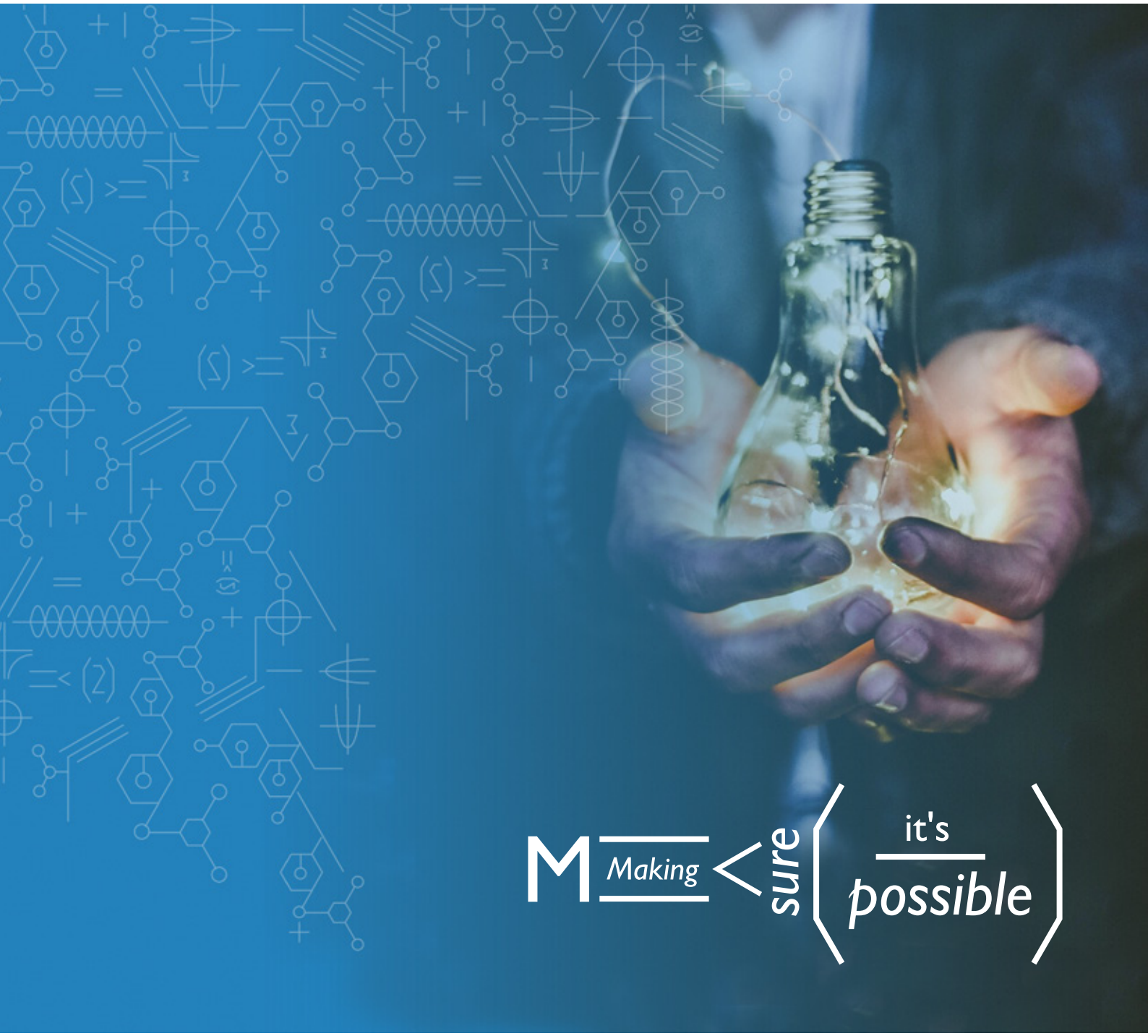
SOUTH AFRICAN NATIONAL SURVEY OF INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER AT PUBLICLY FUNDED RESEARCH INSTITUTIONS

SECOND NATIONAL SURVEY: 2014 – 2018



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NIPMO
NATIONAL INTELLECTUAL PROPERTY MANAGEMENT OFFICE
An initiative of the Department of Science and Technology

SARIMA

KISCH IP
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NOTIFICATIONS

This Report was produced by the Department of Science and Innovation (DSI), the Southern African Research and Innovation Management Association (SARIMA), the National Intellectual Property Management Office (NIPMO) and KISCH IP.

First published: May 2021

DISSEMINATION

This Report, the survey questionnaire forming the basis of this Report as well as the survey questionnaire instructions, abbreviations and definitions document may be downloaded free of charge from the following websites:

DSI: https://www.dst.gov.za/index.php/resource-center/rad-reports/ip-tt-survey

NIPMO: https://nipmo.dst.gov.za/resources/south-african-national-survey-of-intellectual-property-and-technology-transfer-at-publicly-funded-research-institutions-2014-to-2018

SARIMA: https://www.sarima.co.za/resources/innovation-technology-transfer/

The baseline survey, for the period 2008 to 2014, may be downloaded free of charge from the following websites:

DSI: https://www.dst.gov.za/index.php/resource-center/rad-reports/tt-ip-survey

NIPMO: https://nipmo.dst.gov.za/resources/reports-1

SARIMA: https://www.sarima.co.za/resources/innovation-technology-transfer/#02

Data extractions may be provided free of charge in response to a written request to the Deputy Director General: Socioeconomic Innovation Partnerships (DSI). The DSI reserves the right to prohibit or restrict access to data on reasonable grounds and/or in accordance with applicable national legislation. If a substantial amount of analytical work is required to meet any such request, a charge may be raised. Only aggregated and suitably anonymised data will be made available on request. Survey respondents have access to their own data.

DATA NOTES

Unless otherwise specified, the results presented in this Report are for the study period 2014 to 2018.

Totals indicated in this Report may not add up to the sum of their constituent items due to rounding. Data was compiled based on valid non-missing responses for all relevant years in the study period. Summary data was not reported if it was based on input data that was too sparse to preserve confidentiality. Refer to Section 1 herein for an overview of the methods used in the survey and analysis which form the basis of this Report.

Data notes are provided throughout the Report indicating the sample size "n" on which each table, graph and infographic is based. Unless indicated otherwise, the sample size refers to the number of institutions that provided a valid non-missing response for all years in the study period, or where applicable, the last year in the study period. The survey targeted all 37 "institutions" defined in the Intellectual Property Rights from Publicly Financed Research and Development Act (No. 51 of 2008) (IPR Act), as amended at September 2019, which definition encompasses 26 Higher Education Institutions (HEIs) and 11 statutory institutions listed under Schedule 1 of the IPR Act.

All currency values reported are at the value of the financial quantity in the reference period quoted, unless otherwise indicated. Where constant prices are indicated, the price level of base year 2014 is used to deflate current values using the GDP deflator.

REVISIONS

The DSI, SARIMA and NIPMO jointly reserve the right to revise the data and the indicators contained in this Report. Explanations regarding any revisions will be made available and accessible on the DSI website.

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FOREWORD

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Science, technology and innovation embody some of the best qualities of humanity, such as curiosity, creativity and aspirational thinking, which should be harnessed and utilised to create a more equal, socially-just and sustainable world. This is the central commitment of our Government to promoting a transformed science, technology and innovation (STI) system.

The National Development Plan (Vision 2030) states that" Innovation is critical for introducing new products into the market and producing goods and services more efficiently." Innovation is therefore crucial for South Africa's economic growth and competitiveness. Furthermore, it is vital also that innovative thinking and praxes also enriches the transformation and development of civil society, such that individual and collective citizens have access to the best of these technologies to build social cohesion, solidarity and social transformation.

Over the past two decades, meaningful progress has been made in establishing a number of institutions that are required for a functional system of innovation, such as the Department of Science and Innovation, the National Advisory Council on Innovation (NACI), the Technology Innovation Agency (TIA) and the National Intellectual Property Management Office (NIPMO). Furthermore, legislation on governing intellectual property (IP) that emanates from publicly funded research and development has been promulgated.

The 2019 White Paper on Science, Technology and Innovation highlights the importance of research and experimental development (R&D) to innovation and advances in knowledge to prepare a society for the future. One of its policy intents is to support commercialisation of publicly funded IP. The White paper states that Offices of Technology Transfer (OTTs) in higher education institutions (HEIs) and science councils (SCs) play an important role in identifying and protecting IP that has the potential to be developed into new products, processes and services, sourcing commercial partners, and establishing firms to market new technologies.

Effective policy making requires evidence. The inaugural baseline survey published in 2017, for the period 2008 to 2014, defined specific indicators that government and its stakeholders could use to measure the capacity, outputs, targeted outcomes and impact of publicly funded R&D. This second survey of IP and technology transfer at publicly financed institutions builds on the baseline survey and has produced some encouraging results.

A strong emphasis of the policy interventions is building requisite capacity within OTTs, and in doing this, the development of specialised skill sets within OTT teams is critical. Transformation is an imperative in South Africa to redress the past inequalities in terms of race, gender and other forms of representation. It is therefore encouraging to see that the number of black individuals has increased from the baseline survey. Black staff members representation now stands at the increased level of 81.9% at HEI and 68% of SC OTT teams, an increase of 25.5 and 11.7 percentage points respectively. In addition, female representation remained dominant, at 64% of HEI and 68.2% of SC OTT teams. However, the demographic profile of the broader STI research community on which this OTT system rests continues to face challenges of sufficient levels of representation.

A key driver of economic growth is the creation of new firms. There are positive trends in this regard. The number of start-up companies formed more than doubled over the survey period 2014 to 2018, with 55 startups being formed. Employment created by start-ups increased by 37% over the period.

This data illustrates how fostering the publicly funded technology transfer environment can drive a globally competitive economy, create employment and improve the quality of life of all citizens. The survey data, collected from 37 institutions, illustrates the important and evolving role which OTTs within institutions play by ensuring that knowledge is identified, protected (where appropriate) and most importantly finds application in society.

In the pages of the report you can read more about the capabilities and capacity of the OTTs, the institutional expenditure and funding, IP portfolios of the institutions, trends in IP transactions including licensing, assignments and start-ups. We've also included a few stories to illustrate the impact technology transfer has made on our lives.

I wish to thank all the institutions for participating in this survey. It is not often that a survey receives a 100% response rate. Your efforts provide government with a critical evidence base for science, technology and innovation to play a transformative role in addressing our social, economic and environmental development challenges. I further want to thank the Southern African Research and Innovation Management Association (SARIMA) which brings together technology transfer actors from across these institutions, for partnering with the Department in the inaugural baseline survey, and continuing that partnership in this survey. Thanks also go to Kisch IP for their efforts in conducting this survey on behalf of Department of Science and Innovation.

I am encouraged by the progress to date and look forward to realising the vision of our National Development Plan and 2019 White Paper on Science, Technology and Innovation.

Dr BE Nzimande, MP
Minister of Higher Education, Science and Innovation

STATEMENT FROM SARIMA

The Southern African Research and Innovation Management Association (SARIMA) brings together managers of research, as well as innovation and technology transfer, from across the Southern African Development Community region. Its mission includes the development and professionalisation of these disciplines, as well as the expansion of capacity and capabilities of research and technology transfer offices, so as to enable institutions to produce increasing levels of impactful research, and to facilitate the realisation of that impact in the form of new products, processes and services.

In this regard SARIMA has been very fortunate to have had the opportunity to partner with the South African Department of Science and Innovation, and more specifically the National Intellectual Property Management Office (NIPMO) and the Socio-Economic Innovation Partnerships Programme in the department, in the surveys conducted. SARIMA's support for these surveys is motivated by the need to track important indicators of technology transfer, so as to provide the evidence needed by policy makers to support areas of weakness, and to showcase progress and successes. It also provides a benchmarking opportunity for individual institutions, to assist in their capacity development planning, and provide critical inputs in their engagement with decision makers to support this key activity, which in many cases is not core to their institution's mission.

The baseline survey covered the periods 2008 to 2014, and the findings in the baseline survey report, issued in 2017, echoed many of the sentiments expressed amongst our members of the progress and challenges experienced in establishing and growing technology transfer capabilities within institutions. We have therefore participated in this second survey with great anticipation to establish the extent of expansion in capabilities and capacity to perform technology transfer activities, as well as its enablers, which drive the eventual impact that can be achieved by this relatively new part of the innovation system.

This survey has extended the indicators from those established in the baseline survey, providing additional insights into the technology transfer landscape. It has also provided comparisons of some indicators with a range of other countries, so as to facilitate benchmarking of the sector and performance of our institutions. On the whole, the trends show positive development and growth of the sector, whilst providing evidence of areas where there is room for improvement. The stories interwoven in the report, showcasing impact from the commercialisation of research outputs, are equally valuable, and serve to inspire the hard work of technology transfer teams in institutions.

I wish to acknowledge the considerable efforts of the technology transfer offices in the surveyed institutions, all of whom participated in what is an extensive data gathering exercise. I would like to extend thanks to several leaders in the technology transfer offices of institutions who have participated in the technical committee that designed this second survey, and contributed to the development of this report. I wish to particularly thank Ms Ela Romanowska, Past President of SARIMA, for her dedication in leading SARIMA's participation since the inception of the baseline survey. Furthermore, we thank KISCH IP for their committed efforts in the implementation of the survey. Finally, we extend our deepest gratitude to the Department of Science and Innovation, for the partnership on the design, implementation and reporting on the survey, the results of which will benefit all stakeholders in the intellectual property and technology transfer landscape, in South Africa, and beyond.

Dr Therina Theron
President of SARIMA

EXECUTIVE SUMMARY

Technology transfer (TT) is the process of translating ideas into products, processes and services. More specifically, in a South African institutional context, framed within the Intellectual Property Rights from Publicly Financed Research and Development Act (IPR Act), TT involves the identification, protection and putting into use (also referred to as commercialisation) of promising technology concepts emanating from publicly financed research activities, for the benefit of society.

This resonates with South Africa's policy intent to improve the regulatory environment for the identification and utilisation of intellectual property (IP), which aims to increase the deployment of research results for economic impact as well as improving the living standards of its citizens.

The baseline South African National Survey of IP and TT at Publicly Funded Research Institutions, which covered the period 2008 – 2014, established a number of indicators to track overall activity in IP management and TT. This Survey, covering the period 2014 – 2018, builds and expands on the foundation set by the baseline survey. This Survey was conducted with all "institutions" as defined in the IPR Act – 26 Higher Education Institutions (HEIs) and 11 Schedule 1 institutions or Science Councils (SCs). All 37 institutions participated in the Survey.

Overall, this Survey shows encouraging trends in a range of indicators pertaining to IP creation, TT activities and the economic impact created as a result of these.

The majority of institutions have an active IP portfolio that is being managed by the offices of technology transfer (OTTs) within these institutions. Almost half of all staff members within these offices have five or more years of TT experience, with a majority female and black representation, an improvement from the baseline survey. Despite the good work performed by the OTTs, key skill sets remain lacking.

A stepping stone towards creating impact is the conclusion of IP transactions with commercial partners to further develop and deploy the resulting products, processes or services. In this regard, 292 new licences and 40 new assignments were concluded over the Survey period. What is of interest is that for four out of the five years of the Survey period, the same five institutions accounted for 80% or more of the licences concluded. If more institutions can achieve these levels of transactions, the potential for economic impact can increase. In terms of revenues generated for the institutions, 238 transactions collectively yielded revenues of over R185 million across 17 institutions. The average number of IP transactions per year yielding revenue almost doubled from that reported in the baseline survey. It should be appreciated that the full impact of these transactions is also seen in the commercial partners' gross revenue, employment created and improvement in the quality of lives from the deployment of the IP. Future surveys should report in more detail on these indicators.

An enabler for development and commercial deployment of IP is funding for particular phases of development and commercialisation. There is encouraging growth in seed funding, which increased 52% in the first four years of the Survey period. However, more than R0.5 billion is estimated to be required over a two-year period across the innovation value chain from technology development right through to series B funding.

A potentially high impact modality of TT is the formation of start-up/spin-out companies founded on institutional IP. In total, 55 such companies were formed over the Survey period, employing over 320 people. Four institutions accounted for 70% or more of the reported number of start-up/spin-out companies formed in any year. As more institutions are able to create start-up/spin-out companies, the potential for impact will increase. Of the total of 100 companies formed since 2008, 72 remained operational as at 2018, which is positive in light of the known high failure rates associated with start-up/spin-out companies.

Further key findings, providing a snapshot of the South African IP and TT landscape and progress made in developing this important sector of the National System of Innovation are provided.

KEY FINDINGS – A SNAPSHOT OF INTELLECTUAL PROPERTY AND TECHNOLOGY TRANSFER IN SOUTH AFRICA

STRUCTURE AND CAPABILITIES OF THE TECHNOLOGY TRANSFER FUNCTION

37 publicly funded R&D institutions governed by the IPR Act:

- 26 Higher Education Institutions (HEIs)
- 11 Schedule 1 Institutions/Science Councils (SCs)
- 100% response rate
- IPR Act mandates that offices of technology transfer (OTTs) are established within institutions to fulfil the technology transfer function (TTF), and to perform the required technology transfer activities (TTA)

As at 2018:

92%
of institutions had a dedicated technology transfer function (TTF)

169
staff members are employed in the TTF across all institutions:

- Average staff headcount of TTFs established before 2010, is **7.3** per TTF
- Average staff headcount of TTFs established after 2010, is **3.2** per TTF
- Almost half of all TTF staff members have **five or more years** of TT experience

60%+
of TTF staff members are employed on a permanent basis

64% | 68%
of HEIs/SCs TTFs are female

82% | 68%
of HEIs/SCs TTFs are Black (African, Coloured, Indian/Asian)

99%
of TTF staff members hold tertiary qualifications, with the majority of staff holding qualifications in the fields of life sciences, business/commerce and law

76%
of the institutions reported a lack of certain skills within their TTF

EXPENDITURE AND FUNDING

Over the survey period (2014 – 2018), institutions reported:

R50bn+
expenditure on R&D

R4bn+
expenditure on clinical trials

R265m+
expenditure on IP registrations and maintenance costs

R315m+
expenditure on technology transfer operations

R2.74m+
expenditure on IP enforcement

R215m+
in seed funding awarded to institutions

As at 2018:

78%
of institutions reported that they did not have sufficient funding for technology development, upscaling and commercialisation

INTELLECTUAL PROPERTY PORTFOLIOS

As at 2018:

81%
of institutions have an IPR Act patent portfolio*

57%
of institutions have an IPR Act trade mark portfolio

46%
of institutions have an IPR Act registered design portfolio

8%
of institutions have an IPR Act plant breeders' rights portfolio

30%
of institutions have a non-IPR Act patent portfolio**

16%
of institutions have a non-IPR Act trade mark portfolio

5%
of institutions have a non-IPR Act registered design portfolio

5%
of institutions have a non-IPR Act plant breeders' rights portfolio

Over the survey period (2014 – 2018), institutions reported:

1 250+
actionable disclosures reported to NIPMO

700+
new IPR Act patent applications filed with more than 900 patents granted

350+
patent families with at least one granted patent, 200+ IPR Act and 150+ non-IPR Act

300+
new IPR Act trade mark applications filed with almost 300 trade marks granted

±100
new IPR Act design applications filed with 65 designs registered

45
new IPR Act plant breeders' rights applications filed

INTELLECTUAL PROPERTY TRANSACTIONS AND START-UP/ SPIN-OUT COMPANIES

As at 2018:

65% | 46%
of HEIs/SCs describe the approval processes to conclude an IP transaction as efficient

42% | 55%
of HEIs/SCs executed IP transactions

60%+
of TTFs indicated that TTFs are not empowered to establish start-up/spin-out companies or incubators

54% | 82%
of HEIs/SCs indicated that either they don't have a formal approval process in place to form a start-up/spin-out company, or that such a process is complex and inefficient

320+
FTEs are employed by start-up/spin-out companies

Over the survey period (2014 – 2018), institutions reported:

55
start-up/spin-out companies were formed by TTFs;

70%+
of start-up/spin-out companies formed by four institutions

290+
licences concluded

80%+
of licences concluded by five institutions

40+
assignments concluded

235+
IP transactions yielded revenue to the institutions, with just over 50% yielding less than R100 000 in any given year

R185m+
IP transaction revenue was generated

R23m+
commercialisation revenue paid to 270+ IP creators/enablers

96
options were granted of which 95% were granted by HEIs

100
start-up/spin-out companies formed since 2008, 95% of these from HEIs and 72 were still operational in 2018

* *The IPR Act governs all IP created after 2 August 2010 which emanated from publicly financed R&D in South Africa.*

** *Non-IPR Act IP (i.e. not governed by the provisions of the IPR Act) is therefore IP that was created before the IPR Act came into operation or where the associated R&D activities were not publicly financed.*

ACKNOWLEDGEMENTS

The South African National Survey of Intellectual Property and Technology Transfer at Publicly Funded Research Institutions for the period 2014 to 2018 is the Second National Survey following on the inaugural baseline survey which was conducted for the period 2008 to 2014.

This second survey was conducted jointly by the Southern African Research and Innovation Management Association (SARIMA), the National Intellectual Property Management Office (NIPMO) and the Department of Science and Innovation (DSI), with project implementation by KISCH IP.

The project team expresses appreciation for the leadership of the Director-General of the DSI, Dr Phil Mjwara and his Executives, Mr Imaraan Patel (Deputy Director-General: Socio-economic Innovation Partnerships) and Dr Mmboneni Muofhe (Deputy Director-General: Technology Innovation).

The project team further extends its appreciation for the initiation of the second survey project to Ms Ela Romanowska (SARIMA); Dr Kerry Faul and Ms Jetane Charsley (NIPMO); Mr Godfrey Mashamba and Ms Kgomotso Matjila (DSI), and their respective teams.

We convey our gratitude to the team at KISCH IP, under the leadership of Mr Dawid Prozesky and Mr Jaco Theunissen, for project implementation.

The project team wishes to express its sincere gratitude to the oversight committee, and the technical committee whose inputs to the questionnaire and report were invaluable. The oversight committee members were Ms Ela Romanowska (SARIMA) and Ms Jetane Charsley (NIPMO) and was chaired by Ms Kgomotso Matjila (DSI). The members of the technical committee were Dr Ana Casanueva (UWC/SARIMA), Dr Andrew Bailey (UCT/SARIMA), Mr Ayanda Noma (UNISA/SARIMA), Ms Charlotte Mashaba (UKZN) and Dr Revel Iyer (CPUT) and was chaired by Ms Jetane Charsley (NIPMO).

Our thanks go to the DSI and NIPMO teams, including Ms Christel Wolmarans, Dr Elmary Buis, Ms Paballo Phiri, Mr Thabo Manyaka and Ms Tshidi Mamogobo, as well as the KISCH IP team of Dr Daniel Mak, Dr Bernard Dippenaar and Ms Guinevére Thomas.

