% received training in formal SAQA-accredited courses, 20,3% attended internal workshops, and 9% attended external workshops (as shown in figure 10).

Figure 10: Type of training provided

4.6.3.3. Performance management and support

This section looks at mentors assigned to interns, and the interns' level of satisfaction with the mentors assigned to them. It further looks at whether interns were provided with performance agreements to plan and manage their progress during the course of the programme.

Approximately 84% of the interns were assigned mentors, while 16% were not. This is in line with earlier findings where companies indicated that not all interns received mentors.

The data shows that a satisfactory number of interns who were assigned mentors (95.4%) indicated that they had good working relationships with their mentors. In addition, 93,4% of the interns that indicated that mentors were available to answer questions; 90,4% indicated that mentors provided them with the necessary skills to work effectively in their respective jobs. This shows the relevance of Itukise and the need to grow the programme into the future.

Respondents were asked to indicate whether an agreement was used to plan and manage their performance: 58,6% indicated that their performance was monitored using a performance agreement, while 41,4% had no such agreement. This is in line with earlier findings, which indicated that more than 40% of interns were not formally assessed.

Interns were asked if their host companies had given them the necessary soft infrastructure, which refers to aspects such as computer programs and project information that the intern would need to fulfil their daily tasks. Approximately 80% answered in the affirmative, while 20% said they had not. This would vary from job to job. This finding once again speaks to the service provider's (that is, Deloitte) ability to track the requirements of the service-level agreement, i.e. all companies had to be assessed to ensure that the necessary soft and hard infrastructure were in place.

Approximately 82% of the interns said they had been provided with the necessary hard infrastructure to conduct their work, while 18% said they had not. Hard infrastructure refers to the tools and equipment the intern would require in order to fulfil their job requirements.

4.6.3.4. Skills development

Interns were asked to rate their skills before and after participation in the Itukise programme on a scale of one to 10, one being 'poor" and 10 "excellent".

Table 9 below provides the results post participation in the programme. Adaptability and flexibility was the highest rated skill, with 94,2% rating it between six and 10. It is satisfactory that approximately 93% of the interns rated their level of skills in interpersonal relations, time management, critical thinking/problem solving, and positive attitude and energy between six and 10. Positive attitude and energy was rated as excellent by 45,9% of the interns, while 90% rated computer and technical literacy, and decision-making between six and 10. Overall, all the skills were rated above 85%.

Table 9: Skills after the internship programme

POOR													EXCELLENT							
Rating	1	%	2	%	3	%	4	%	5	%	6	%	7	%	8	%	9	%	10	%
Effective Communication	6	1,4	1	0,2	6	1,4	9	2,1	25	5,8	19	4,4	62	14,3	141	32,5	75	17,3	90	20,7
Effective Reporting	11	2,5	2	0,5	9	2,1	14	3,2	21	4,8	23	5,3	78	18,0	109	25,1	76	17,5	91	21,0
Computer and Technical Literacy	12	2,8	1	0,2	5	1,2	7	1,6	17	3,9	11	2,5	40	9,2	93	21,4	87	20,1	161	37,1
Interpersonal Relations	5	1,2	0	0,0	4	0,9	7	1,6	14	3,2	21	4,9	63	14,6	111	25,6	100	23,1	108	24,9
Time Management	4	0,9	0	0,0	2	0,5	4	0,9	20	4,6	20	4,6	54	12,4	94	21,7	78	18,0	158	36,4
Critical Thinking/ Problem Solving	7	1,6	1	0,2	3	0,7	7	1,6	10	2,3	20	4,6	55	12,7	120	27,7	106	24,4	105	24,2
Work Experience	10	2,3	6	1,4	6	1,4	15	3,5	27	6,2	31	7,1	53	12,2	71	16,4	88	20,3	127	29,3
Work Readiness	11	2,5	1	0,2	4	0,9	11	2,5	18	4,2	20	4,6	41	9,5	99	22,8	88	20,3	141	32,5
Decision Making	7	1,6	2	0,5	3	0,7	9	2,1	15	3,5	15	3,5	60	13,8	122	28,1	106	24,4	95	21,9
Positive Attitude and Energy	5	1,2	0	0,0	1	0,2	8	1,8	13	3,0	10	2,3	40	9,2	67	15,4	91	21,0	199	45,9
Adaptability and Flexibility	4	0,9	0	0,0	3	0,7	6	1,4	12	2,8	9	2,1	44	10,2	94	21,7	114	26,3	147	34.00