The report was reviewed by an external panel of experts, Ms Jaci Barnett (University of Bristol) and Prof David Walwyn (University of Pretoria/ RESEVA (Pty) Ltd), whose considered inputs are greatly appreciated.

Lastly, we are most grateful for the survey inputs provided by the respondents during this second survey, and their willingness to respond to queries raised in the validation of data and preparation of this Report. In addition, we thank the institutions that assisted with invaluable input into the pilot survey, namely the Council for Geosciences, the South African Medical Research Council, Stellenbosch University and the University of South Africa.

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LIST OF ABBREVIATIONS

ARIPO	African Regional Intellectual Property Organisation
ATTP	Alliance of Technology Transfer Professionals
AUTM	Association of University Technology Managers
CIPC	Companies and Intellectual Property Commission
CLP	Certified Licensing Professional
DSI	Department of Science and Innovation
FTE	Full-Time Equivalent (see use in definitions for TT FTE and OTHER FTE)
GDP	Gross Domestic Product
HEI	Higher Education Institution
IP	Intellectual Property
IPR ACT	Intellectual Property Rights from Publicly Financed Research and Development Act (No. 51 of 2008) and the regulations thereto, as amended from time to time
NDP	National Development Plan
NIPMO	National Intellectual Property Management Office, as established in terms of Section 8 of the IPR Act
NSI	National System of Innovation
OECD	Organisation for Economic Cooperation and Development
OTT	Office of Technology Transfer as established in terms of Section 6 of the IPR Act
PCT	Patent Co-operation Treaty
PPP	Purchasing Power Parity
R&D	Research and Development
RTTP	Registered Technology Transfer Professional
SA	South Africa
SARIMA	Southern African Research and Innovation Management Association
SC	Science Councils
SMME	Small, Medium and Micro Enterprises (enterprises with less than 200 employees)
STI	Science, Technology and Innovation
TIA	Technology Innovation Agency, as established in terms of the TIA Act (No. 26 of 2008)
TT	Technology Transfer
TTA	Technology Transfer Activities
TTF	Technology Transfer Function
UK	United Kingdom
US	United States of America

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SECTION A: INTRODUCTION

1. INTRODUCTORY COMMENTS AND AIM OF THE SURVEY

Innovation is crucial for South Africa's economic growth and competitiveness. Scientific research and development (R&D) is therefore necessary to enhance technological innovation.

To reap the full benefits of public R&D investment and grow the knowledge economy, South Africa must accelerate the transfer and commercialisation of results from its publicly funded R&D in ways that benefit the country. It is on this basis that, among other measures, the Intellectual Property Rights from Publicly Financed Research and Development Act (No. 51 of 2008) (the IPR Act) was introduced to incentivise actors in the research-to-innovation value chain to improve their capabilities in managing intellectual property (IP) for eventual commercial and social use.

Effective policymaking requires evidence-based information. The aim of this Survey is to track the capacity and overall activity, including the associated outputs, outcomes and impacts, of IP and TT at institutions. Institutions include the 26 South African Higher Education Institutions (HEIs) and the 11 statutory institutions, as listed under Schedule 1 of the IPR Act (commonly referred to as Science Councils or SCs).

This Survey builds on the baseline indicators established in the baseline survey for the years 2008 to 2014, published in April 2017.

2. SCOPE AND APPROACH

The Survey response period is 2014 to 2018, in each case being the start of the financial year, which is January for HEIs and April for SCs. This response period follows on the baseline survey with a one-year overlap in 2014 to account for institutions that did not respond to the baseline survey.

As noted, the Survey targets all institutions defined in Section 1 of the IPR Act. Each of these institutions are mandated by the IPR Act, with respect to publicly financed R&D, to establish an Office of Technology Transfer (OTT) for: i) developing and implementing various policies; ii) receiving IP disclosures; iii) analysing disclosures for any commercial potential; iv) attending to aspects of statutory protection of IP (where appropriate); v) attending to aspects of IP transactions and the commercialisation of IP; and vi) conducting evaluations on the scope of statutory protection of IP in all geographic territories subject to the commercialisation potential of the IP.

This legislative mandate ideally positions the OTTs to serve as the source of primary data for the Survey. The use of external data has been limited to instances where reported indicators require the standardisation of primary data, or for the validation of primary data during fieldwork. Participation by the OTTs as respondents in the Survey was wholly voluntary. The fact that **a 100% participation rate was achieved**, speaks to the commitment and support by the OTTs and the institutions which they represent. The time and effort of the OTTs to participate is commendable, and greatly appreciated by the DSI, NIPMO and SARIMA.

The Survey has been structured to allow for international benchmarking to assist the interpretation of findings where possible. To this end, the survey questionnaire, including the accompanying definitions of terms and/or concepts contained therein, was in part standardised with similar international TT or "knowledge transfer" surveys.

3. REPORT STRUCTURE

This Report presents the findings of the second IP and TT survey, with key findings and a snapshot of the high-level indicators presented in advance of this Section A. Section B sets out the context of IP and TT in South Africa, including the establishment of a definition of TT, the South African legislative context for IP emanating from publicly funded R&D, as well as a brief international context.

Section C, divided into six subsections, encompass the main section of the Report[1]. The first subsection presents findings on the capabilities and structure of the technology transfer function (TTF) at the institutions, including the age and legal nature of the TTF, staffing and skills and institutional policy considerations. The second subsection presents findings with respect to the TTF, more specifically the importance, capabilities and capacity of the TTF in undertaking TT activities. The third subsection presents findings on institutional expenditure and funding. The fourth subsection pertains to the IP portfolios of the institutions, divided into IPR Act and non-IPR Act IP portfolios[2]. The fifth subsection presents findings on IP transactions and IP transaction revenue divided into an overview of IP transactions and revenue, and IPR Act intellectual property transactions. The final subsection presents the findings on start-ups and spin-out companies formed to commercialise institutional IP.

Section D provides an interpretation of the survey results, specifically with respect to TTF input and output indicators, as well as select international comparative data, with Section E providing aggregated data relating to the types of HEIs (not presented in Section C) as well as data on the jurisdictional distribution of patents granted to the institutions over the survey period.

Section F provides a summary of the technology transfer value chain and Section G lists external sources referenced.

Finally, dispersed throughout the Report sections are stories showcasing the significant contributions specific innovations emanating from publicly funded R&D have made, not only in South Africa, but internationally.

1. Refer to Section I for the methodology employed in establishing the data presented in Section C.
2. Refer to Section B on the South African legislative context for the distinction between IPR Act-related and non-IPR Act-related IP and IP transactions.

1. DEFINING TECHNOLOGY TRANSFER

In the context of the objectives of this Survey, technology transfer (TT) is defined as the process of transferring research findings from one organisation to another, typically through transactions with respect to IP rights, for further development and/or commercialisation.

In the South African context, HEIs and SCs play a unique role in facilitating this transfer within the National System of Innovation (NSI). This role requires institutions to not only generate knowledge through basic and applied research, but also to provide crucial support for the "*translation of knowledge*" into "*innovative products, processes and services*" emanating from this knowledge. The technology transfer function (TTF) is the capability within the institution that provides such support.

Accordingly, the IPR Act has as its objective to "*make provision that intellectual property emanating from publicly financed research and development is identified, protected, utilised and commercialised for the benefit of the people of the Republic*"[3].

In practise, TT is a fluid and dynamic process providing one of the forms of translation of **knowledge** into **impact** within institutions. A more detailed description of the activities and processes in TT is provided in Section F.

2. SOUTH AFRICAN LEGISLATIVE CONTEXT

The IPR Act, the result of over a decade's policy evolution in South Africa, was signed on 22 December 2008 and put into operation on 2 August 2010 with the publication of the Regulations. The policy evolution originated from the Science and Technology White Paper of 1996, the first comprehensive policy document in South Africa on science, technology and innovation (STI), introducing the NSI as the "*set of functioning institutions, organisations and policies that interact constructively in the pursuit of a common set of social and economic goals and objectives, and that use the introduction of innovations as the key promoter of change*"[4].

Within two years after the publication of the White Paper of 1996, a system-wide review of public sector STI institutions was undertaken and the National R&D Strategy of 2002 was formulated along with the establishment of the Innovation Fund[5].

Importantly, the National R&D Strategy of 2002 identified "*inadequate intellectual property legislation and infrastructure*" as a key factor that needed to be addressed in South Africa's NSI. More specifically, it was found that "*inventions and innovations from publicly financed research*" in South Africa were not being effectively protected and managed.

Against this backdrop, the developments after the White Paper of 1996 gave rise, amongst other interventions, to the development of a South African intellectual property rights from publicly financed research policy framework in 2006, informed in part by an OECD review of South Africa's innovation policy, focused on identifying and clearly defining the challenges in the NSI.

Further to the policy framework, a 10 Year Innovation Plan was formulated in 2008 to help drive South Africa's transformation towards a knowledge-based economy. The drive behind this transformation was focused on four elements: human capital development; knowledge generation and exploitation; knowledge infrastructure; and the enablers to address the gap between research results and socioeconomic outcomes (often referred to as the *innovation chasm*). In line with the National R&D Strategy of 2002, the 10 Year Innovation Plan expressed the need for a national IP management office to enhance the protection of IP rights and ensure synergy within the NSI policy framework.

It is in this context, and as a result of this evolution, that the IPR Act came into operation to provide for: i) more effective utilisation of IP emanating from publicly financed R&D; ii) the establishment of the National Intellectual Property Management Office (NIPMO); the iii) IP Fund[6] and OTT Support Fund; and (iv) OTTs at institutions[7]. The IPR Act governs all IP created after 2 August 2010 which emanated from publicly financed R&D[8] in South Africa. Importantly, where an institution undertakes R&D which is not publicly financed, the provisions of the IPR Act do not apply[9]. Non-IPR Act IP (i.e. not governed by the provisions of the IPR Act) is therefore IP that was created before the IPR Act came into operation[10] or where the associated R&D activities were not publicly financed.

The National Development Plan (NDP) was launched in 2013. The NDP identified IP and the associated IP rights as critical aspects to innovation and economic growth, thereby holding a key to South Africa's future. Policy developments such as the NDP emphasise the importance of the role which the TT capabilities in institutions, and the IPR Act, have and will continue to play in the NSI.

Most recently, a White Paper on STI was published in 2019 which is focused on "*science, technology and innovation* [for] *enabling inclusive and sustainable South African development in a changing world*".

This Survey forms part of a range of indicators aimed at informing the progress achieved with the South African innovation policy evolution, a timeline of which is set out in figure 1.

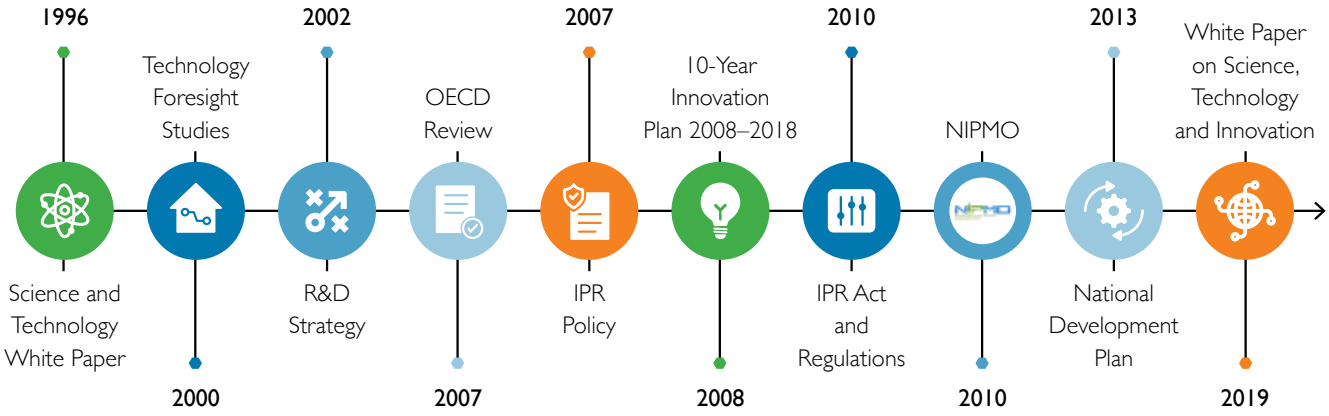


Figure 1: Timeline of South Africa's innovation policy evolution

3. Section 2(1) of the IPR Act.
4. The National Research and Development Strategy of 2002.
5. The Innovation Fund provided grants to fund end-stage research so as to enable the transfer of knowledge into new and improved products, processes and services.
6. Section 13(2) of the IPR Act, one of the key purposes of the IP Fund is to provide financial support to "institutions" for the statutory protection and maintenance of intellectual property rights.
7. The long title, with "institutions" in this context defined in Section 1 of the IPR Act.
8. In accordance with the presumption against retrospectivity of an Act in South Africa as established by the Appellate Division in Jockey Club of South Africa v Transvaal Racing Club, 1959, (2) 54.
9. Section 15(4)(a) of the IPR Act.
10. 2 August 2010.

3. INTERNATIONAL CONTEXT

The provisions and ambit of the IPR Act drew in part on the US Bayh-Dole Act of 1980 and the UK Patents Act of 1978, and the experience of other countries.

It is of value when reading this Report to have regard to the impact of regulatory frameworks in countries such as the US, Brazil, etc. to understand the progress, and possible future trajectory, in South Africa. However, direct comparisons may not be useful as such comparisons do not take into account the legislative context and drivers of all the variables across the comparator countries.

In light of the availability of international data, where possible, this Report includes a high-level international comparative analysis as part of Section D, taking these challenges into account.

The historical context of formalised TT in the US, Canada and Brazil is summarised as follows:

- The US Bayh-Dole Act was passed in 1980 and implemented in 1981. The aim of the Bayh-Dole Act is to facilitate patenting by US research universities through the standardisation of rules and procedures for doing so across funders, while also providing government endorsement for more active involvement of research entities in commercialisation of research outputs. From the 187 respondent research universities participating in the AUTM US Licensing Survey of 2017, a total of US$68.2 billion in research expenditure was recorded (US$0.36 billion average per respondent), 24 998 disclosures reported (133.7 average per respondent), 7 798 licences and options concluded (41.7 average per respondent) and 1 080 start-ups formed based upon foundational university IP (5.8 average per respondent).
- From the 34 respondent research universities participating in the AUTM Canada Licensing Survey of 2017, a total of US$4.7 billion (calculated using Canadian dollar PPP for 2017) in research expenditure was recorded (US$0.13 billion average per respondent). Furthermore, a total of 1 882 disclosures were reported (55.4 average per respondent), with the conclusion of 706 licences and options (20.8 average per respondent) and 111 start-ups formed based upon foundational university IP (3.3 average per respondent).
- The significant differences between the US and Canadian figures for the same indicators, following the same survey methodology, highlight the difficulty of direct international comparative analysis. Additional contextual and/or normalising analysis would be required to make meaningful comparisons.
- In Brazil the concept of the entrepreneurial university only became institutionalised through the 2004 Brazilian Innovation Law[11] (Soares, Torkomian, & Nagano, 2020). As per the annual FORMICT survey for 2017, the average number of disclosures per respondent was 12.6 and the average number of licences which were concluded was 2.6 (Ministério da Ciência, Tecnologia, Inovações e Comunicações, 2019). Without contextual understanding one cannot make direct comparisons between the Brazilian, US and Canadian survey. The FORMICT survey does not include start-ups and research expenditure within the indicators reported, and further highlights the difficulty of harmonised direct international comparison.

11. Complemented by Law 13.243, known as the Legal Mark of Science, Technology and Innovation.

SECTION C: SURVEY RESULTS

This section of the Report presents the findings of the second IP and TT survey for the study period 2014 to 2018, with select qualitative findings as at 2018. A list of terms or phrases that are to be accorded a specific definition throughout this section is provided at the start of each subsection, and a list of accompanying definitions is provided in Section H.

Where relevant, and unless otherwise indicated, only those institutions for which data was available for every year in question were included. This was done to avoid skewing of the trends as a result of intermittent values. In some instances, the 2018 results were compared with that of the baseline survey in terms of the same respondents. Where possible, HEI data was segregated into the three types of HEIs and reported within this Section C or provided in Section E.

1. CAPABILITIES AND STRUCTURE OF THE TECHNOLOGY TRANSFER FUNCTION

This section describes the capabilities and structures that exist within the institutional technology transfer functions (TTFs), including human resource capacity and demographics, such as population group and gender, to assist with the tracking of transformation within the TTF from the baseline survey findings as at 2014.

The IPR Act mandates that offices of technology transfer (OTTs) are established within institutions to fulfil the TTF, and to perform the required technology transfer activities (TTA). Section 7(1) specifically requires that the TTF must be "*performed by appropriately qualified personnel, whom, when considered collectively, has interdisciplinary knowledge, qualifications and expertise in the identification, protection, management and commercialisation of IP and in IP transactions*". In supporting the necessary skillset and capacity development, the IPR Act makes provision for assistance to institutions through the NIPMO-managed OTT Support Fund. Thus, the indicators reported in this subsection provide an indication of the impact of NIPMO's assistance, and the commitment of OTTs to fulfil these requirements.

Defined terms used in this section include:

- 0.5 PROFESSIONAL
- FTE
- INSTITUTIONS
- IPR ACT
- OTHER FTE
- TECHNOLOGY TRANSFER ACTIVITIES (TTAs)
- TECHNOLOGY TRANSFER FUNCTION (TTF)
- TT FTE

(Refer to Section H)

1.1 PROFILE OF THE TECHNOLOGY TRANSFER FUNCTION

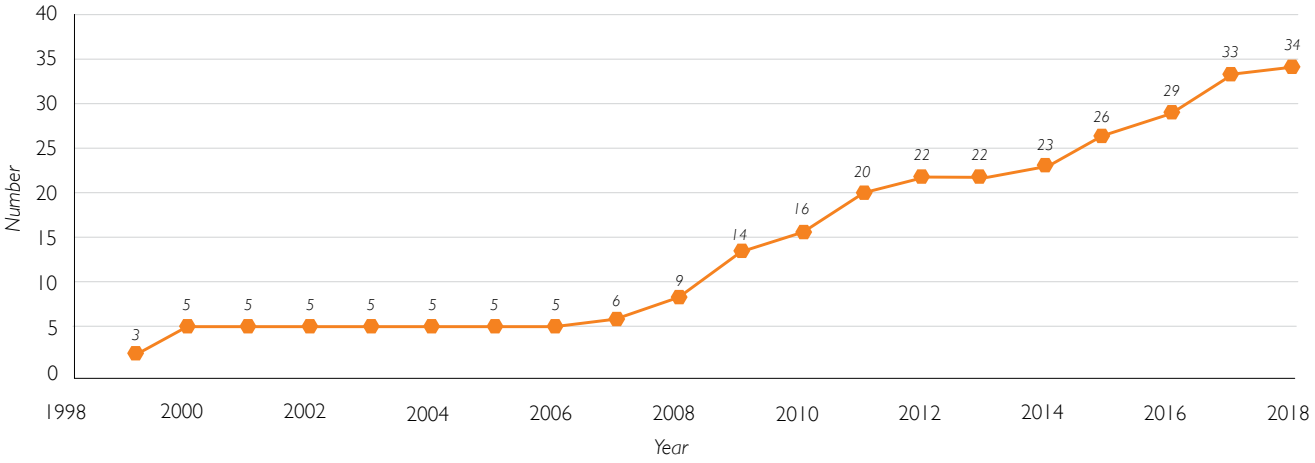


Figure 2: Cumulative number of institutions to first dedicate 0.5 professional persons to the TTF

Data note: n = 37

Figure 2 shows the cumulative number of institutions which dedicated at least 0.5 professional persons as defined in Section H to the technology transfer function (TTF) for the first time. It is particularly exciting that in the survey period, 12 institutions were able to create TTFs, such that in 2018 there were only three institutions that were still on the path of establishing a TTF.

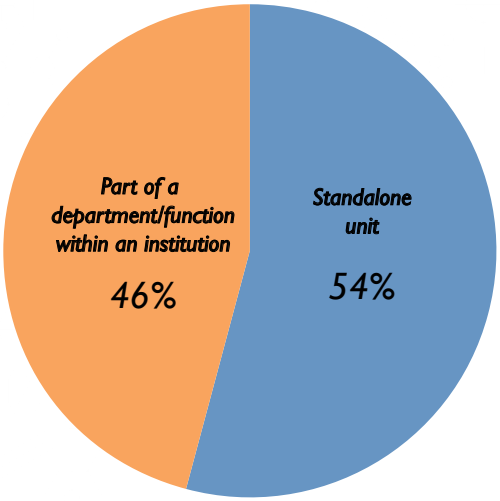


Figure 3: Type of TTF structure, 2018

Data note: n = 34

The type of structure a TTF takes is determined by each institution, taking into account its objectives and environment. Historically, TTFs had one of three structural forms: i) part of a department or function within the institution; ii) standalone unit, such as a subsidiary company of the institution/department; or iii) part of a regional OTT. It should be noted that it is open for TTFs to take other structural forms they deem appropriate.

Figure 3 shows that by 2018, 54% of the institutions had a standalone unit/directorate. Two of these institutions (10%) indicated that they have a separate legal entity which performs all of the TTFs.

Table 1 and figures 4 to 12 present data obtained on staffing at the TTFs, including experience, demographics and employment type as at 2018, compared to the baseline survey. The respondents were asked to provide information for each individual in the TTF.

"…difference in the average staff headcount between TTFs established after 2010, at 3.2 per TTF, and those established on or before 2010, at 7.3 per TTF."

	HEI	SC	Total
Total headcount/individuals	**125**	**44**	**169**
TT FTEs	92.1	23.8	115.9
OTHER FTEs	24	14.4	38.4
Total FTEs	**116.1**	**38.2**	**154.3**

Table 1: Total FTEs and headcount of TTF staff by institution type, 2018

Data note: HEI n = 26, individuals =125; SC n = 11, individuals = 44

Table 1 shows the total staff headcount at the TTFs, together with a breakdown of total FTEs by TT FTEs and OTHER FTEs. An analysis of the data showed uneven distribution of staffing across the TTFs. This disparity in staffing headcount and FTEs can be attributed to, amongst others, the timing of the creation of the TTF: the older and more established the TTF, the greater the staff headcount and total FTEs. From analysis of the data, the extent of this becomes evident when comparing the difference in the average staff headcount between TTFs established after 2010, at 3.2 per TTF, and those established on or before 2010, at 7.3 per TTF.

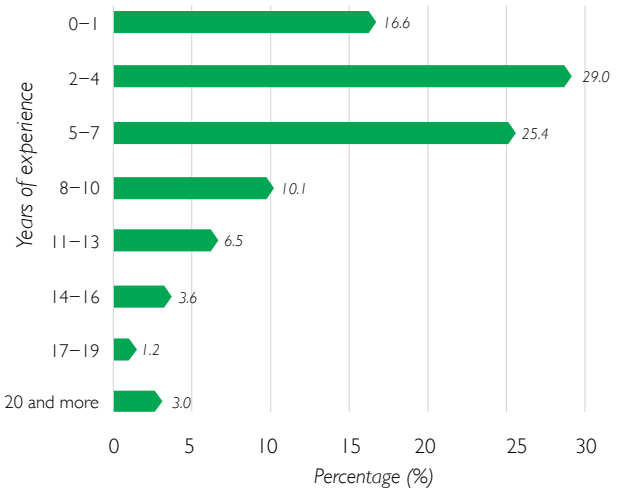


Figure 4: Percentage distribution of years of TT experience of individual TT staff members, 2018

Data note: n = 37 (161 individuals)
Note: For a breakdown by types of HEIs, see Section E.

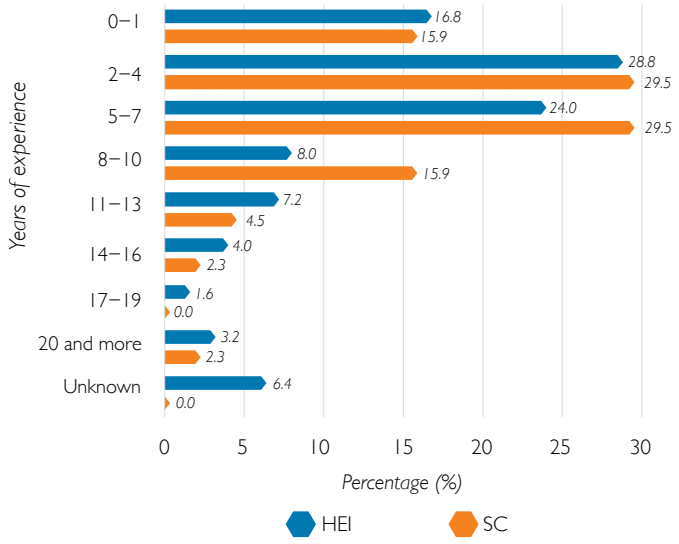


Figure 5: Percentage distribution of years of TT experience of individual TT staff members by institution type, 2018

Data note: HEI n = 26 (125 individuals), SC n = 11 (44 individuals)

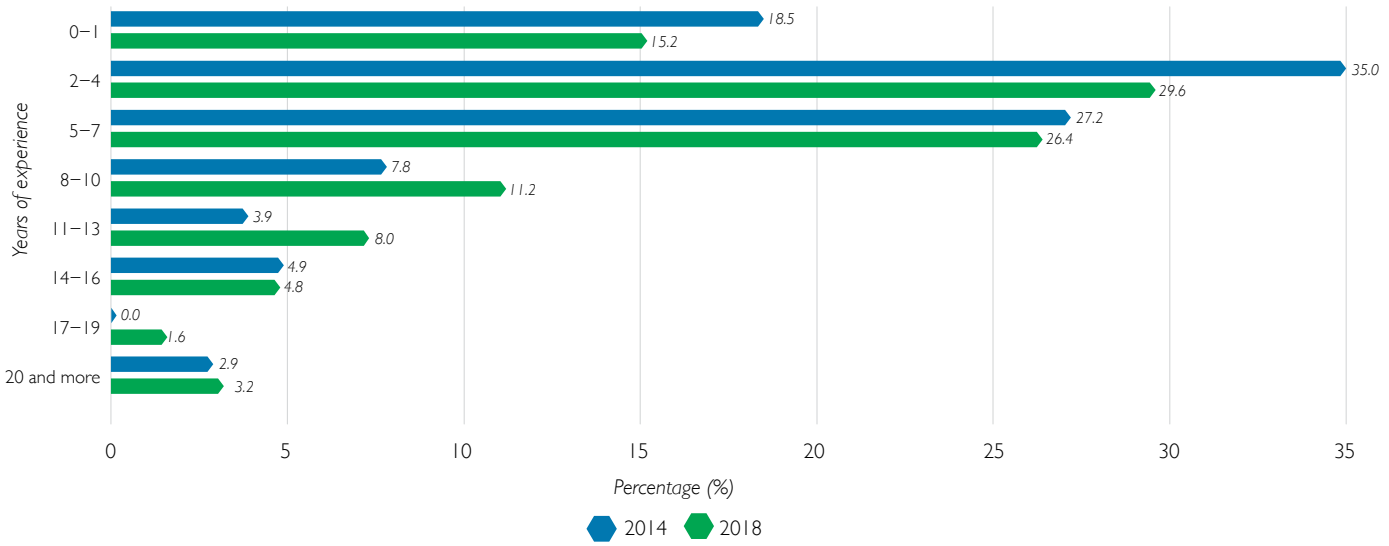


Figure 6: Percentage distribution of years of TT experience of the individual staff members, 2014 vs 2018 – same respondents

Data note: n = 22 (2014: 103 individuals; 2018: 125 individuals)

Figure 4 shows that in 2018, almost half of all TTF staff members had five or more years of TT experience. In light of the fact that a professional accreditation body such as the ATTP[12] requires three or more years' experience as one criterion to apply for RTTP status, this finding is encouraging. Figure 5 indicates that in SCs there is a higher percentage of individuals with five to ten years of experience as compared to HEIs but HEIs have a higher proportion of staff with more than 11 years' experience.

Figure 6 compares 2018 results with that of the 2014 baseline survey in terms of the same 22 respondents. Whereas in 2014, 53.5% of staff members had less than five years TT experience, in 2018 this number dropped by ~9 percentage points. At the same time there was an increase from 11.7% (2014) to 19.2% (2018) in terms of individuals having eight to 13 years' experience. This increase in levels of experience is in the context of an ~21% increase in the number of staff members, for those 22 respondents, between 2014 and 2018. This suggests that experience levels are increasing, which is a very encouraging trend.

12. Alliance for Technology Transfer Professionals.

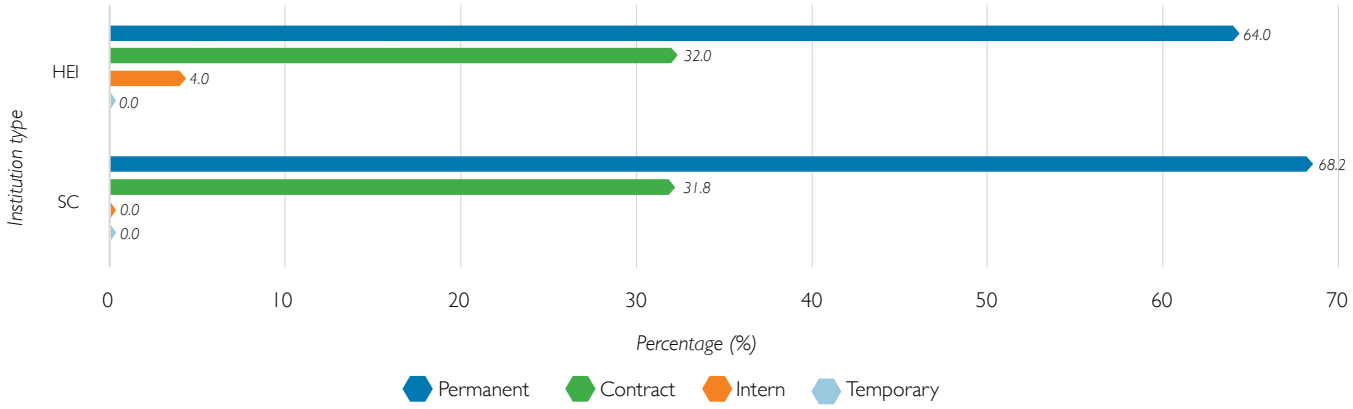


Figure 7: Percentage distribution of employment categories by institution type, 2018

Data note: HEI n = 26 (125 individuals); SC n = 11 (44 individuals)

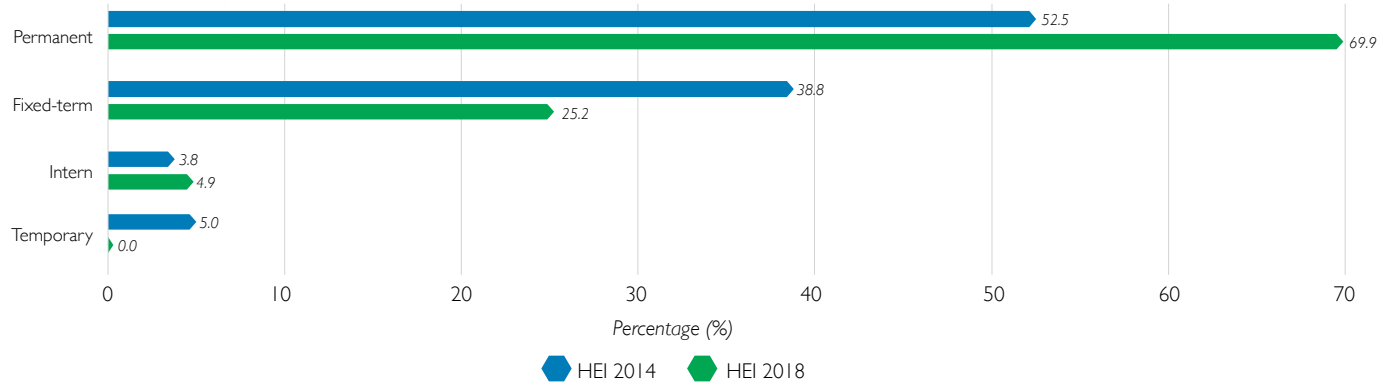


Figure 8: Percentage distribution of employment categories for HEIs, 2014 vs 2018 – same respondents

Data note: HEI n = 16 (2014: 80 individuals; 2018: 103 individuals)

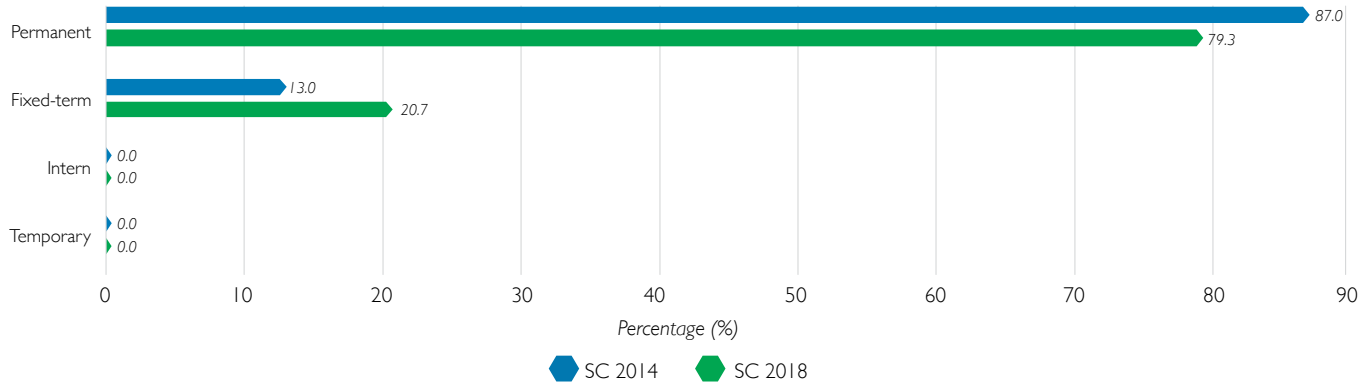


Figure 9: Percentage distribution of employment categories for SCs, 2014 vs 2018 – same respondents

Data note: SC n = 6 (2014: 23 individuals; 2018: 29 individuals)

In 2018, over 60% of TTF individuals are employed on a permanent basis as seen in figure 7. Permanent employment alludes to a continuity within the TTF which is an important factor in the functioning of a TTF. A lack thereof may lead to the potential loss of valuable and specialised skills.

Figures 8 and 9 compare 2018 results with that of the 2014 baseline survey in terms of the same 22 respondents. It is encouraging to see that in HEIs, permanent employment increased by 17.4 percentage points to ~70%. In the SCs there was a slight decrease in permanent employment of 7.7 percentage points to ~79%. As was the case in figure 6, these changes are in the context of a ~21% increase in the number of staff members between 2014 and 2018.

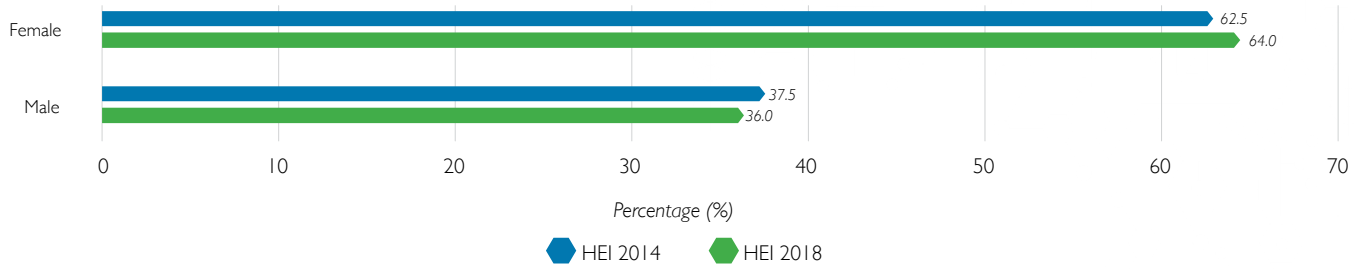


Figure 10: Percentage distribution of HEI staff members by gender, 2014 vs 2018

Data note: 2018: HEI n = 26 (125 individuals); 2014: HEI n = 16 (80 individuals)

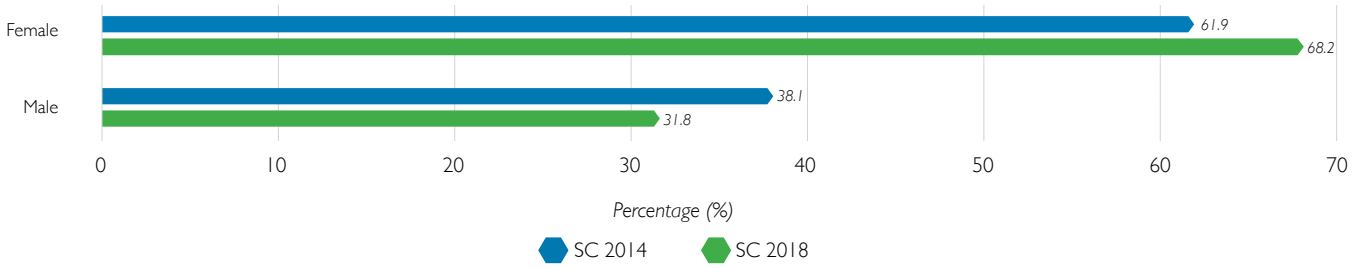


Figure 11: Percentage distribution of SC staff members by gender, 2014 vs 2018

Data note: 2018: SC n = 11 (44 individuals); 2014: SC n = 5 (21 individuals)

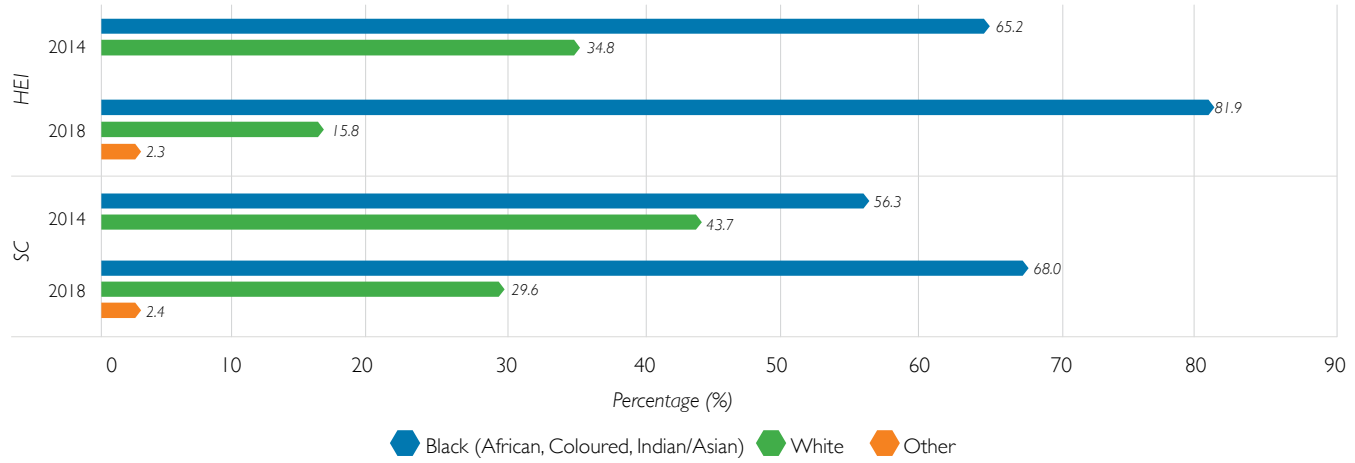


Figure 12: Percentage distribution of TTF staff members by population group, 2014 vs 2018

Data note: 2014: HEI n = 16 (80 individuals); SC n = 6 (23 individuals)
Data note: 2018: HEI n = 26 (125 individuals); SC n = 11 (44 individuals)

Transformation is an imperative in South Africa to redress past inequalities in terms of race, gender and other representation. This Survey focused on data for race and gender.

Figures 10 and 11 show that female representation within the TTF has remained dominant, increasing slightly from 2014 to 2018 in both HEIs and SCs. Referring to figure 12, it is encouraging to see that the number of black individuals (which in terms of the Employment Equity Act (No. 55 of 1998) include African, Coloured and Indian/Asian individuals) has increased substantially from the baseline survey. In HEIs the increase is 16.7 percentage points to 81.9% and in SCs it is 11.7 percentage points to 68%.

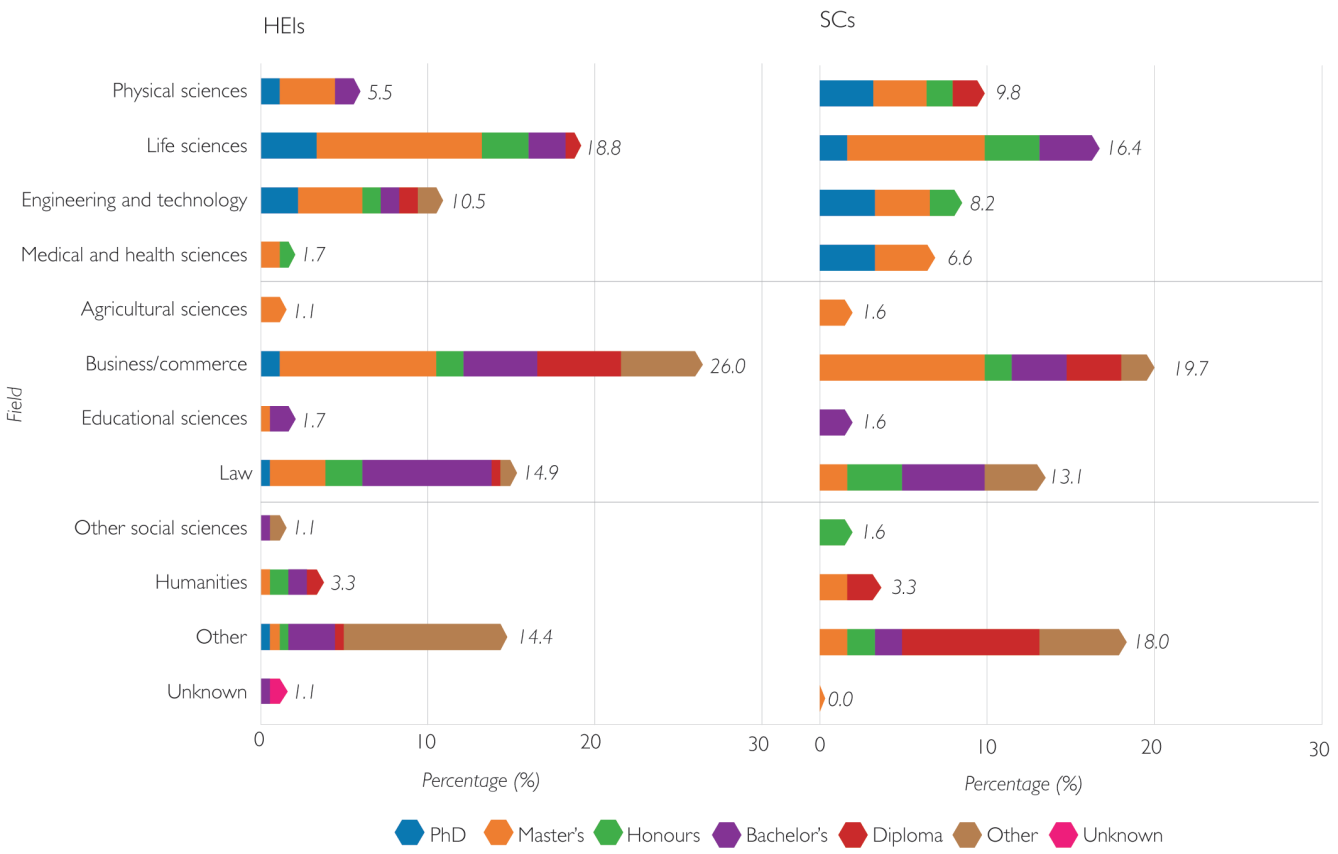


Figure 13: Percentage distribution of staff qualifications (up to three fields per individual) by field and highest qualification for HEIs and SCs, 2018

Data note: HEI n = 26 (125 individuals); SC n = 11 (44 individuals)
Note: For a breakdown by types of HEIs, see Section E.

Figure 13 shows the percentage distribution of qualifications by TTF staff, per field (discipline) and highest qualification in a field. It should be noted that a single individual may have up to three fields of qualifications. In such instances, each field and the individual's highest qualification therein has been counted separately.

From further inspection of the data:

- At least 99.4% of staff across the TTF hold a tertiary qualification in a particular field, 35% hold a tertiary qualification in a second field, and 8% hold a tertiary qualification in a third field[13].
- 36.5% and 41% of HEI and SCI staff respectively have degrees in the physical sciences, life sciences, engineering and technology or medical and health sciences fields, with the majority of staff qualified in these fields holding advanced degrees (i.e. a master's degree or a PhD).
- 26% and 19.7% of HEI and SC staff respectively have qualifications in business/commerce, with 46.2% and 60.9% of these being at postgraduate level.
- From the above it indicates that staff have added a postgraduate business degree to undergraduate qualifications in other fields.