Table 10: Skills before the internship programme

POOR	EXCELLENT																			
Rating	1	%	2	%	3	%	4	%	5	%	6	%	7	%	8	%	9	%	10	%
Effective Communication	10	2,3	6	1,4	16	3,7	43	9,9	113	26,0	64	14,7	66	15,2	51	11,7	23	5,3	43	9,9
Effective Reporting	19	4,4	10	2,3	22	5,1	43	10,0	78	18,0	76	17,5	60	13,8	48	11,1	32	7,4	46	10,6
Computer and Technical Literacy	8	1,8	6	1,3	8	1,8	15	3,5	45	10,3	55	12,6	70	16,1	90	20,7	37	8,5	101	23,2
Interpersonal Relations	4	0,9	6	1,4	5	1,2	25	5,8	76	17,5	79	18,2	81	18,6	71	16,3	40	9,2	48	11,0
Time Management	2	0,5	8	1,8	16	3,7	31	7,1	60	13,8	51	11,7	72	16,6	60	13,8	44	10,1	91	20,9
Critical Thinking/ Problem Solving	4	0,9	6	1,4	5	1,2	19	4,4	53	12,2	69	15,9	84	19,3	94	21,6	58	13,3	43	9,9
Work Experience	66	15,2	23	5,3	29	6,7	51	11,7	86	19,8	50	11,5	39	9,0	32	7,4	26	6,0	33	7,6
Work Readiness	25	5,8	18	4,2	22	5,1	65	15,0	80	18,4	48	11,1	50	11,5	50	11,5	26	6,0	50	11,5
Decision Making	3	0,7	7	1,6	17	3,9	29	6,7	62	14,3	70	16,1	78	17,9	83	19,1	40	9,2	46	10,6
Positive Attitude and Energy	3	0,7	3	0,7	5	1,2	19	4,4	37	8,5	41	9,4	71	16,3	82	18,9	55	12,6	119	27,4
Adaptability and Flexibility	2	0,5	5	1,2	7	1,6	17	3,9	50	11,5	54	12,4	77	17,7	95	21,8	48	11,0	80	18,4

Table 10, on the other hand, looks at the skills interns had when they came into the programme. Overall, interns have shown significant development in all the listed skills during the course of the programme. More than 90% ated their skills in computer and technical literacy, critical thinking, positive attitude and energy, and adaptability and flexibility as having significantly improved after the completion of Itukise. Approximately 80% rated these skills at 60% pre-Itukise and close to 100% post-Itukise. Similarly, approximately 73% rated their skills in interpersonal relations, time management and decision-making below 50% pre-Itukise and at more than 85% post-Itukise.

4.6.3.5. Exposure to the field of work and employment opportunities

Table 11 shows the number of interns working in positions in line with their qualifications and indicates whether this was relevant to their areas of expertise: 76,3% said they worked in positions in line with their qualification, approximately 90% of which believed the positions to be relevant to their areas of expertise.

Table 11: Working in a position in line with qualification

WORKING IN A POSITION IN LINE WITH QUALIFICATION	Number	%
Yes	332	76.3
No	103	23.7
TOTAL	435	100.0
IF YES, DO YOU FEEL THIS WAS RELEVANT TO YOUR AREA OF EXPERTISE		
Yes	298	90.6
No	31	9.4
TOTAL	329	100.0

Respondents were asked whether they had to submit reports to mentors/supervisors and how often: 71,8% indicated that they had to submit reports, 42,7% on a monthly basis and 40,6% on a weekly basis.

Table 12 looks at the current employment status of the interns who participated in the programme as well as the number employed by their host companies. Approximately 57% of interns indicated they were currently employed. Fifty-five per cent of those that found employment were absorbed by their host companies. It was found that 81,3% are employed within their fields of study. This is a significant finding since similar international examples only reported figures as high as 72%.