A further unpacking of the data for types of HEIs shows that TT staff in comprehensive universities and universities of technology have, "*as a percentage of TT staff employed within these institutions*", ~ 35% business/commerce degrees while traditional universities have 19%. Furthermore, it is noteworthy that universities of technology have a substantially lower percentage of staff qualified in the physical sciences, life sciences, engineering and technology or medical and health sciences fields at 22.7% compared to traditional universities (41%) and comprehensive universities (40.6%).

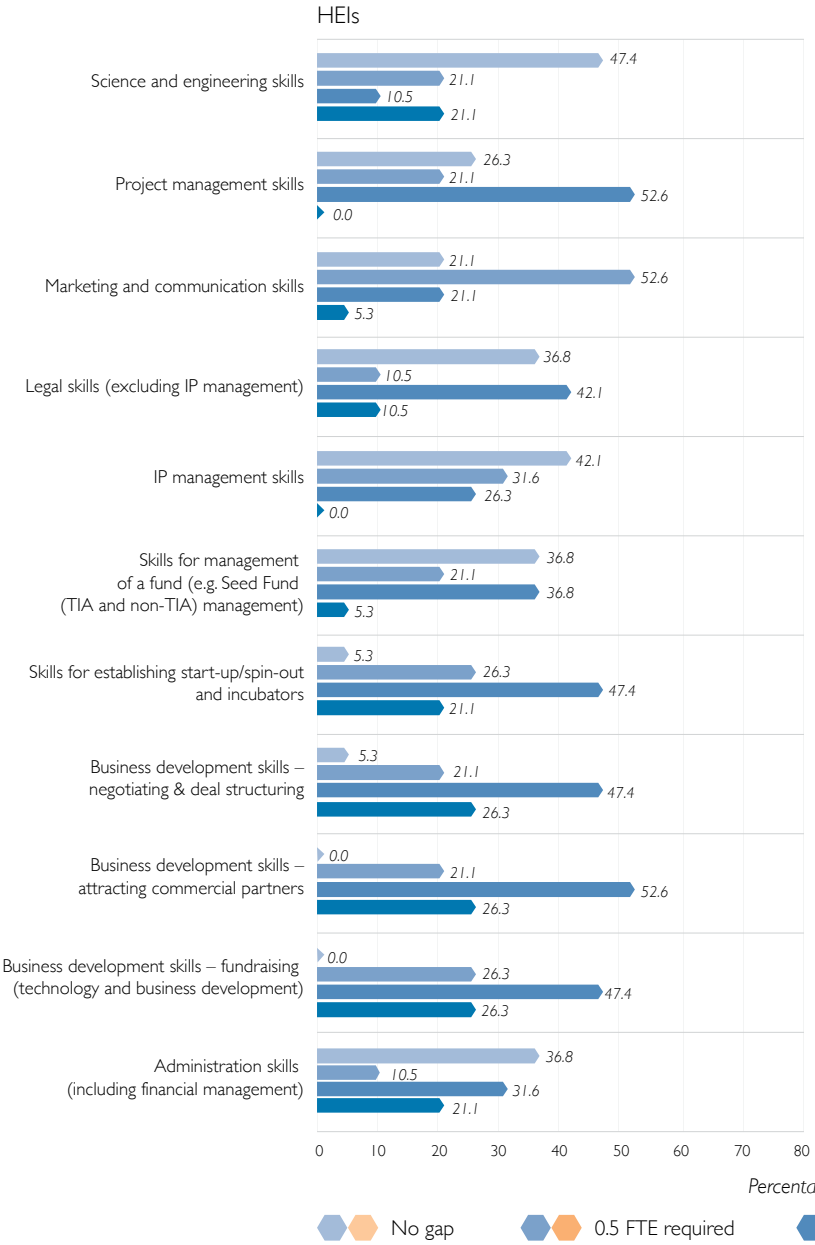
Over and above formal qualifications held by individuals in the TTF, there is the option for individuals to obtain professional accreditations. In this regard two international accreditations are most recognised: Certified Licensing Professional (CLP), which is administered by the Licensing Executive Society; and the Registered Technology Transfer Professional (RTTP), which is administered by the Alliance of Technology Transfer Professionals (ATTP). According to the responses received, four individuals have CLP accreditation (an increase from no individuals in 2014), and ten individuals have an RTTP accreditation (an increase from six individuals in 2014). It is noteworthy that two of the reported individuals have both CLP and RTTP accreditation.

"At least 99.4% of staff across the TTF hold a tertiary qualification in a particular field, 35% hold a tertiary qualification in a second field, and 8% hold a tertiary qualification in a third field."

13. The survey questionnaire only allowed up to three fields of qualifications.

1.2 REPORTED GAPS IN THE SKILLS BASE OF THE TECHNOLOGY TRANSFER FUNCTION

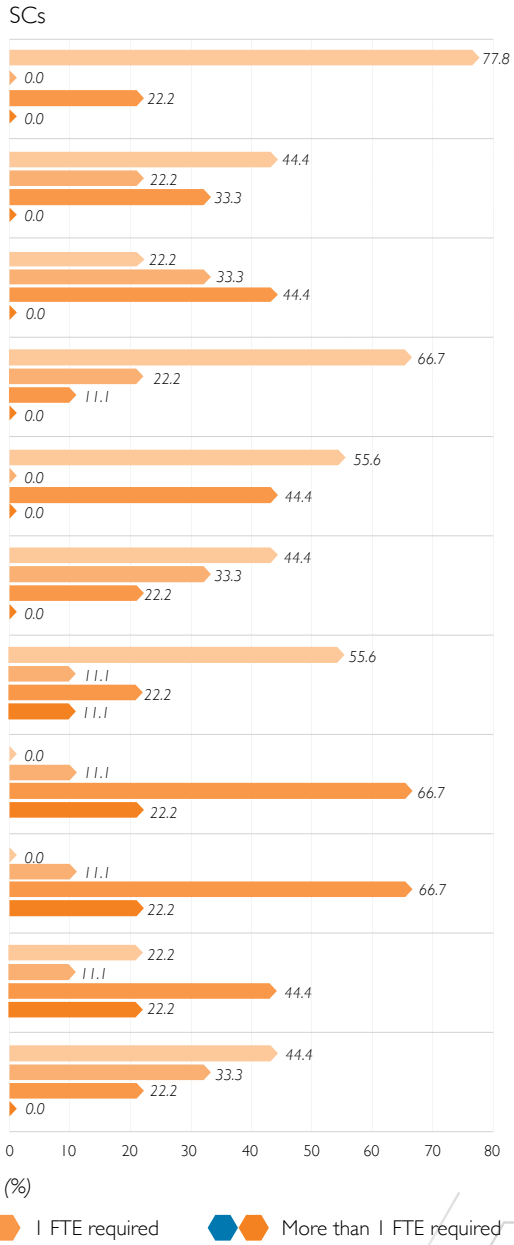
Figure 14: Percentage of HEIs reporting extent to which there is a skills gap for different types of skill sets in a TTF, 2018



Data note: HEI n = 19

Note: For a breakdown by types of HEIs, see Section E.

Figure 15: Percentage of SCs reporting extent to which there is a skills gap for different types of skill sets in a TTF, 2018



Data note: SC n = 9

"76% of institutions indicated a lack of skills within their TTF in 2018."

Across the South African TTF, 76% of the institutions reported there to be a lack of certain skills within their TTF.

For HEIs, the skills reported to be most lacking are in commercialisation activities, specifically: i) negotiating and deal structuring; ii) attracting commercial partners; iii) fundraising; and iv) skills required for establishing start-up/spin-out companies and incubators. Although 26% of HEI staff indicated a qualification in business/commerce (see figure 13) it is evident that the commercialisation skills required within the TTF are unique, especially when considering the skillset stipulated within the IPR Act.

SCs report that the gap in skills required for "*establishing start-up/spin-out companies*" is not as significant as reported by HEIs. This may in part be due to reduced activity reported by SCs on the formation of start-up/spin-out companies as an avenue for the commercialisation (see Section 6). As with HEIs, SCs report a gap in business development skills, specifically relating to: i) negotiating and deal structuring; and ii) attracting commercial partners.

If the gaps reported in commercialisation-related skills by HEIs and SCs can be adequately addressed, this could have a positive impact on commercialisation outputs and outcomes. Addressing this gap may include expanding formal and informal training and skills development opportunities.

1.3 THE TECHNOLOGY TRANSFER FUNCTION POLICY FRAMEWORK

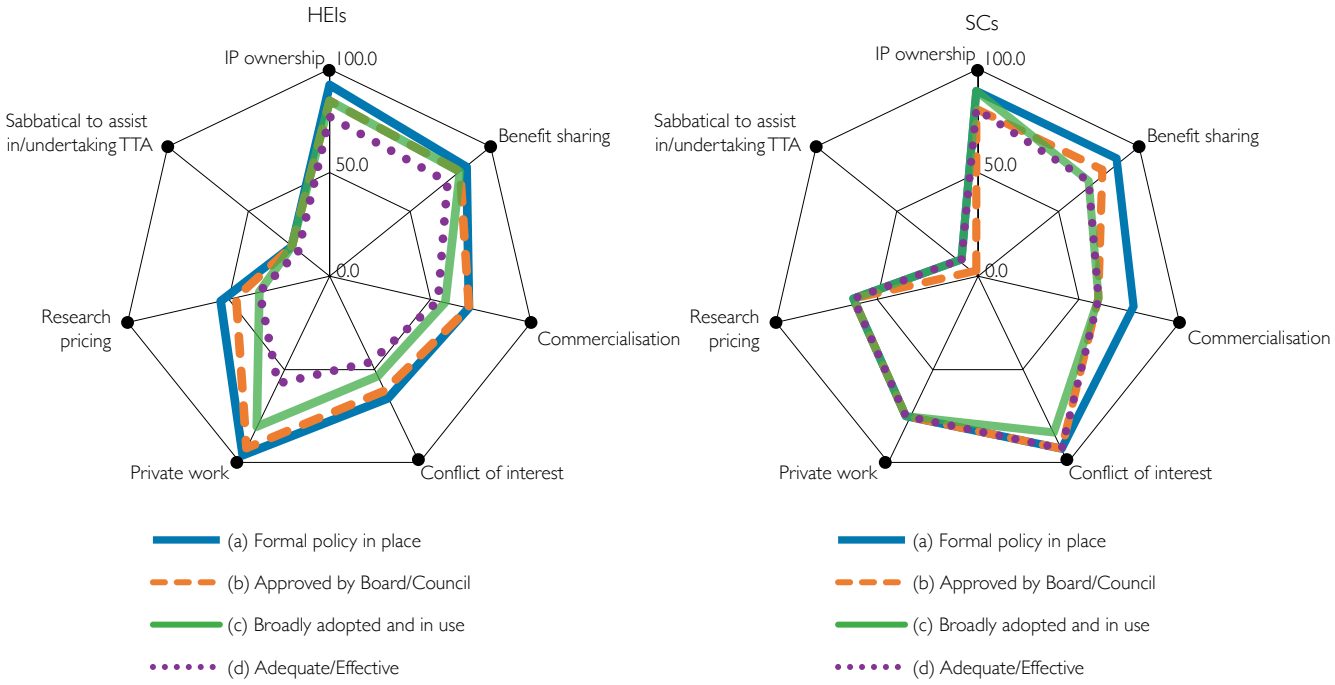


Figure 16: Policy framework indicating (as a percentage of respondents) if: (a) formal policy which deals with the identified aspects is in place; (b) the relevant policy has been approved by the Board/Council; (c) the policies are broadly adopted and in use; and (d) the policies are adequate or effective, 2018

Data note: n = 36 (HEI n = 25, SC n = 11)

Figure 16 reports the extent to which different types of policies are present and functioning in institutions.

In terms of the IPR Act, institutions must have policies in place to regulate benefit-sharing with IP creators, which policies must be approved by NIPMO. It is therefore encouraging that 84.6% of HEIs and 91% of SCs report that they have such policy in place, and it appears to be adequate/effective[14].

It can be seen that for HEIs, TT sabbatical policies are generally not in place. The importance of this policy is the extent to which researchers are enabled/encouraged to use sabbaticals to drive technology transfer outcomes. SCs do not generally have a sabbatical as an employee benefit, which can account for the lack of TT sabbatical policies.

With respect to HEIs, the gaps in terms of research pricing policy are substantial. NIPMO's legal mandate and its responsibilities in terms of the IPR Act apply to the concept of full costing only (i.e. cost of conducting the research) and exclude all pricing considerations. The institution's inability to give direction to researchers on market-related pricing for research, may lead to under-recovery in terms of the value delivered by an institution's research.

In contrast to HEIs, it appears that formal policies directed towards commercialisation and conflict of interest are common among SCs, although some report that these are not adequate or effective. Formal policies on private work at SCs are more widely adopted and seen as adequate/effective as opposed to HEIs, all of whom have Private Work policies but they are not widely seen as adequate or effective.

14. In terms of Section 10(1) of the IPR Act, IP "creators" are granted a right to a portion of the revenues that accrue to the "institution" from their IP, referred to as "benefit-sharing".

UNIVERSITY SPIN-OUT COMPANY ENABLES LOW-COST HIV DRUG-RESISTANCE TESTING WORLDWIDE

Exatype, developed at the University of the Western Cape (UWC) as a platform for analysing drug resistance in Human Immunodeficiency Virus (HIV) genomes, led to the birth of Hyrax Biosciences (Pty) Ltd, which now analyses DNA data for several diseases, including TB and SARS-CoV-2, for public and private diagnostics institutions around the world.

The initial problem the UWC team had set out to address was around HIV drug resistance. HIV has the ability to mutate and reproduce itself in the presence of antiretroviral (ARV) drugs, which can lead to the virus no longer responding to these ARVs, leading to a drug-resistant form of infection. There are currently nearly 26 million people on ARV drugs globally, and a drug-resistant virus is estimated to be present in approximately 10% of these people. In South Africa, the rapid year-on-year growth of drug resistance, coupled with substantial numbers of HIV and Tuberculosis (TB) co-infections, means that drug resistance is a major threat to the continued success of HIV and TB treatment programmes in preventing deaths.

Drug-resistance testing (DRT) is used to determine whether a patient has a mutated form of a pathogen – a disease-causing organism – which does not respond to first-line therapeutics. Regular DRT, as part of clinical treatment of HIV-positive patients, is crucial for ensuring effective treatment of HIV. Insufficient DRT can result in treatment failure, progression of the disease in these patients, spread of drug-resistant HIV, and even death, if second- or third-line treatments are not provided timeously.

For resource-constrained countries like South Africa, the cost of DRT for HIV-positive patients is prohibitive. As a result, routine use in the public sector is not feasible. This cost can be significantly reduced by genetic sequencing technologies, which enable the testing of high volumes of patient samples simultaneously. However, these technologies yield highly complex data that require specialist expertise in bioinformatics for correct analysis and interpretation. Not only is this expensive and time-consuming, but the expertise is not always available.

To solve this problem, Prof Simon Travers from the South African National Bioinformatics Institute at UWC assembled a team of PhD students and a postdoctoral fellow, Drs Imogen Wright, Ram Krishna Shrestha and Natasha Wood, respectively. Their search for a solution led to the development of Exatype – an automated, user-friendly, web-based platform that easily and cost-effectively analyses sequence data without the need for any specialised bioinformatics expertise. The platform has many other advantages, including its speed, sensitivity, accuracy, and ease of use. The platform, initially developed for HIV, can also be applied to other pathogens, such as Mycobacterium tuberculosis and SARS-CoV-2, which cause TB and COVID-19 respectively.

Prof Travers, Dr Wright and Dr Wood along with Mr Baruch Lubinsky, subsequently formed Hyrax Biosciences to commercialise Exatype. UWC assigned the intellectual property, including the South African patent for the use of the algorithms in HIV drug-resistance testing, as well as a trade mark for Exatype, to the company to facilitate commercialisation. Hyrax Biosciences has users in countries including South Africa, Kenya, Mozambique, Nigeria, Honduras, Nicaragua and the US.

Exatype has been developed in a modular way so can be easily adapted for use in other disease lines. Most recently, SARS-CoV-2 sequencing has been added to address the COVID-19 pandemic, enabling the easy identification of variants in the virus for surveillance and vaccine development purposes. This home-grown technology has created employment, helped generate foreign revenue, and most importantly, will assist in improving well-being for patients suffering from infectious diseases worldwide.

2. THE TECHNOLOGY TRANSFER FUNCTION

Each office of technology transfer (OTT) or technology transfer function (TTF) within an institution is mandated by the IPR Act to, at a minimum: i) analyse newly disclosed IP for commercial potential (attend to statutory protection where appropriate); and ii) attend to all activities to support commercialisation of the IP.

This section describes the activities performed by the TTFs, including the perceived importance of such activities, as well as the capabilities and capacity to undertake such activities. It further includes information on the importance, presence and functioning of key promotors/enablers of such activities.

Defined terms used in this section include:
- INSTITUTIONS
- START-UP/SPIN-OUT COMPANIES
- TECHNOLOGY TRANSFER ACTIVITIES (TTAs)
- TECHNOLOGY TRANSFER FUNCTION (TTF)

(Refer to Section H)

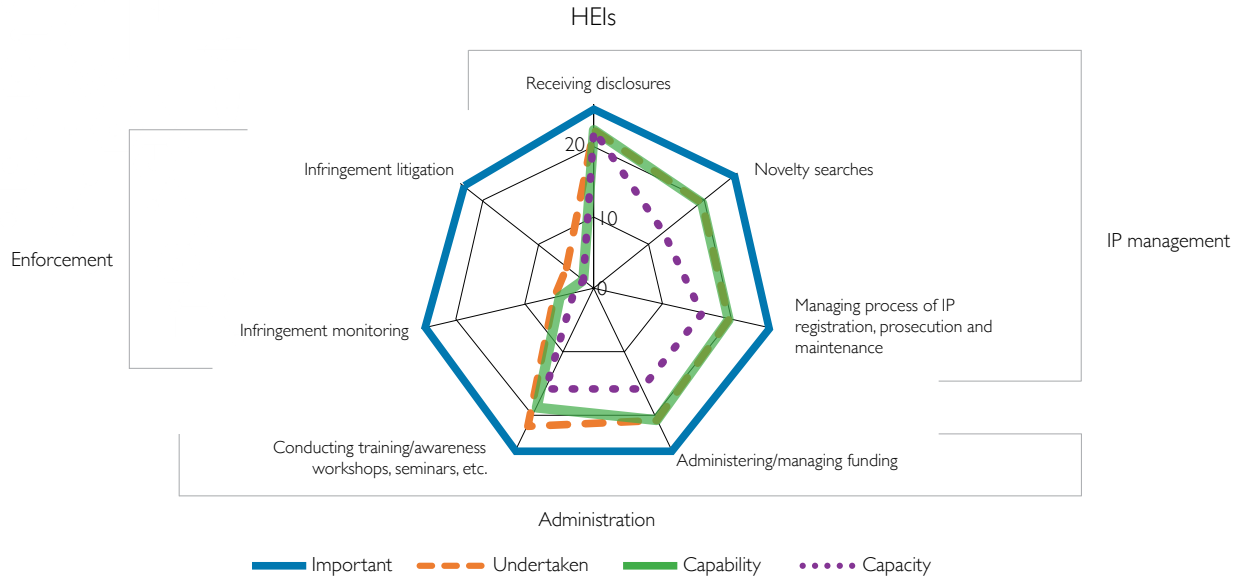


Figure 17: TTA (IP management, administration and enforcement) at HEIs by number of institutions, 2018

Data note: n = 26

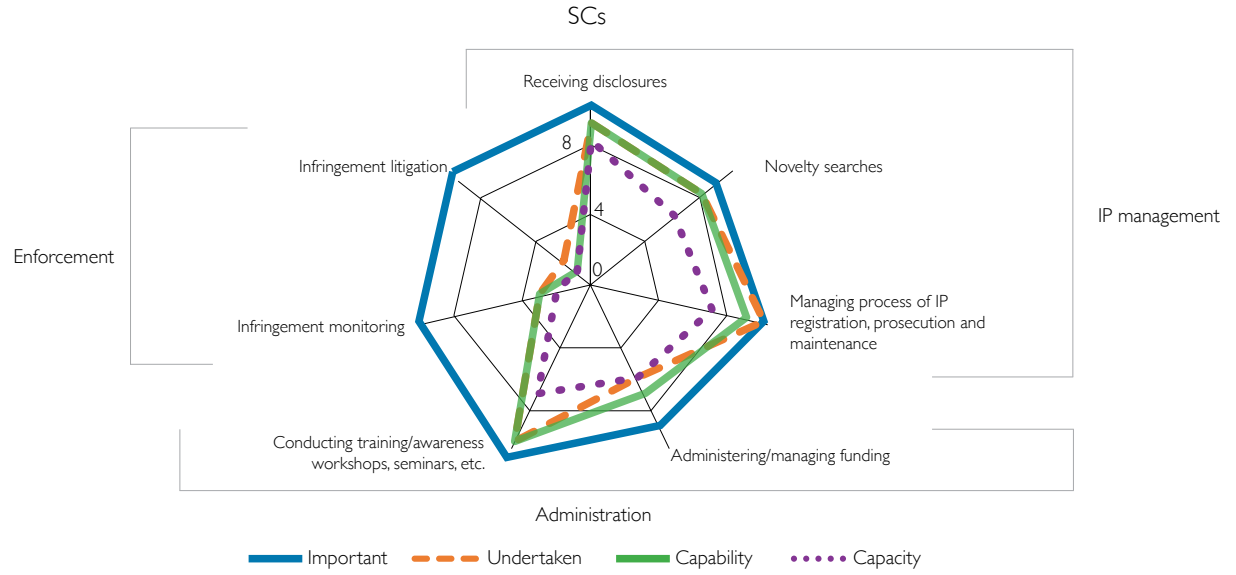


Figure 18: TTA (IP management, administration and enforcement) at SCs by number of institutions, 2018

Data note: n = 11

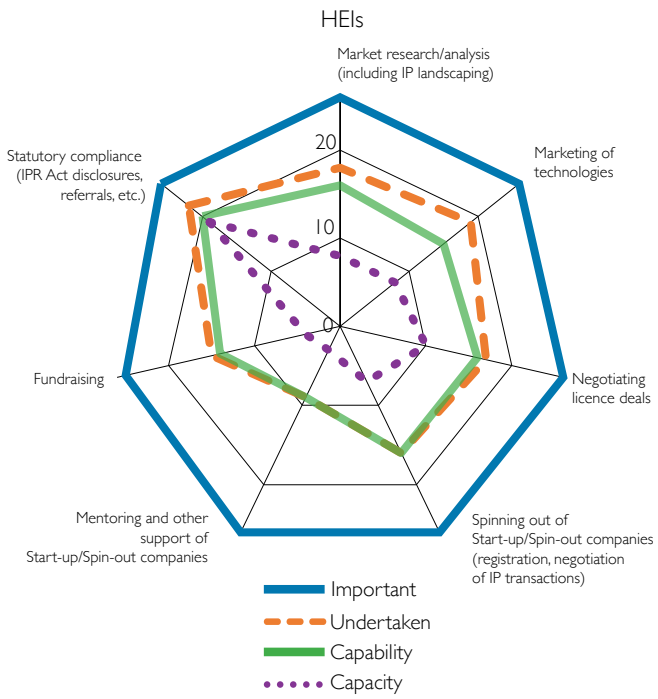


Figure 19: TTA (commercialisation) at HEIs by number of institutions, 2018

Data note: n = 26

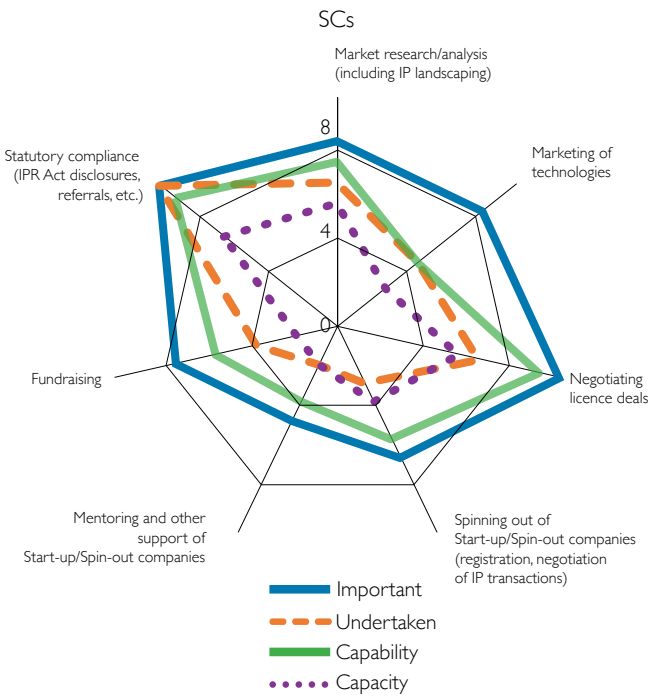


Figure 20: TTA (commercialisation) at SCs by number of institutions, 2018

Data note: n = 11

Figures 17 and 18 indicate key activities undertaken by TTFs in terms of: i) IP management; ii) administration; and iii) IP enforcement, their importance, together with the TTF's capabilities and capacity to undertake these activities.