Table 12: Intern placement after the internship

CURRENTLY EMPLOYED	NUMBER	%
Yes	249	57.4
No	185	42.6
TOTAL	434	100.0
IS IT WITH YOUR HOST COMPANY		
Yes	132	55.0
No	108	45.0
TOTAL	240	100.0
IS IT IN YOUR FIELD OF STUDY		
Yes	187	81.3
No	43	18.7
TOTAL	230	100.0

Table 13 provides results in respect of the 42,6% of interns who indicated they were unemployed. Of these, 26,4% were employed immediately upon completion of the programme, but became unemployed when their contracts ended and hence fall into this category. The remaining 73,6% had not been able to find any employment. Of the 42,6% currently unemployed, 50,9% indicated that they had attended between four and six interviews, while 29,6% attended between zero and three. This ties to the recommendation later in the report that a job portal be developed to help interns find potential job opportunities.

Table 13: Employment following the programme

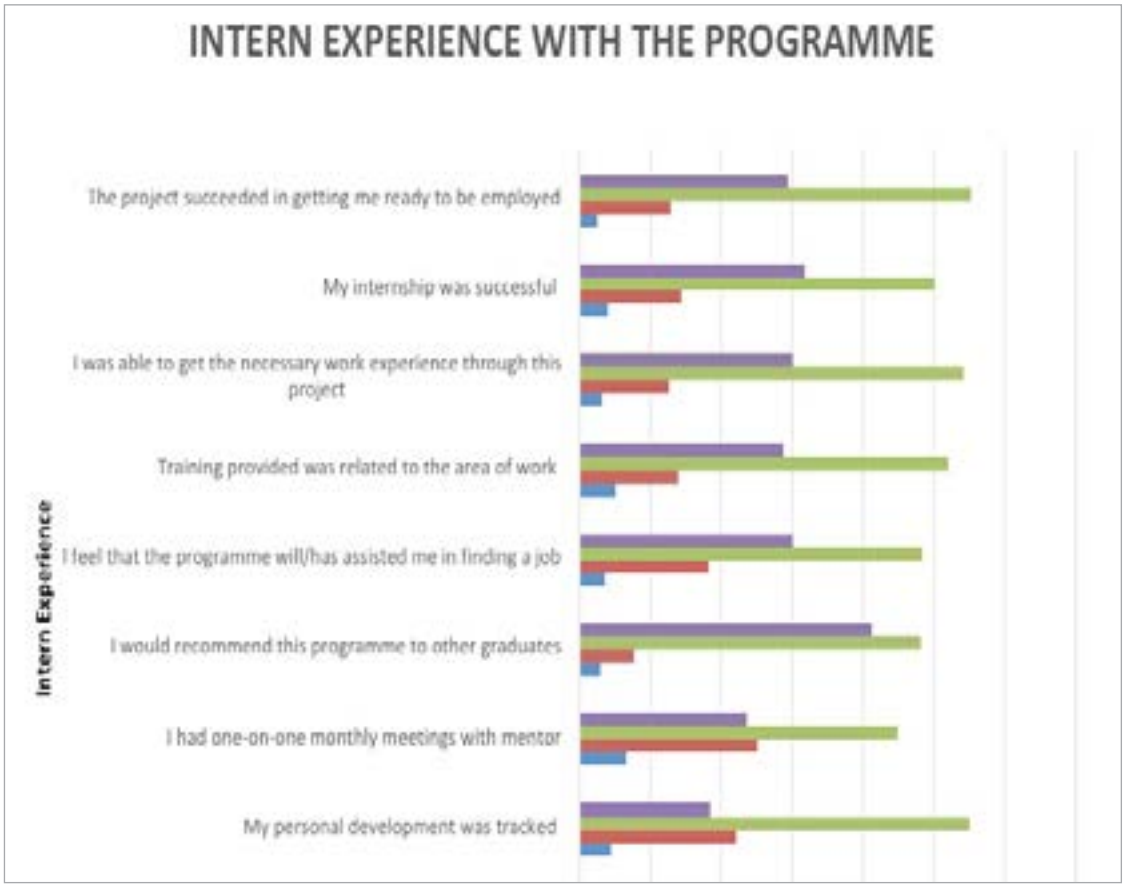
HAVE YOU BEEN EMPLOYED AT ALL AFTER THE COMPLETION OF ITUKISE?	NUMBER	%
Yes	48	26.4
No	134	73.6
Total	182	100.0
HOW MANY INTERVIEWS HAVE YOU ATTENDED SINCE COMPLETING ITUKISE?		
0-3	47	29.6%
4-6	81	50.9%
7-9	20	12.6%
10-12	11	6.9%