In the majority of TTF's there are practically no IP enforcement activities taking place. This could partly be due to the fact that institutions have not yet entered into commercialisation transactions, and where they have done this, it is often the responsibility of the licensee/assignee to undertake infringement monitoring. Furthermore, the data shows that institutions do not have the capability to undertake these activities.

All HEIs deem IP management and administration activities as important. However, ~25% do not have the capability, and an even higher proportion do not have sufficient capacity to undertake these activities. SCs appear to have the capabilities to undertake IP management activities, however, similar to HEIs, lack capacity.

From analysis of the data, almost all HEIs deem commercialisation activities as important, however, capabilities and capacity to undertake these activities are severely lacking specifically as it relates to: i) fundraising; and ii) mentoring and other support for start-up/spin-out companies. For fundraising activities, about 15% of HEIs indicated that they have the capability **and** capacity to undertake such activity, while ~42% indicated capabilities but no capacity. Furthermore, with respect to support for start-up/spin-out companies, ~12% of HEIs indicated that they have the capability **and** capacity to undertake such activity, while 23% indicated capabilities but no capacity.

For SC, the importance of: i) fundraising activities; as well as ii) activities related to the mentoring and other support for start-up/spin-out companies, is lower than HEIs. This may be in part due to the organisational mandate and its implementation within SCs. However, similar to HEIs, a gap exists between the capabilities and capacity to undertake the TTF commercialisation activities.

"In the majority of TTFs there are practically no IP enforcement activities taking place."

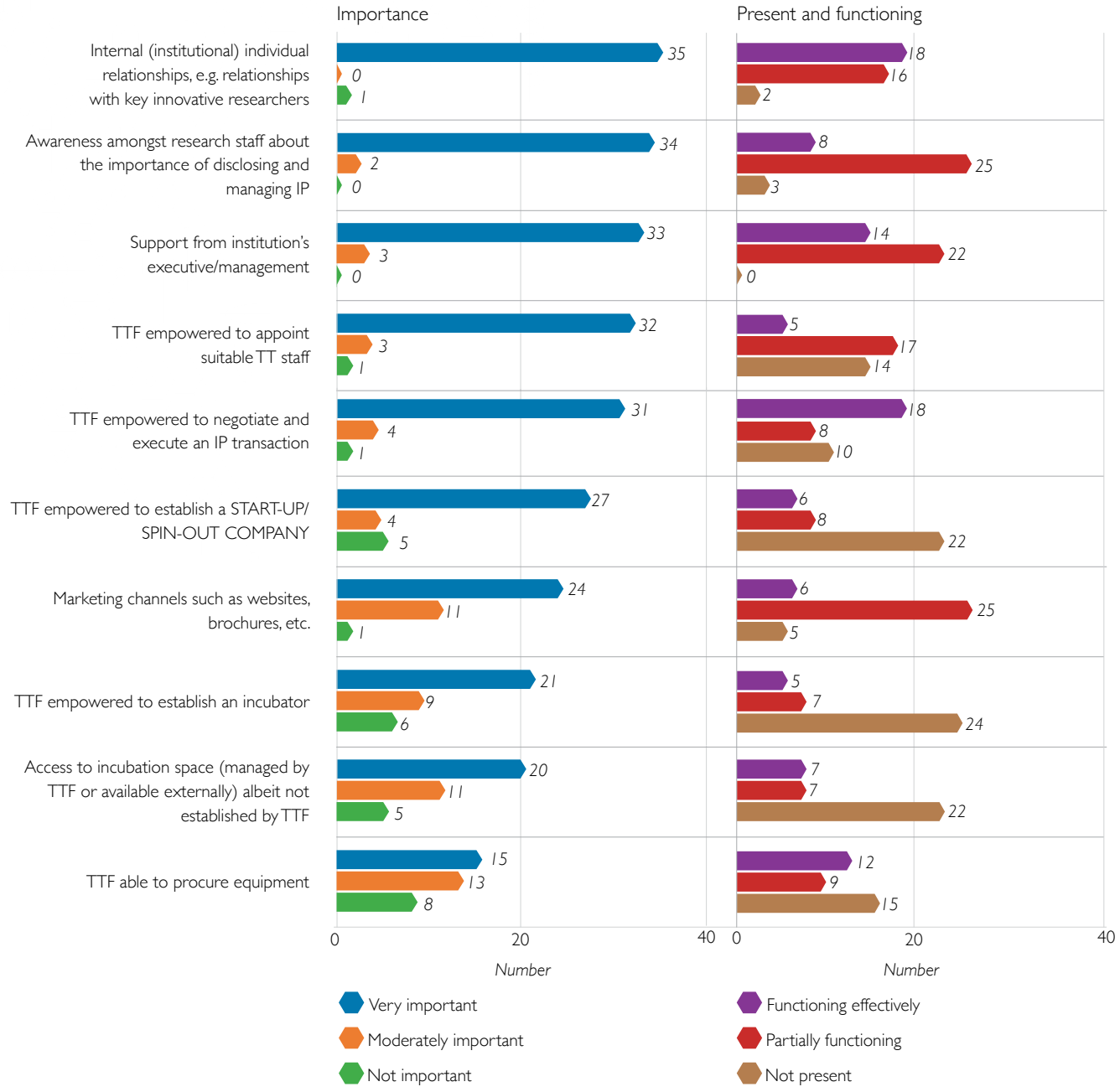


Figure 21: Importance, presence and functioning of internal promotors/enablers of the TTF, 2018

Data note: n = 36

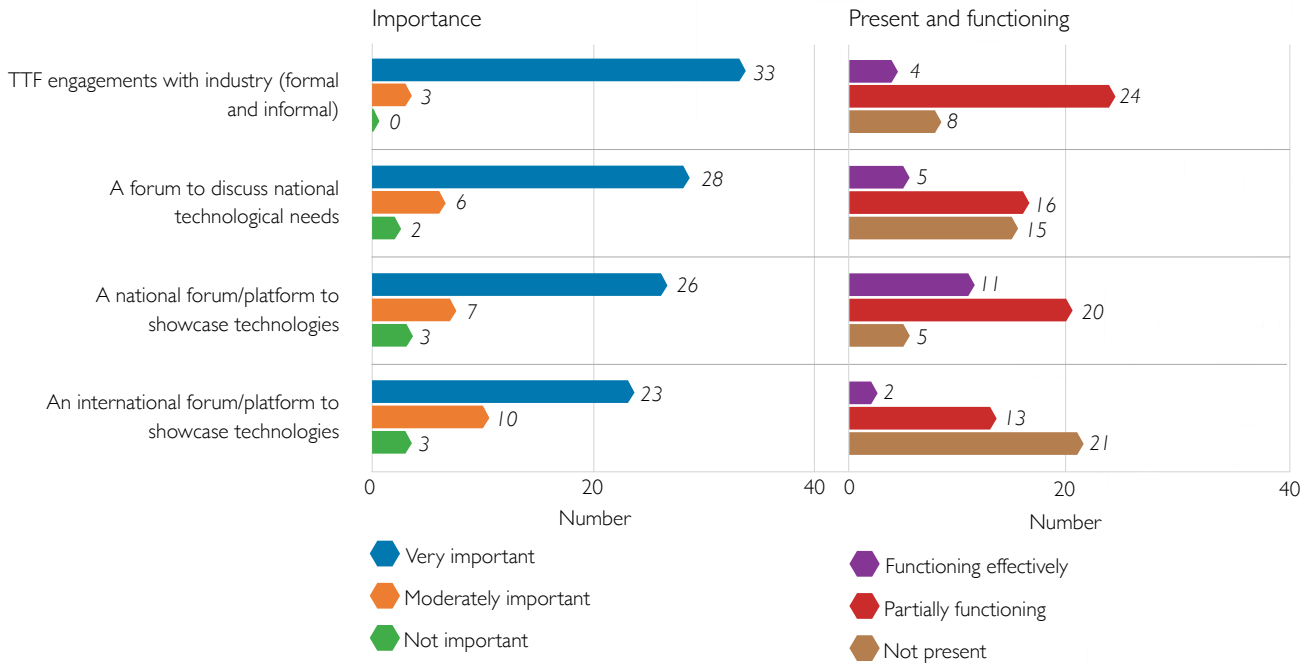


Figure 22: Importance, presence and functioning of external promotors/enablers of the TTF, 2018

Data note: n = 36

Figures 21 and 22 show the importance of key internal and external promotors/enablers of the TTF, and their associated levels of functioning.

The results show that 97% of TTFs consider internal individual relationships within the institution, such as relationships with key researchers, to be very important. However, only 50% reported this to be functioning effectively at their institution. This significant gap could lead to sub-optimal IP management and commercialisation.

Regarding staff recruitment, 89% of TTFs reported that being empowered to appoint suitable staff is considered very important. However, only 47% reported being empowered to some extent and 39% indicated that they are not empowered at all. This suggests that the ability of institutions to attract the unique skillsets and levels of experience required for the effective functioning of the TTF is constrained, which may be cause for concern.

The three promotors most critical to the creation of spin-out companies are:

- TTFs' empowerment to establish start-up/spin-out companies.
- TTFs' empowerment to establish incubators.
- Access to incubation space.

Over 60% of TTFs indicated that none of these are present. This indicates a substantial barrier to one key avenue of creating impact.

Formal and informal engagements with industry is considered to be the most important external promotor, where 92% of TTFs reported this as very important. It is therefore concerning that only 11% indicated that it is functioning effectively at their institutions.

INNOVATIVE WATER FILTER SET TO BENEFIT THOUSANDS OF RURAL HOUSEHOLDS

Access to good quality drinking water remains an out-of-reach luxury for millions of South Africans. According to Statistics South Africa's 2018 General Household Survey, one in four households in the Eastern Cape and Limpopo, and one in ten nationwide, lacks access to potable – drinking quality – water. The challenge is particularly acute in rural areas where communities have to rely on untreated water drawn from rivers, dams and boreholes. These households stand to benefit from a new water purification product, the VulAmanz Water System.

The VulAmanz point-of-use water treatment system makes use of a woven fabric microfiltration technology developed by Prof Lingam Pillay and his team at Durban University of Technology (DUT), and at Stellenbosch University (SU) after he moved there. A significant advantage of the VulAmanz filtration system is that it does not need electricity, as the water treatment is gravity-driven. However, the units do need to be maintained, and an important aspect of the pilot project is the testing of two alternative maintenance models, namely, a community-developed and supported model in Bizana in the Eastern Cape; and a municipality-supported model in the Capricorn District in Limpopo, each of which have deployed around 500 filtration devices. Developing the right maintenance model is a critical aspect of the VulAmanz business model, as a number of water provision projects undertaken in South Africa have failed as a result of maintenance challenges.

VulAmanz has developed two products based on the technology – a gravity-driven unit for individual rural households; as well as a pressurised water station for multiple households, schools and clinics. The latter is ideally suited to be connected to a continuous water supply such as untreated water from a reservoir, or pumped directly from the river or stream into a tank, or sourced from rainwater collection tanks.

The intellectual property underpinning this innovative technology consists of several patents. It is owned by the Water Research Commission to complement its existing suite of water purification technologies, which has entered into an exclusive licence agreement with VulAmanz for the commercialisation of the system.

During the development of VulAmanz, a team visited several rural villages in Limpopo. An elderly grandmother in one such village described how she was raising her grandchildren while her daughters were away in the city. For the first six months of her grandchildren's lives, she had taken them to the community clinic nearly every week to be rehydrated because of chronic diarrhoea. She thought it was due to having to mix baby food with the local untreated water, but buying clean water was simply too expensive. Once a filter was installed, the diarrhoea cleared up and the babies began to thrive.

It is such stories of the improvement in the quality of lives of South Africans that motivates the VulAmanz team to bring these critically needed solutions to fruition.

3. EXPENDITURE AND FUNDING ASSOCIATED WITH THE TECHNOLOGY TRANSFER FUNCTION

This section provides data on expenditure associated with the TTF, including institutional expenditure on clinical trials, institutional research and development (R&D) expenditure and IP, TT operations and litigation expenditure. Furthermore, it covers sources of funding, IP expense reimbursements, and funding requirements.

3.1 EXPENDITURE

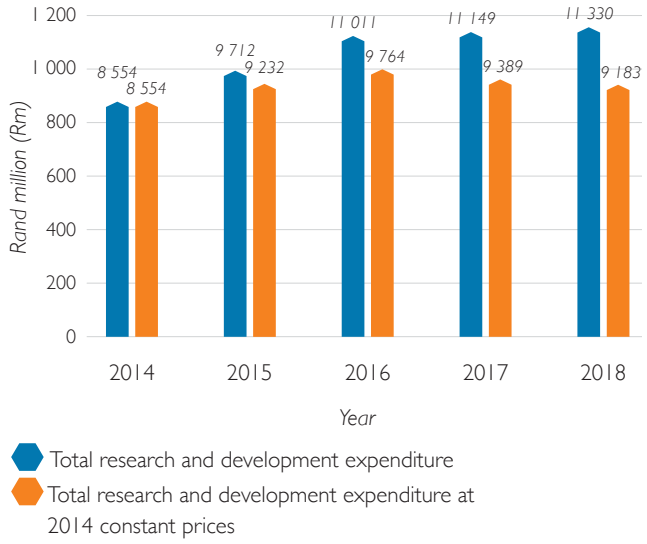


Figure 23: Total research and development expenditure, 2014 – 2018

Data note: n = 23 (HEI n = 15, SC n = 8)

"… R&D expenditure at the institutions has largely stagnated since 2016 …"

Defined terms used in this section include:

- CLINICAL TRIALS
- INSTITUTIONS
- IP EXPENDITURE
- LITIGATION EXPENDITURE
- NON-TIA SEED FUNDS
- RESEARCH AND DEVELOPMENT EXPENDITURE
- START-UP/SPIN-OUT COMPANIES
- TECHNOLOGY TRANSFER FUNCTION
- TIA SEED FUNDS
- TT OPERATIONS EXPENDITURE

(Refer to Section H)

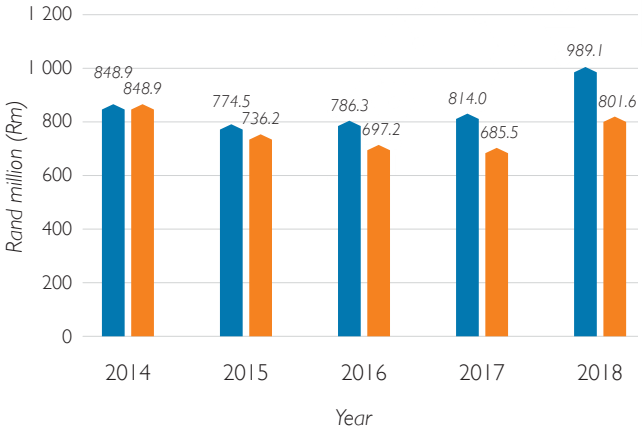


Figure 24: Total expenditure on clinical trials, 2014 – 2018

Data note: n = 9

The values on total research and development expenditure represents 62% of the respondents (some respondents were not able to provide R&D expenditure of all 5 years and were therefore excluded). The data shows that nominal R&D expenditure at the institutions has largely stagnated since 2016, and consequently real expenditure has declined. This is in line with the statistical report for 2017/18 on the *South African National Survey of Research and Development* published in October 2019.

In figure 24, seven HEIs and two SCs reported clinical trial expenditure. As reported, there was a decline in nominal and real terms from 2014 to 2017. By 2018, real clinical trial expenditure was approaching 2014 levels.

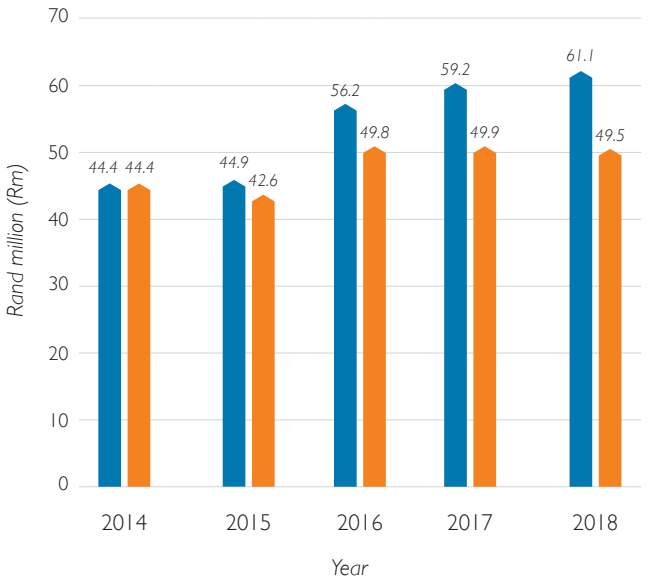


Figure 25: Total IP expenditure, 2014 – 2018

Data note: n = 25
Note: For a breakdown by types of HEIs, see Section E.

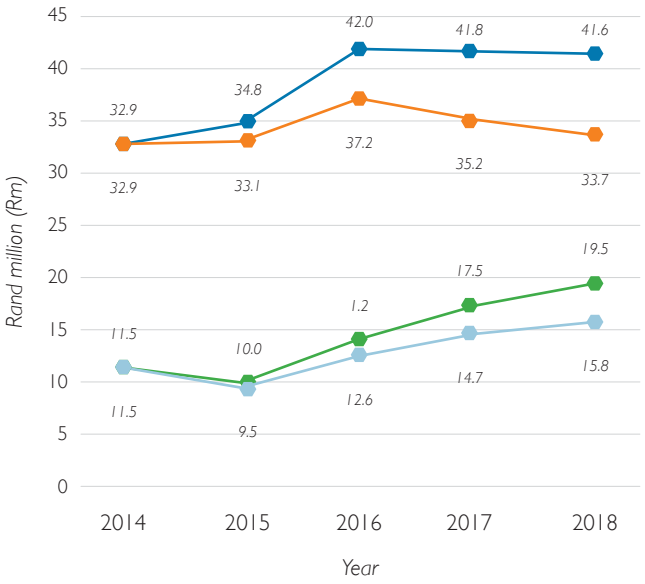


Figure 26: Total IP expenditure per type of institution, 2014 – 2018

Data note: *HEI n = 21, SC n = 4*

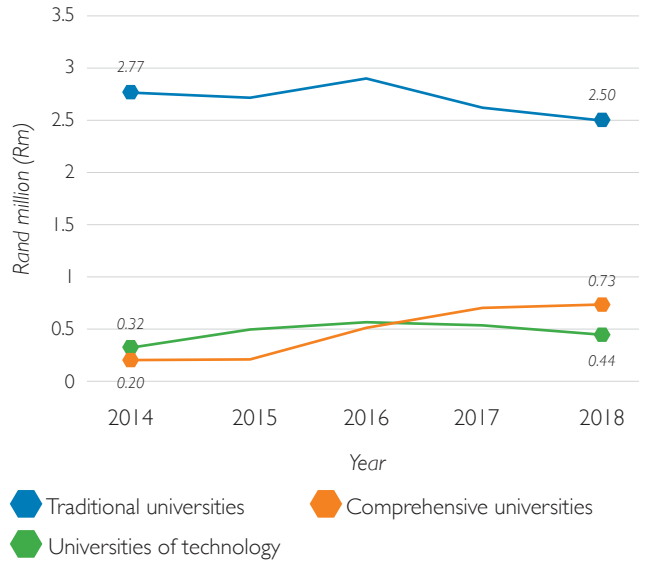


Figure 27: Average IP expenditure at 2014 constant prices per type of HEI, 2014 – 2018

Data note: n: traditional universities = 11; comprehensive universities = 6; universities of technology = 4

Figure 25 shows that real IP expenditure has stagnated from 2016 to 2018. For HEIs, figure 26 shows that nominal IP expenditure has largely stagnated since 2016, with real expenditure declining. For SCs, nominal and real expenditure increased by 95% and 66% respectively from 2015 to 2018.

It is instructive to see trends amongst different types of universities, bearing in mind somewhat different contexts to R&D activities, which lead to the creation of IP. With regard to the average IP expenditure per type of HEI, figure 27 shows that the real IP expenditure for comprehensive universities and universities of technology increased by 265% and 37.5% respectively; while there was a 9.7% decline in the IP expenditure for traditional universities.