4.6.3.6. Overall perception of the programme

This last section of the study looks at the overall perception of the interns towards the Itukise programme. Interns were asked to rate the various aspects of the programme, including project administration, personal development, and the success of the project in preparing interns for the workplace. Interns were further asked to comment on why some left the internship prematurely and what areas of the project could be improved.

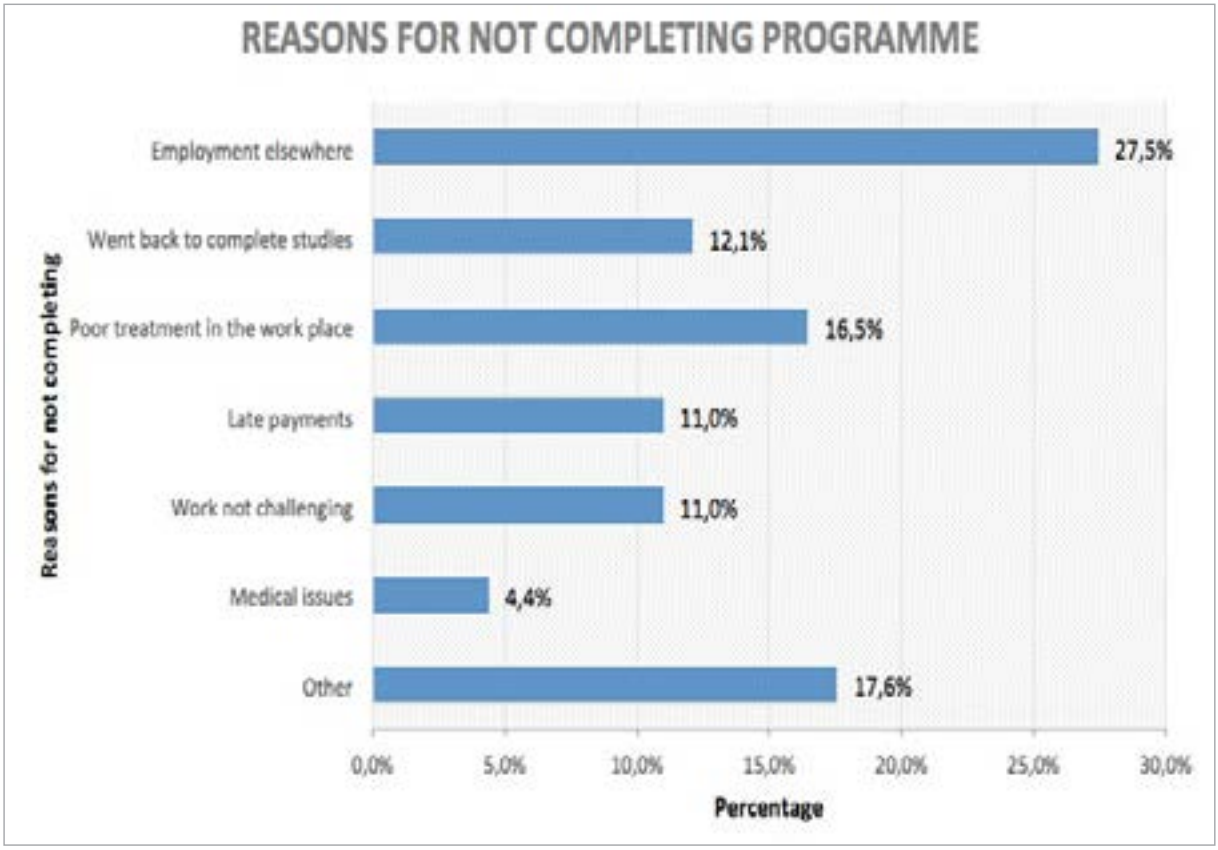
Interns were asked to rate various aspects of the programme using the scale “Strongly Disagree” to “Strongly Agree”. Figure 11 shows that 89,35% of the interns indicated that they would recommend the programme to other graduates. Approximately 84% agreed that the programme helped them gain the necessary work experience and succeeded in preparing them for employment, while 81% indicated that the project administration was good and the internship was an overall success. The lowest rated aspects of the project were stipend payment and meetings, with 32,3% saying they did not receive their stipends on time and 31,6% indicating that they did not have one-on-one monthly meetings with their mentors.