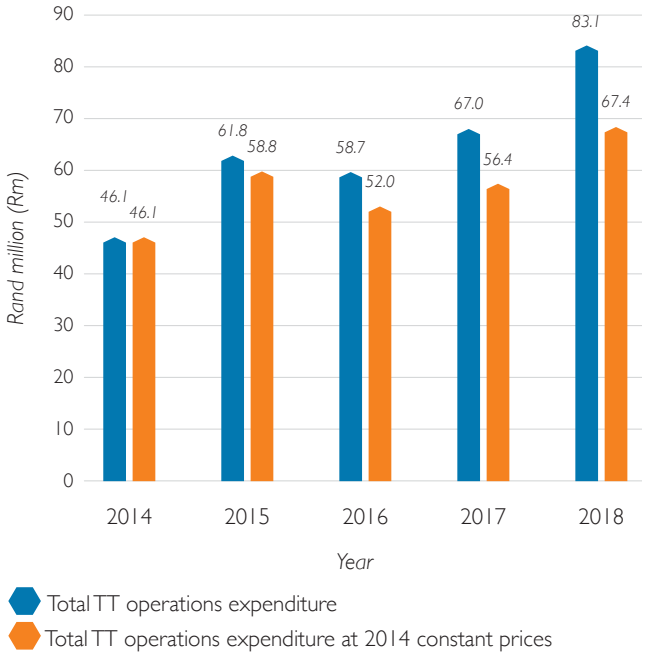


Figure 28: Total TT operations expenditure, 2014 – 2018

Data note: n = 23
Note: For a breakdown by types of HEIs, see Section E.

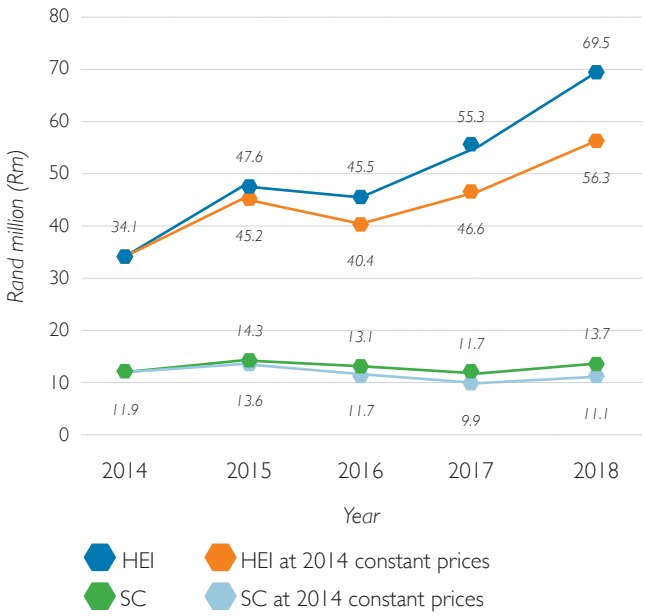


Figure 29: Total TT operations expenditure per type of institution, 2014 – 2018

Data note: HEI n = 18; SC n = 5

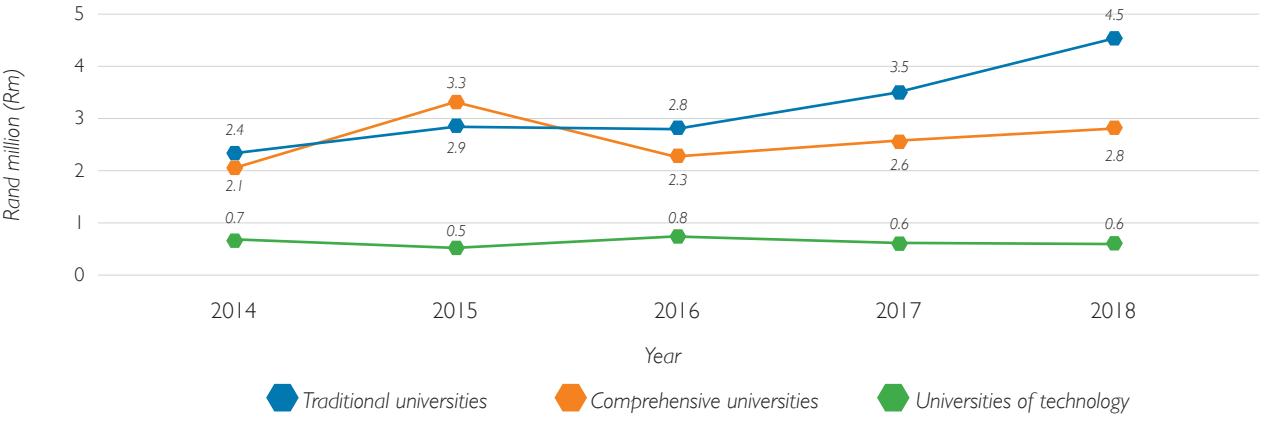


Figure 30: Average TT operations expenditure at 2014 constant prices per type of HEI, 2014 – 2018

Data note: n: traditional universities = 8; comprehensive universities = 6; universities of technology = 4

Referring to figure 28, the total real and nominal TT operations expenditure decreased slightly in 2016 but increased between 2016 and 2018. Figure 29 illustrates that there was a 65% increase in total TT operations expenditure for HEIs over the survey period, while SCs' TT operations expenditure stayed relatively stagnant (increase in nominal terms of 15.1%).

In terms of the expenditure per type of HEI, figure 30 shows that traditional and comprehensive universities had an increase in average TT expenditure in real terms of 87% and 33.3% respectively, while universities of technology saw a decline of 14.3%.

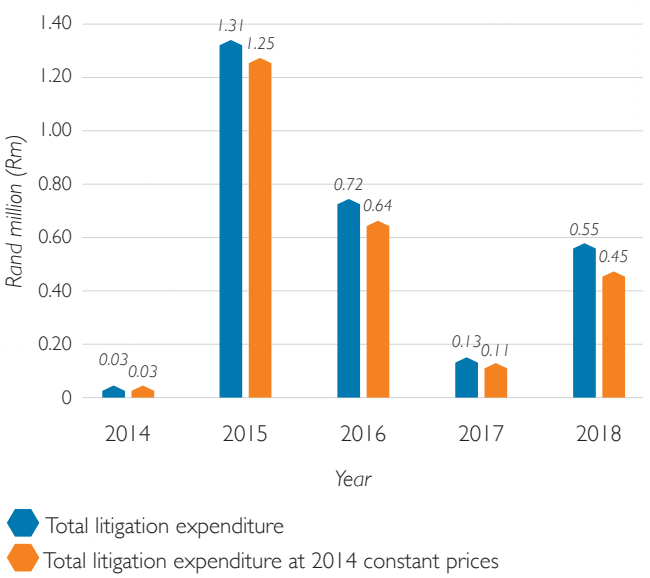


Figure 31: Total litigation expenditure, 2014 – 2018

Data note: n = 26

Substantial fluctuations in TTF litigation expenditure can be seen over the period in figure 31. No more than two institutions reported any expenditure in a particular year. These fluctuations and small number of institutions reporting any litigation expenditure are not surprising. Factors which may influence the fluctuations include the *ad hoc* nature of litigation and, as is shown in Section 2, figures 17 and 18, few TTFs undertaking IP monitoring and enforcement activities.

3.2 SEED FUNDING

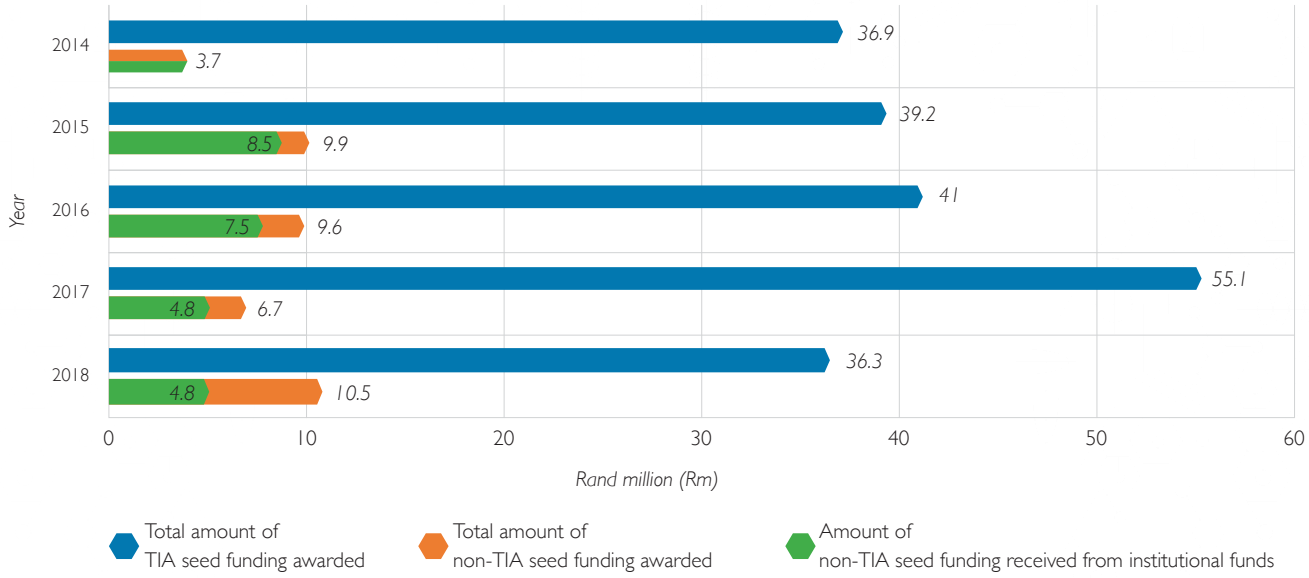


Figure 32: Seed funding in millions of Rands as reported, 2014 – 2018

Data note: n = 26

Seed funding is an important form of funding in developing promising research outputs (and underlying IP) beyond proof of concept, and to support the development of a business case. Figure 32 presents the amounts of seed funding received by the institutions, categorised according to that received from the Technology Innovation Agency (TIA), and from other sources.

TIA created its Seed Fund in 2013 to *"enable innovators* [including those at HEIs and SCs[15]] *to evaluate, demonstrate and advance the value proposition and commercial potential of their research outputs*"[16], and has been the dominant source of this funding in the survey period.

In light of the funding requirements indicated by institutions in figures 33 and 34 on pages 35 and 36, there is an ongoing need for seed funding. While other sources of funding have not increased substantially, it can be concluded that TIA's continued support of this funding instrument is important.

"70% of institutions indicated that they had access to seed funding by 2018."

15. Note that not all SCs qualify for TIA Seed Fund support.
16. The information on the TIA Seed Fund has been taken from the TIA official website www.tia.org.za. Last accessed: 1 November 2020.

3.3 FUNDING REQUIREMENTS

By 2018,

78%

of TTFs reported that they did not have sufficient funding for technology development, upscaling and commercialisation.

Of the 37 institutions, 78% reported that they did not have sufficient funding for technology development, upscaling and commercialisation.

For HEIs, the most significant funding gaps are: i) technology development/ early commercialisation funding (41% reported R10 million or more is required); ii) support funding for the incubation of start-up/spin-out companies (36% reported that R10 million or more is required); and iii) series B funding (32% reported that R10 million or more is required). Since these types of funding are important to support commercialisation, it may be appropriate to undertake further analysis of these funding gaps to understand the implications and propose potential solutions.

For SCs, the most significant funding gaps are: i) technology development/ early commercialisation funding; and ii) early-stage venture capital/ commercialisation funding (43% reported R10 million or more is required in both instances). Of interest, 57% of SCs indicated no funding gap with respect to: i) incubation of start-up/spin-out companies; ii) series A; and iii) series B funding[17]. Analysis of these SCs' mandates, suggests less focus on establishing start-up/spin-out companies, and this may explain why they have reported no gap in these funding categories.

In terms of funding for: i) technology development/early commercialisation; ii) seed funding; iii) early-stage venture capital/commercialisation funding; iv) Series A; and v) Series B funding, the data indicates at least R575 million more is required over two years. This reported funding requirement may need further analysis in light of funding available through existing public and private instruments.

"… for: i) technology development/early commercialisation; ii) seed funding; iii) early-stage venture capital/commercialisation funding; iv) Series A; and v) Series B funding, the data indicates at least R575 million more is required over two years."

STAGES FOR FUNDING
(within the present context)

GOVERNMENT FUNDING/ GRANTS
Undertaking of R&D activities to create research outputs

SEED FUNDING
Early-stage development and translation of research outputs into prototypes and fundable ideas for commercialisation

POST SEED FUNDING
Further technology development and early commercialisation

SERIES A
Funding for the formation/ incorporation of a company/first-round funding

SERIES B
Company scale-up funding (business strategy and customer track record established)

SERIES C AND ONWARDS
Further scale-up/ expansion funding (i.e. development of further product lines, increase market share, etc.)

17. In conjunction with the findings presented in Subsection 2 on skill requirements at SC TTFs, figure 15, and SC TTA, figure 20.

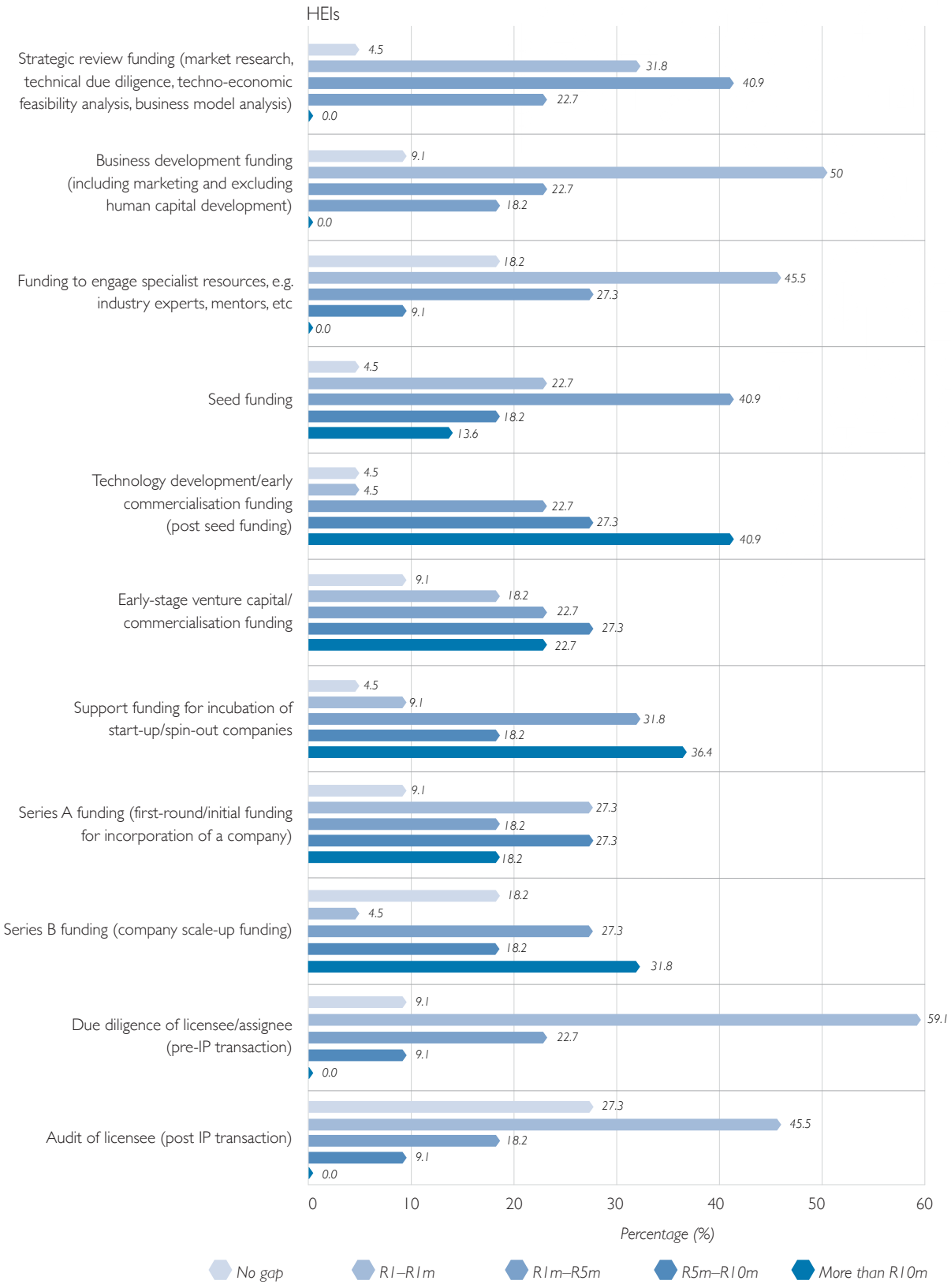


Figure 33: Extent of funding required by HEIs that reported a funding gap by funding type, 2018

Data note: n = 22

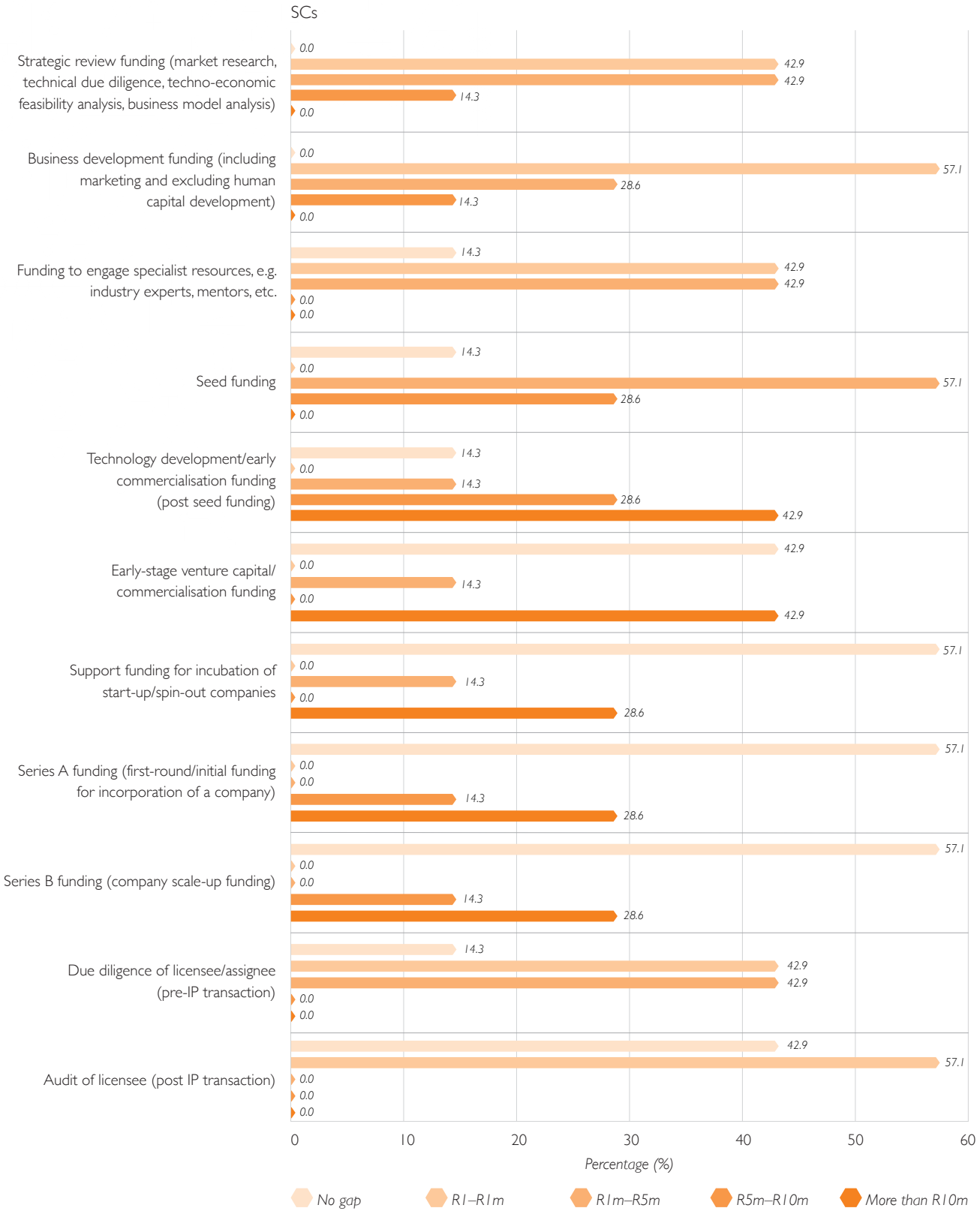


Figure 34: Extent of funding required by SCs that reported a funding gap by funding type, 2018

Data note: n = 7

POWER LINE INSPECTION ROBOT ATTRACTS ATTENTION OF JAPANESE PARTNER

A power line inspection robot (PLIR) developed by researchers at the University of KwaZulu-Natal (UKZN) promises to solve the problems faced by power utilities around the world for inspecting power transmission lines. The technology has drawn interest from TEPCO Power Grid, Incorporated, which will be investigating the use of the robot in Japan.

Overhead power lines are valuable assets that are exposed to environmental risks such as lightning damage, fatigue from wind-induced vibration, corrosion from salty air, and encroachment onto the installation by vegetation or unauthorised construction. Preventive maintenance is therefore necessary to ensure that electricity distribution networks continue to operate safely and reliably, and this makes regular inspections vital.

Currently, inspection methods include the use of helicopters, remotely operated vehicles, and inspectors walking the lines. However, these methods are costly, prone to human error and dangerous. Seeing the opportunity for the use of non-human technology to carry out the dangerous and time-consuming task of inspecting power cables, UKZN researchers Mr Trevor Lorimer and Prof Edward Boje applied robotics to develop a solution.

The resulting PLIR is capable of providing data that allows for an accurate assessment of the degradation of power lines, their components and environment, thereby enabling timeous maintenance or replacement, where required. The data include visual, ultraviolet and infrared images that are geolocation-tagged and time-stamped, allowing for effective management of data over multiple scheduled inspections of the same line.

The PLIR offers several advantages, being lightweight, easy to deploy, and providing consistent inspection standards and data. It is also much simpler to operate than piloting a helicopter. Besides the reduced physical demands on the inspector, the PLIR requires minimal setup to deploy from a tower onto a live line. It has the ability to climb around suspension towers, comes with automated sequences for climbing around line hardware, and its cameras are in close proximity to the line, resulting in improved visibility.

Patents for the PLIR are in force in a number of countries, facilitating commercialisation that is protected from potential competitors. Ms Suvina Singh, Director: IP and Commercialisation at UKZN, says: "*We are delighted that the PLIR has attracted international interest. This is potentially a source of foreign revenue and equally importantly, shows how South African ingenuity can solve problems experienced all over the world. We are excited to work with TEPCO PG to improve the product in terms of their requirements, and other commercial partners in the future.*"

4. INTELLECTUAL PROPERTY PORTFOLIO

This section provides information on the number of disclosures, technologies, patents, designs, trade marks and plant breeders' rights in the institutional IP portfolios. The IPR Act and non-IPR Act IP portfolios are reported separately in subsections 4.1 and 4.2 respectively.