Figure 11: Overall intern experience



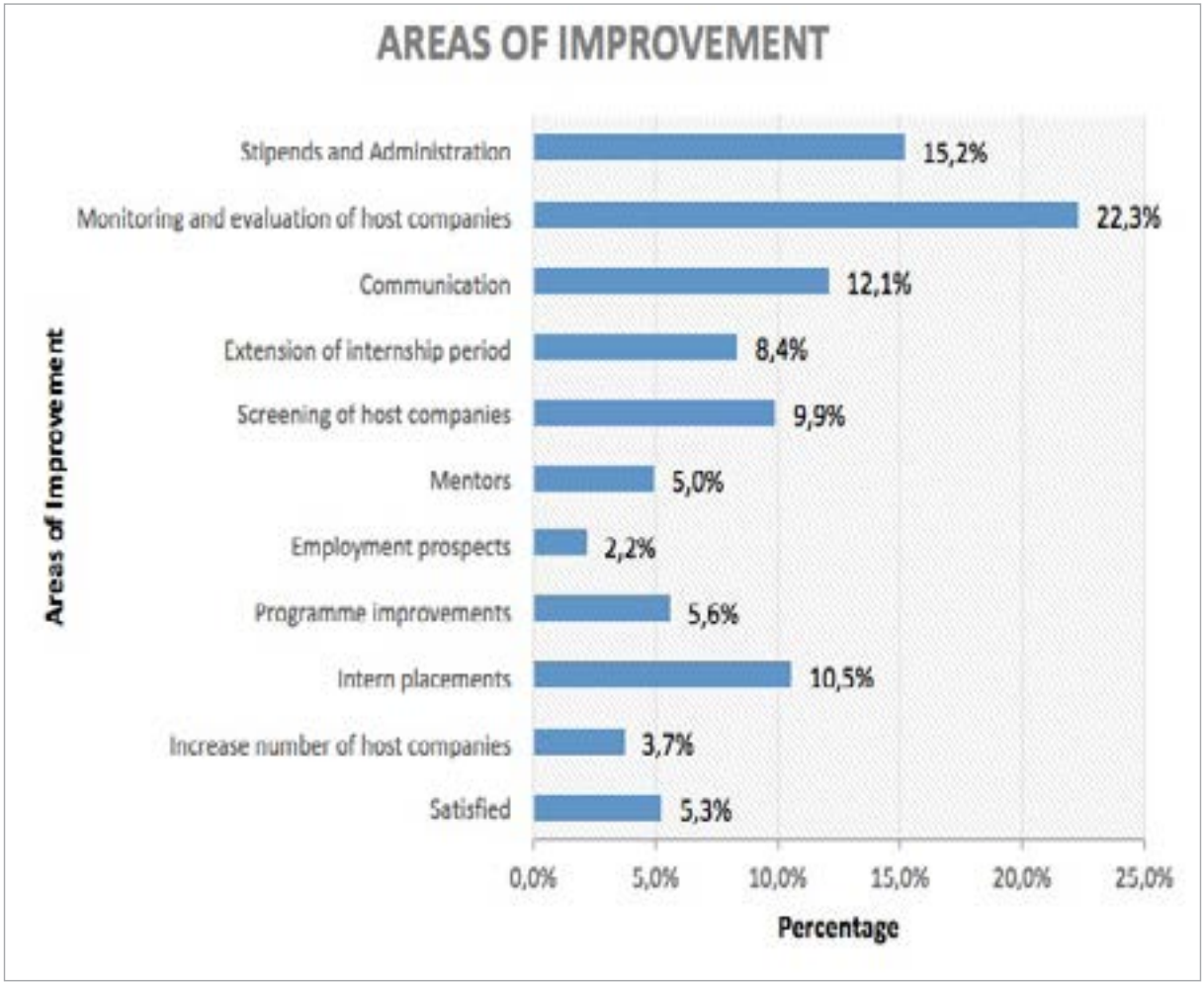
Interns who did not complete the programme were asked as to why they departed prematurely. Figure 12 shows that approximately 30% were offered employment elsewhere, 17,6% left for reasons they did not wish to disclose, 16,5% due to poor treatment from host companies, and 11% because of the late payment of stipends. This aligns with the results in the host company survey.

Figure 12: Reasons for non-completion



Interns were asked to give their input as to how the Itukise programme could be improved. Figure 13 shows that 325 interns chose to comment on this section. Of these, 22,3% highlighted the need for more monitoring and evaluation in host companies, 15,2% improved stipend payment and project administration, 12% better communication between the implementing agent and interns, and 10,5% improvements in the intern placement process.

Figure 13: Areas of improvement



4.7. Conclusions, recommendations and swot analysis

The conclusions and recommendations have been structured around each of the aims and objectives of the project. The information presented in the preceding sections has been used to develop a SWOT analysis (Point 4).

4.7.1. To evaluate:

- the relevance and impact of the programme on participating interns, in-service trainees and companies.
- To evaluate the overall relevance of the programme to the planned objectives of the project – this part of the assessment focuses on how relevant the programme is perceived to be by the stakeholders and programme participants.

Findings: The following key results emerged from the interviews conducted with the host companies, mentors and interns:

- When asked if the programme provided the interns with the necessary work experience:
  - 93,6% of host companies agreed (65,9% strongly);
  - 93,5% of mentors agreed; and
  - 84,1% of interns agreed.
- 87,5% of host companies and 89,1% of mentors agreed with the recommendation that companies employ interns at conclusion of the programme, provided they have the means to do so.
- 84,7% of interns agreed that the programme was successful in that it prepared them for employment.
- 78,3% of the interns agreed that the programme had been successful in helping them find employment.
- 68,4% of interns were employed directly following Itukise, with the current employment rate sitting at 57,4%. This was calculated by asking interns if they were employed directly following Itukise and if they were currently employed. The employment rate was then calculated by taking the number that answered positively out of the total number that responded to the question.
  - 55% of these interns are employed in their host companies; and
  - 45% in other companies.

These results show that the project has met its target of relevance and all stakeholders have indicated that they perceive the benefit in the project. It bodes well because it shows that stakeholders see value in the project and are likely to continue to support it.

Recommendation: The results across all the stakeholder groups were very positive and should be used as a benchmark going forward. It is recommended that **the dti,** in conjunction with the service provider, setup a graduate portal that can be accessed by recruiters and companies looking to employ staff. This will assist interns who could not be employed once completing the programme.

4.7.2. To evaluate:

- the relevance and impact of the programme on participating interns, in-service trainees and companies.
- To evaluate stakeholder satisfaction: The views of the two main stakeholder groups, i.e. the participating companies (including mentors) and interns and in-service trainees must be canvassed to assess their experience of the operational aspects of the programme, such as 'ease of use', and the level of support provided by the project team, among other indicators.

Findings: The following results emerged from the analyses:

- 98,5% of host companies and 89,2% of mentors agreed that the Itukise programme should continue (a proxy for satisfaction).
- 81,71% of interns agreed that their internship was successful.
- In terms of operational aspects of the project the following can be reported:
  - 84,4% of host companies and 85,9% of mentors agreed that adequate guidance was provided by Deloitte in programme implementation.
  - 57,2% of host companies agreed that stipend payments were made on time, while 11% of interns who left the programme said they did so due to the late payments of stipends.
  - Interns indicated the following:
    - 68,4% had weekly access to their mentors (one-on-one meetings);
    - 73,4% indicated that their personal development was tracked; and
    - 67,7% indicated that their stipends were paid on time.