As stated in Section B, in this Report "IPR Act IP" refers to all IP created after 2 August 2010 which emanates from publicly financed R&D. "Non-IPR Act IP" refers to: i) IP created before 2 August 2010; or ii) IP created after 2 August 2010 but where the R&D was not publicly financed.

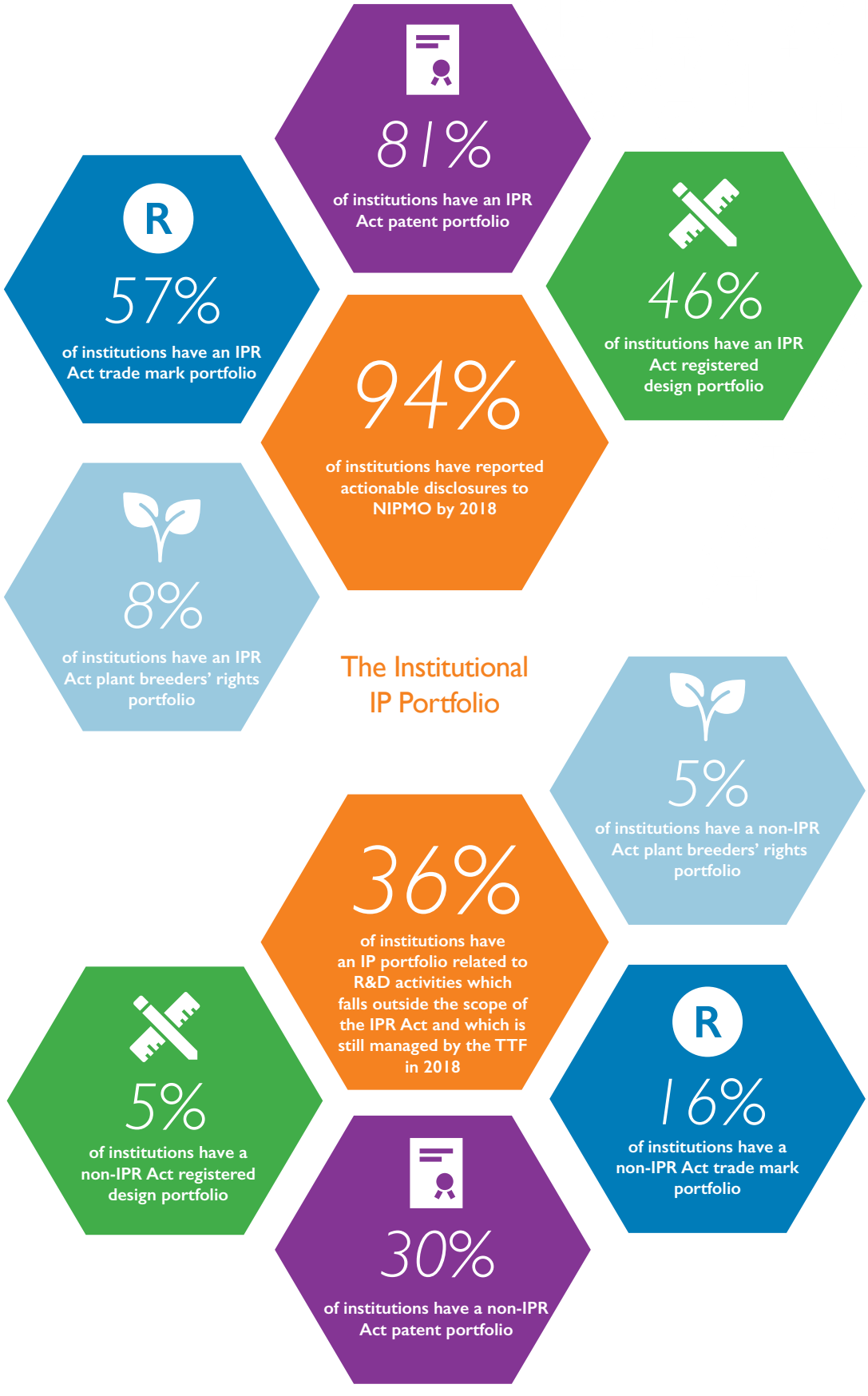
Defined terms used in this section include:

- ACTIONABLE DISCLOSURES
- INSTITUTIONS
- NEW PATENT APPLICATIONS
- NEW PLANT BREEDERS' RIGHTS APPLICATIONS
- NEW REGISTERED DESIGN APPLICATIONS
- NEW TRADE MARK APPLICATIONS
- PATENT FAMILY(IES)
- PATENT(S) GRANTED
- PLANT BREEDERS' RIGHTS FAMILY
- PLANT BREEDERS' RIGHTS GRANTED
- REGISTERED DESIGN(S) GRANTED
- SA COMPLETE PATENT APPLICATIONS
- SA PROVISIONAL PATENT APPLICATIONS
- TECHNOLOGIES
- TECHNOLOGY TRANSFER FUNCTION
- TRADE MARK(S) GRANTED

(Refer to Section H)

IPR ACT IP

NON-IPR ACT IP



4.1 IPR ACT INTELLECTUAL PROPERTY

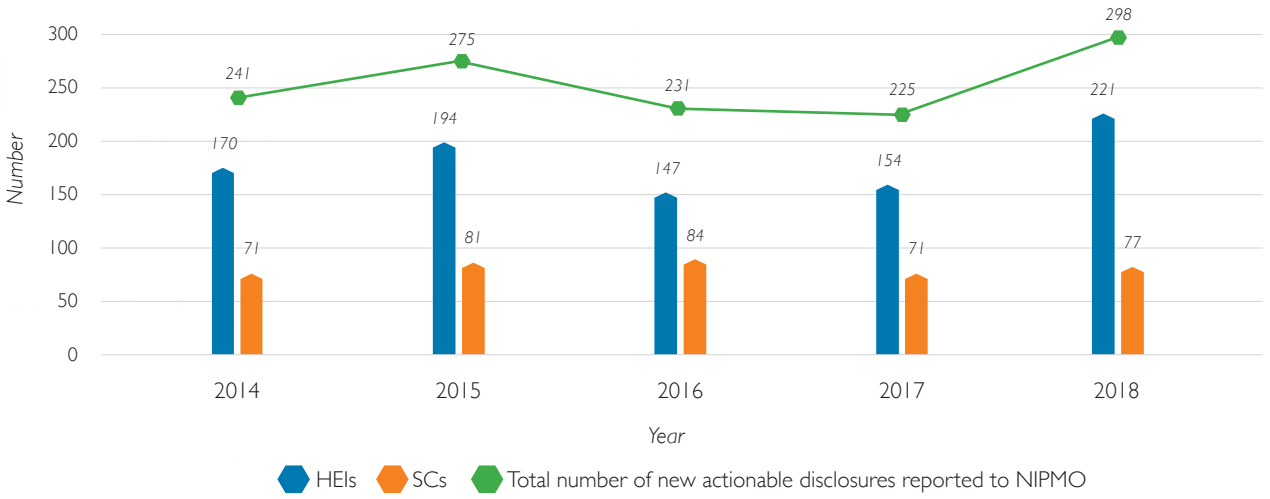


Figure 35: IPR Act IP: Number of actionable disclosures reported to NIPMO by the TTF, 2014 – 2018

Data note: n = 31 (HEI n = 22; SC n = 9)

Note: For a breakdown by types of HEIs, see Section E.

Actionable disclosures are those which the institution elects to retain within their IP portfolio as having the potential to: i) address socioeconomic needs; or ii) can be utilised/commercialised. Overall, there is a 23.7% increase in reported new actionable disclosures over the survey period. As expected, there are fluctuations, as the creation of IP is dependent on a number of factors that vary from year to year.

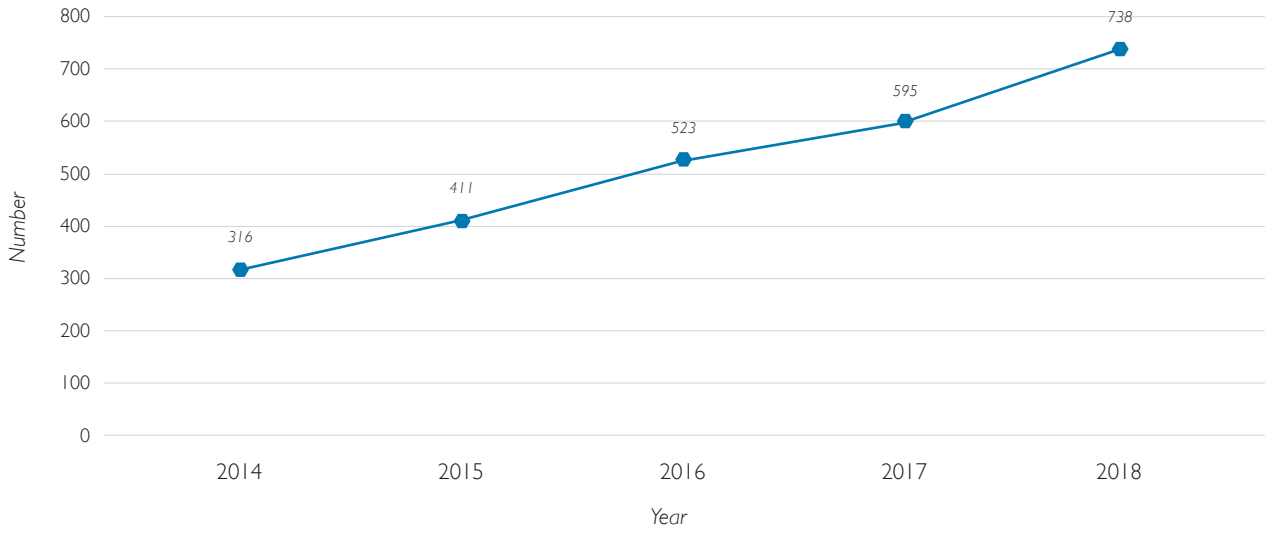


Figure 36: IPR Act IP: Total number of actionable disclosures in the portfolio managed by the TTF, 2014 – 2018

Data note: n = 24

The total number of actionable disclosures managed by TTFs more than doubled over the survey period.

PATENTS

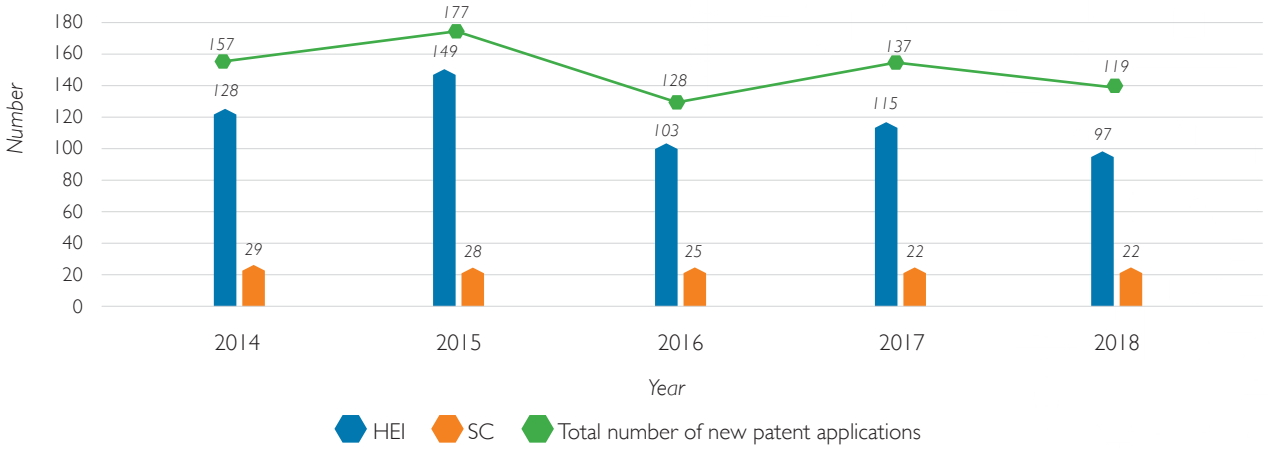


Figure 37: IPR Act IP: Number of new patent applications, 2014 – 2018

Data note: n = 37
Note: For a breakdown by types of HEIs, see Section E.

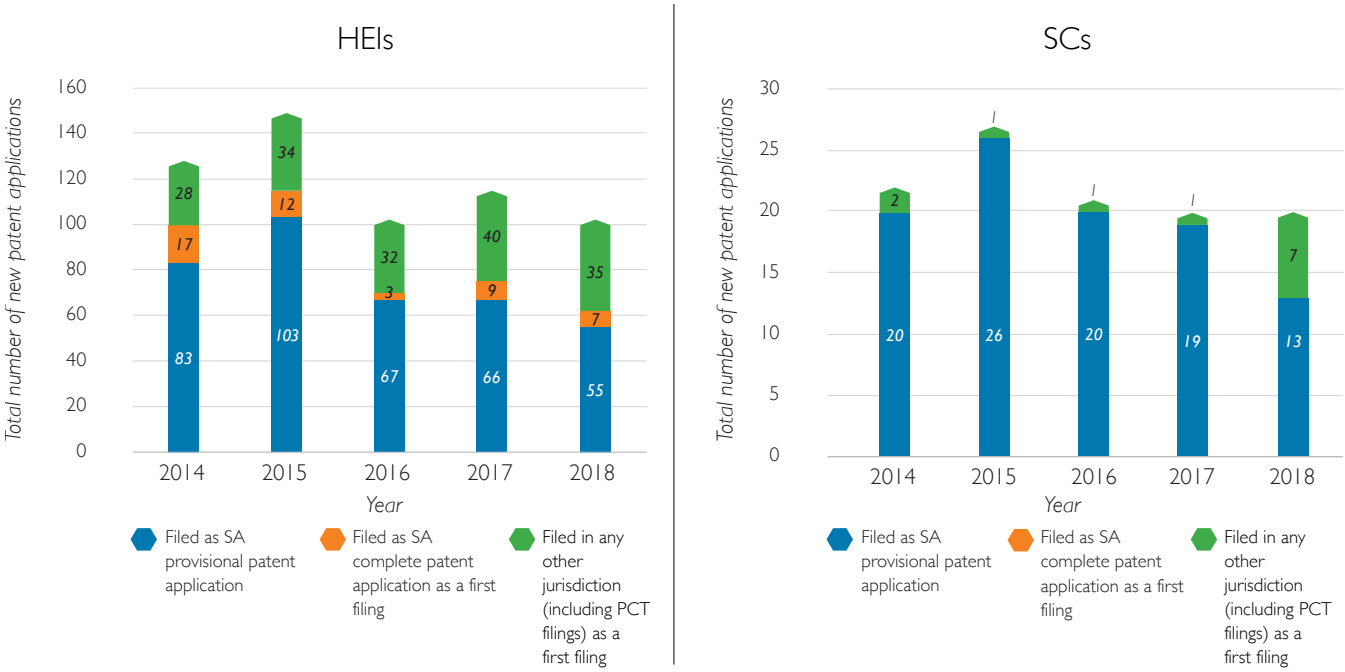


Figure 38: IPR Act IP: Types of patent applications filed as first filing, 2014 – 2018

Data note: n = 37
Note: For a breakdown by types of HEIs, see Section E.

Of the total number of respondents, 29 (21 HEIs and eight SCs) indicated that they filed at least one patent application over the survey period and provided the number of patent applications filed over the survey period. In terms of new patent applications filed, there is a downward trend (figure 37). The filing of new patent applications is influenced by a number of factors. The decline could be due to the improved capacity within the TTFs to conduct in-depth assessment of the patentability and commercial potential of a disclosure, and thus make a more informed decision on whether to incur the cost of filing a patent application. It may also be due to budget constraints.

Referring to figure 38, filing a South African provisional patent application is the dominant first filing (information from 28 respondents: 21 HEIs and seven SCs). There has, however, been a substantial increase in first filings in foreign jurisdictions over the period. By directly filing in a foreign jurisdiction which conducts substantive examination, it is possible to obtain a preliminary search report. Although more expensive than filing in South Africa, this approach may provide information on the prospects for obtaining a granted patent in a much-reduced timeframe. As a result, the decision on whether to proceed with further filings can be made before significant additional costs are incurred.

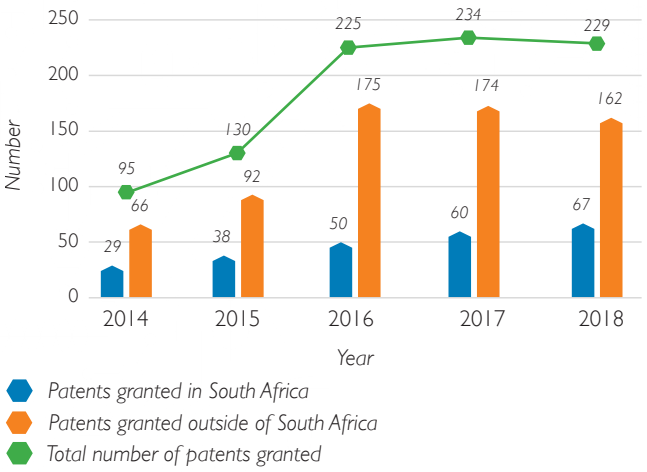


Figure 39: IPR Act IP: Number of patents granted, 2014 – 2018

Data note: n = 37
Note: For a breakdown by select number of countries, see Section E.

Of the total number of respondents, 21 indicated that they had patent(s) granted in the survey period. The total number of patents granted more than doubled over the period.

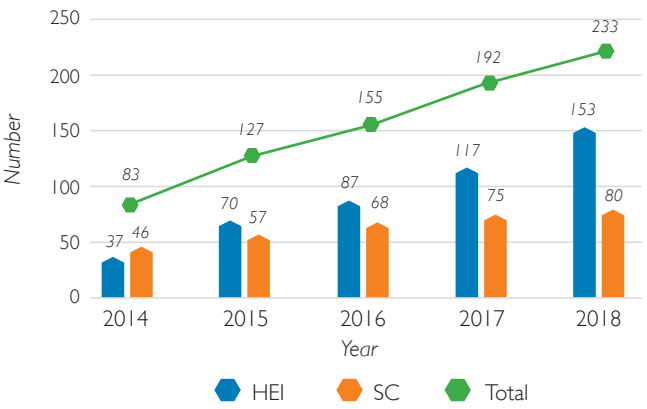


Figure 40: IPR Act IP: Total number of patent families in the portfolio with at least one jurisdiction granted, 2014 – 2018

Data note: n = 37
Note: For a breakdown by types of HEIs, see Section E.

Of the total number of respondents, 21 (16 HEIs and five SCs) reported that they managed one or more patent families comprising a patent granted in at least one jurisdiction. Over the period, the number of such patent families has almost trebled.

TRADE MARKS

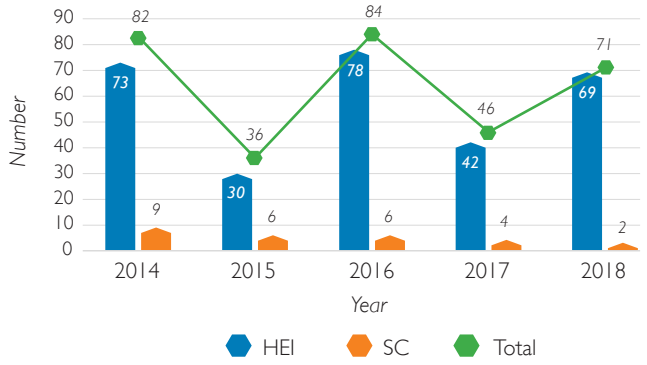


Figure 41: IPR Act IP: Total number of new trade mark applications filed, 2014 – 2018

Data note: n = 37

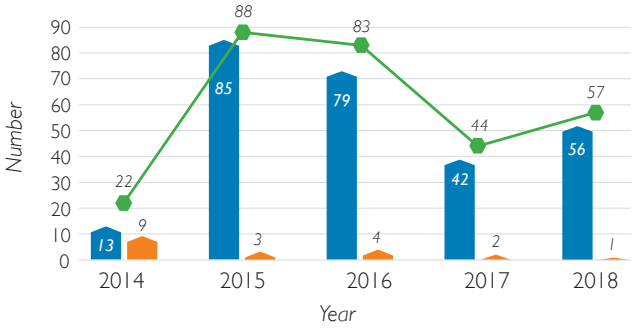


Figure 42: IPR Act IP: Number of trade marks granted, 2014 – 2018

Data note: n = 37

Of the total number of respondents, 16 (13 HEIs and three SCs) reported either a new trade mark application or a granted trade mark over the survey period. Trade marks are marks or brand assets that are capable of registration in terms of trade mark legislation and is used or proposed to be used in relation to goods or services. The focus of trade marks filed by institutions is South Africa. There is significant fluctuation in the number of new trade mark filings. Unlike patents and registered designs which must be filed within a prescribed period, trade mark applications can be filed in different countries at different times. As a result, trade mark applications are typically only filed in a particular country when entering that market with a product or service. Trade marks are therefore often filed not by the institution, but rather by the commercialisation partner, and only once commercial readiness is reached.

REGISTERED DESIGNS

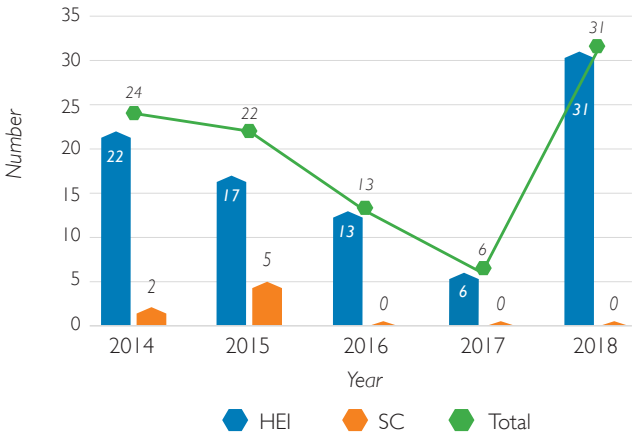


Figure 43: IPR Act IP: Total number of new design applications filed, 2014 – 2018

Data note: n = 37

Of the total number of respondents, 14 (12 HEIs and two SCs) reported either a new design application or a registered design. Registered designs offer protection for the design as applied to an article to be manufactured by an industrial process, whether for its aesthetics or as necessitated by the function which the article is to fulfil. In this regard, this type of protection is applicable to only certain technologies. This may explain the fact that the number of new design applications is substantially lower than the number of new patent applications filed, and the fluctuations from year to year.