Recommendations: These results, as in the last case, can be used as a benchmark for future evaluations. However, areas that require improvement include intern support and the payment of stipends.

- **the dti,** in conjunction with the service provider, should develop a manual for distribution to companies and mentors. This will ensure that the necessary one-on-one meetings take place and the personal development of interns is tracked. This can be combined with a quarterly satisfaction survey to assess where interns require further support.
- There needs to be a clear system for the payment of stipends. Host companies indicated that **the dti** had not assisted in this regard. The service provider had indicated to host companies that the delay in stipend payments was due to a delay in processes within **the dti,** which was not the case.

4.7.3. - To propose recommendations for the improvement of the programme in the future.

- To evaluate the strengths and weaknesses of the programme and make recommendations. This part of the report will include a SWOT analysis and feasibility recommendations.

Strengths

- All stakeholders agree that the programme is relevant and should continue.
  - When interns were asked if the programme was successful in assisting them to find a job, 78,3% agreed.
  - 68,4% of interns were employed directly following Itukise, with the current employment rate sitting at 57,4%. These levels of employment were also achieved in a macro-economic environment of low GDP/job growth in South Africa.
  - 84,7% of interns agreed that the programme had succeeded in getting them ready for employment.
- The first phase of the programme has been implemented effectively and met the necessary aims and objectives.
- The database of interns and host companies can be used in the future.
- The outcomes of the Itukise programme are on par with and in some cases better than other First World internship programmes. For example, the following results emerged form a Finnish programme:
  - 75% of interns who completed the Finnish programme found employment, while Itukise registered 68,44% employment directly after completion;
  - 72% of the Finnish interns found work that matched their qualifications, while 81,3% of Itukise interns indicated that they had found employment in fields that matched their qualifications;
  - 93% of Finnish interns and 84,7% of Itukise interns believed they were more employable following completion of the respective programmes; and more than 90% of interns indicated that their skills levels had improved.

Weaknesses

- Administrative weaknesses identified during the research include:
  - 68,4% of interns indicated that they had weekly access to their mentors (one-on-one meetings), 73,4% that their personal development was tracked, and 67,7% that their stipends were paid on time.
  - 42,8% of host companies indicated that the stipends were not paid on time.
  - 30,4% of mentors felt that they needed further assistance during implementation.
  - 41% of interns indicated that they had not attended the Work Readiness Programme.
  - The current database on interns and host companies is not up to date.
- 31,6% of interns did not find employment directly after Itukise (currently 42,6% unemployed).
  - **the dti** Project Manager noted the following:
    - communication with interns and host company representatives must be improved;
    - recruitment process must be improved;
    - better database management of intern details is required; and
    - better communication between the service provider and **the dti** is essential.

Opportunities

- Expansion of the programme to other provinces. It should be noted that while the programme was implemented across the country, the majority of host companies (57%) and interns (63%) were based in Gauteng.
- Development of a portal for unemployed interns and companies looking to hire staff.
- Assist both companies and mentors to develop an in-house graduate recruitment programme (currently only present in large companies).
- The development of online mentorship and intern courses (also known as MOOKS or massive online courses). These courses need to be taken by all mentors and interns who participate in the programme. This ensures that the necessary standards are maintained.

Threats

- Poor database management means that interns and companies cannot be tracked and assessed. This means that the outcomes of this report could change significantly with their input.

- Stagnant or marginal economic growth means fewer jobs are created in an economy where there is already high unemployment.
- The current IT system on which programmatic information is captured and run belongs to the service provider. This means that if **the dti** needs to access information or run analyses, it is dependent on the service provider. It is recommended that **the dti** use a system owned by **the dti** to mitigate this risk. A potential solution would be to develop an open-source system that would allow for further cost-effective development to take place.

4.8. Concluding Remarks

The main aim of the Itukise programme was to provide graduates and in-service trainees with work experience. This was done in the hope that these interns would then be able to find jobs and become active participants in the current economy. Overall, it is pleasing to note that the project was able to achieve this objective despite the fact that the economic environment was not conducive. It is also pleasing to note that the programme compares favourably with similar First World programmes and has clearly assisted interns in developing their skills and employability.

Notes

Notes

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