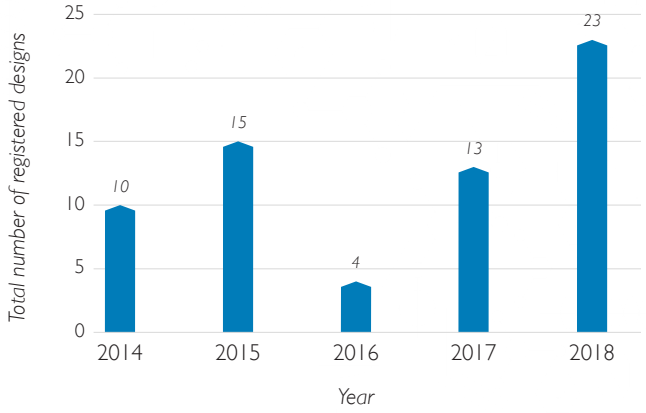


Figure 44: IPR Act IP: Total number of registered designs, 2014 – 2018

Data note: n = 37

PLANT BREEDERS' RIGHTS

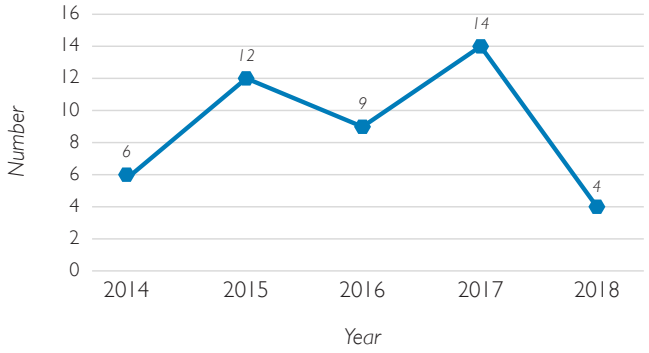


Figure 45: IPR Act IP: Total number of new plant breeders' rights applications filed, 2014 – 2018

Data note: n = 37
Data obtained from the South African Plant Variety Journal.

The survey did not yield sufficient data directly, and therefore figures 45 and 46 provide data obtained from the South African Plant Variety Journal, as published quarterly by the Department of Agriculture, Land Reform and Rural Development (formerly the Department of Agriculture, Forestry and Fisheries).

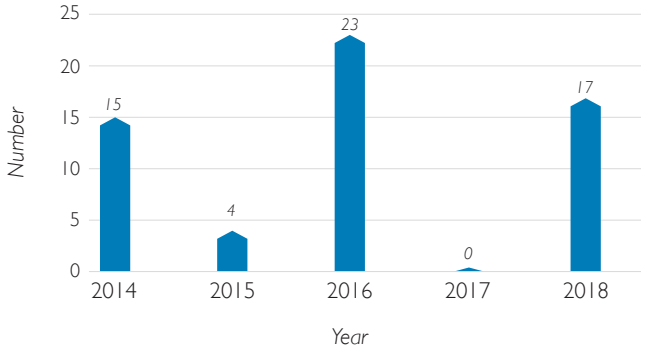


Figure 46: IPR Act IP: Plant breeders' rights granted, 2014 – 2018

Data note: n = 37
Data obtained from the South African Plant Variety Journal.

4.2 NON-IPR ACT INTELLECTUAL PROPERTY

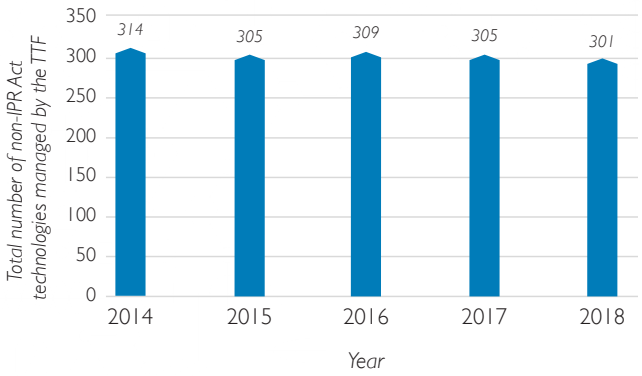


Figure 47: Non-IPR Act IP: Disclosures managed by the TTF, 2014 – 2018

Data note: n = 37

Of the total number of respondents, eight reported disclosures over the survey period that fall outside the scope of the IPR Act that are managed by the TTF. It is noteworthy that more than 300 non-IPR Act disclosures are within the portfolio managed by the TTFs as at 2018. From inspection of the data, two institutions account for more than 80% of the total number of disclosures so managed as at 2018.

PATENTS

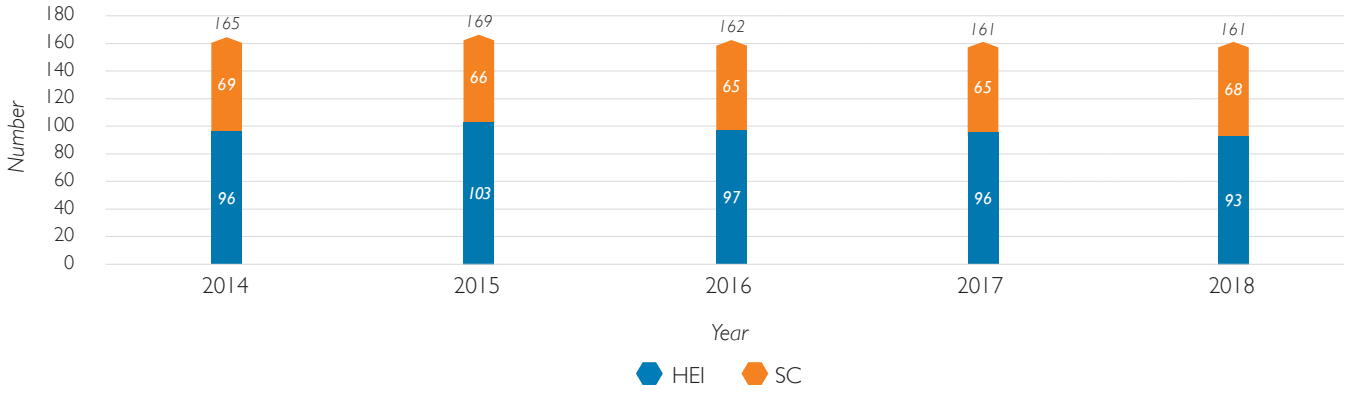


Figure 48: Non-IPR Act IP: Total number of patent families in the portfolio where a patent has been granted in at least one jurisdiction, 2014 – 2018

Data note: n = 37

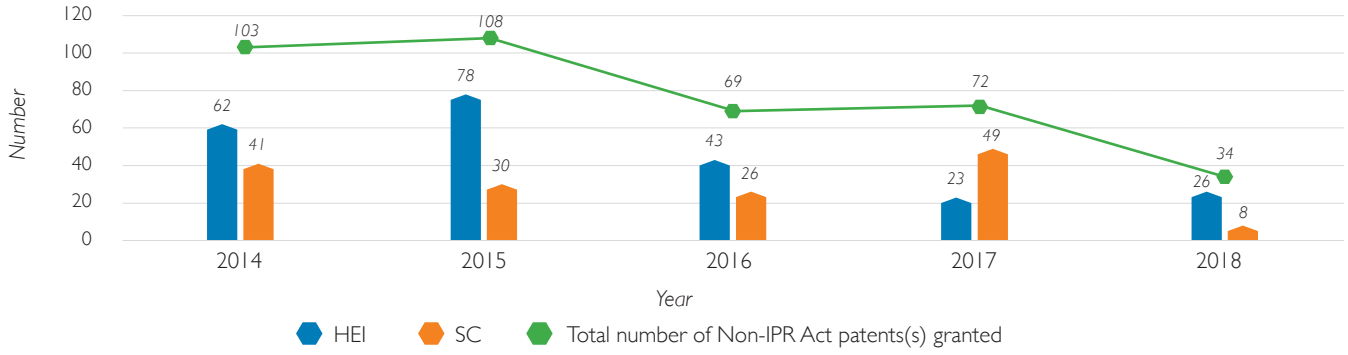


Figure 49: Non-IPR Act IP: Total number of patents granted per institution type, 2014 – 2018

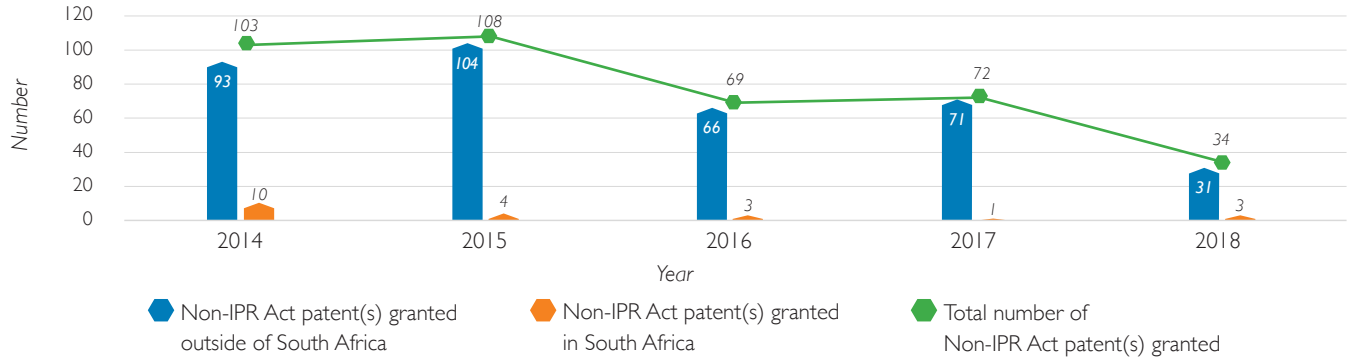


Figure 50: Non-IPR Act IP: Number of non-IPR Act patents granted, 2014 – 2018

Data note: n = 37

Of the total number of respondents, nine (five HEIs and four SCs) reported that they had a non-IPR Act patent portfolio over the survey period. In figure 48, the number of non-IPR Act patent families remains fairly constant over the period, in contrast with the IPR Act patent families which are increasing (see figure 40). Referring to figures 49 and 50, the number of non-IPR Act patents granted in a particular year is declining over time. The reasons for these results may include that the major portion of the patent families had existed prior to 2010. This is apparent from inspection of the data, whereby only 19 non-IPR Act disclosures were received by the TTFs over the survey period, as compared to 1 270 IPR Act actionable disclosures (see figure 35).

OTHER FORMS OF IP

Only 16% of institutions reported non-IPR Act trade marks and 5% have non-IPR Act registered designs and/or granted plant breeders' rights as at 2018. The annual values provided by these institutions are too sparse to include in this Report.

SOUTH AFRICAN TRADE DECISION SUPPORT TOOL ADVISES GOVERNMENTS GLOBALLY

A trade decision support model developed by South African researchers has led to the formation of a thriving spin-out company, Trade Research Advisory (Pty) Ltd, and enabled the successful marketing of trade advisory services to governments and trade and investment promotion agencies around the world.

In 2004, economists at North-West University (NWU) began investigating the use of so-called "big data" processing and analysis to inform evidence-based decision-making for export markets. Big data refers to extremely large datasets which need to be processed and analysed in the context where the data volume can increase exponentially over time. The initiative started with a study by Prof Wilma Viviers at the NWU into the competitive intelligence practices in South Africa and Belgium. This led to an expanded study, together with Prof Ludo Cuyvers of the University of Antwerp, in Belgium on identifying realistic export opportunities for South Africa.

The studies involved the application of selective filters to extract analysis from international trade data combined with other economic data sources, and culminated in the development of a trade decision support model. The TRADE-DSM is the "innovative product" developed from this multi-stage filtering methodology that considers millions of product-country combinations, using a process of elimination to filter the most realistic markets for each priority product, so as to inform strategic export decision-making. Since the TRADE-DSM was applied to South Africa, this pilot enabled the researchers to customise and refine the proprietary set of big data filters.

In 2016, the NWU licensed the TRADE-DSM copyright and know-how to Trade Research Advisory (Pty) Ltd, that was spun out from NWU under the leadership of Mr Martin Cameron, a former student of Prof Viviers. The licensing enabled the commercialisation of the methodology through an economic advisory offering targeting the public sector, particularly trade and investment promotion agencies in various countries.

Trade Research Advisory also developed the TRADE-DSM Navigator software, which partially interprets and presents TRADE-DSM results in an interactive and user-friendly way, and enables users to access them dynamically. The algorithm that was originally developed by Prof Cuyvers and subsequently used by the NWU to adapt the model for South Africa, is the inherent piece of intellectual property at the core of the methodology. The TRADE-DSM and the TRADE-DSM Navigator are further protected by copyright.

Trade Research Advisory not only has clients in South Africa. Models have been developed for other countries including Rwanda, Australia, China, Belgium and Thailand. NWU continuously extends the advisory services offered by Trade Research Advisory with the development of various TRADE-DSMs as part of academic research projects, most recently for Tunisia, while on the commercial research front, the United Nations Economic Council for Africa (UNECA), for example, commissioned a model and an advisory engagement to help with the revision of Cameroon's industrialisation plan in the context of the African Continental Free Trade Area (AfCFTA).

In a post-COVID-19 world, where governments are resetting their economies and businesses and industries are re-examining their business models, there are exciting prospects for the further application of TRADE-DSM. The tool could play a key role in advising on accelerated industrial recovery and job creation through exports, and navigating trade opportunities in the context of international developments like the AfCFTA, BREXIT and the world's largest free trade agreement, the landmark Regional Comprehensive Economic Partnership (RCEP) trade agreement covering Southeast Asian Nations and Oceania. The RCEP trade agreement covers countries that produce approximately 30% of global GDP.

5. INTELLECTUAL PROPERTY TRANSACTIONS AND REVENUE

The ultimate purpose of managing and protecting IP is to enable its commercialisation, so as to contribute to socioeconomic outcomes. These include job creation, direct or indirect impact on gross domestic product, foreign investment, improved public health outcomes, food security, etc. This section relates to the agreements concluded between parties wherein rights, titles and/or interests in the IP or IP rights are transferred to another party for the purpose of commercialisation. These agreements are termed "IP transactions", and can take different forms:

- **Options:** A party is granted an option to negotiate a licence or assignment (see below). An option can be subject to certain conditions being met, and/or a time period during which such party can exercise the option. An option does not generally confer any right to use beyond that which may be required for evaluation.
- **Licences:** A commercialisation partner is granted part or all of the rights to commercialise the IP. Exclusive licences are those limited to a single commercial partner, whereas non-exclusive licences allow for the licensing to more than one commercial partner in respect of the same IP.
- **Assignments.** An agreement where ownership of the IP is transferred to a commercialisation partner.

Defined terms used in this section include:

- ACTIONABLE DISCLOSURES
- ASSIGNMENT(S)
- AVAILABLE
- BBBEE COMPLIANT ENTITIES
- EXCLUSIVE
- FOREIGN-REGISTERED ORGANISATIONS
- INSTITUTIONS
- IP CREATORS/ENABLERS
- IP TRANSACTION
- IP TRANSACTION REVENUE
- LARGE COMPANIES
- LICENCE(S)
- LICENSED ACTIONABLE DISCLOSURES
- NON-EXCLUSIVE
- OPTION(S)
- SOUTH AFRICAN-REGISTERED ORGANISATION
- SMMEs
- START-UP/SPIN-OUT COMPANIES
- TECHNOLOGY TRANSFER FUNCTION

(Refer to Section H)

5.1 OVERVIEW OF IP TRANSACTIONS AND REVENUE

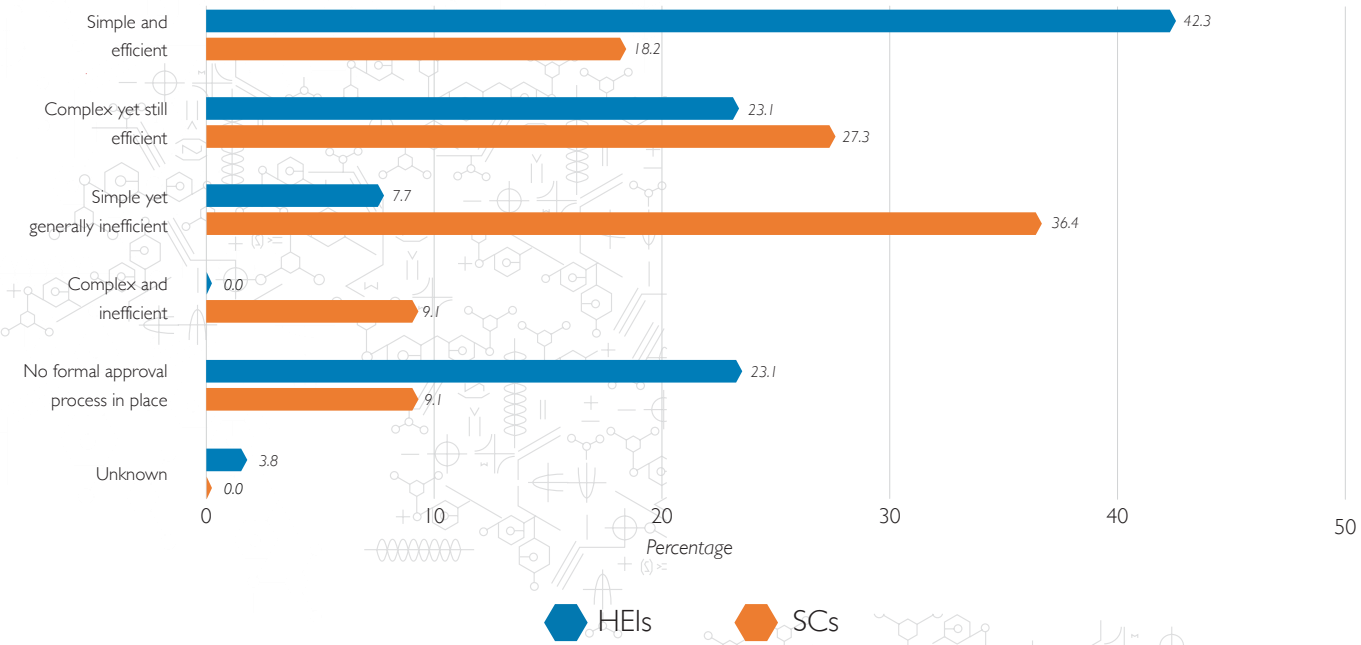
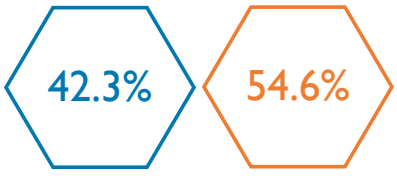


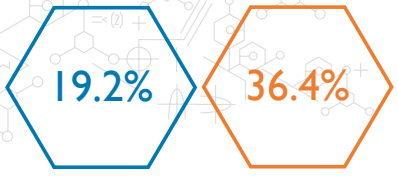
Figure 51: The most appropriate descriptions of the institutional approval processes to conclude IP transactions, 2018

Data note: n = 37



HEIs/SCs that have concluded IP transactions on IPR Act IP since 2010.

HEIs/SCs that have concluded IP transactions on IPR Act-related IP between 2014 and 2018.



HEIs/SCs that have concluded IP transactions on non-IPR Act IP and/or received IP transaction revenue which falls outside the scope of the IPR Act between 2014 and 2018.

Effective and efficient policies and approval processes to conclude IP transactions are important to facilitate timeous commercialisation and eventual impact in society. The figure above indicates that 65.4% of HEIs and 45.5% of SCs describe these approval processes as efficient (simple or complex). It is worth noting that 23.1% of HEIs and 9.1% of SCs indicated that they have no formal approval process in place.

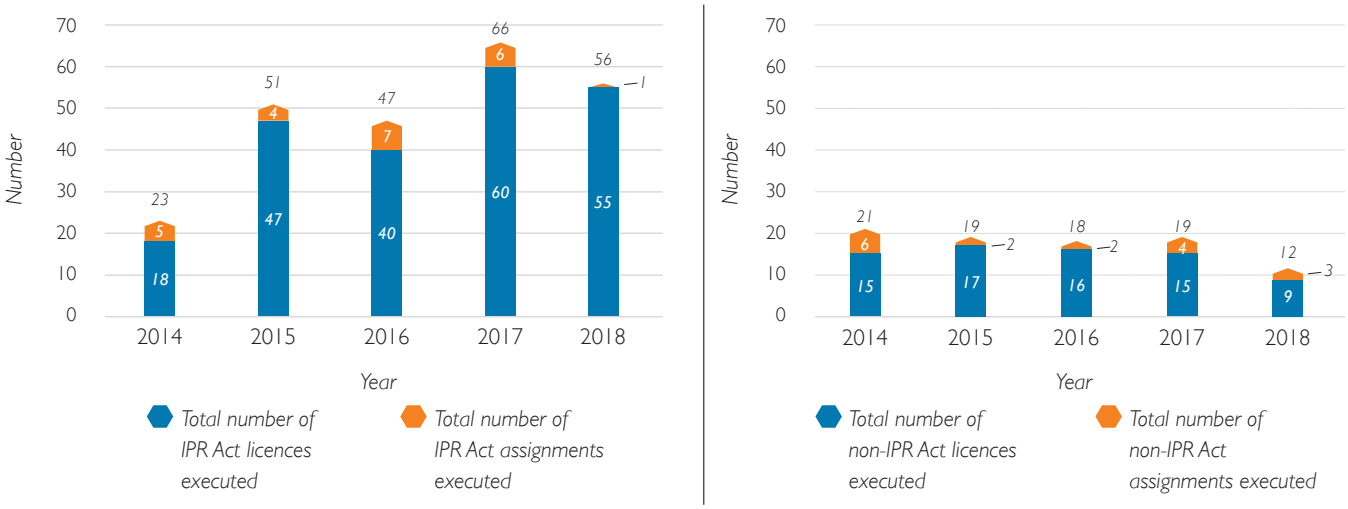


Figure 52: IPR Act IP and non-IPR Act IP: Number of IP transactions concluded, broken down into licences and assignments, 2014 – 2018

Data note: n = 37

Of the total number of respondents, 15 (IPR Act IP) and 14 (Non-IPR Act IP) institutions respectively reported over the survey period that they concluded either a licence or assignment. Licences and assignments are a necessary precursor to commercialisation and eventual impact. There is an encouraging increasing trend of IPR Act licences concluded. Fluctuations, as seen in figure 52, in the number of transactions from year to year may be as a result of the timing of a commercial partnership being established, as well as other factors. From inspection of the data, for four out of the five years of the survey period, five institutions accounted for 80% or more of the licences concluded.

Over the survey period, a total of 96 options were granted by the institutions, of which 94.8% were granted by HEIs.

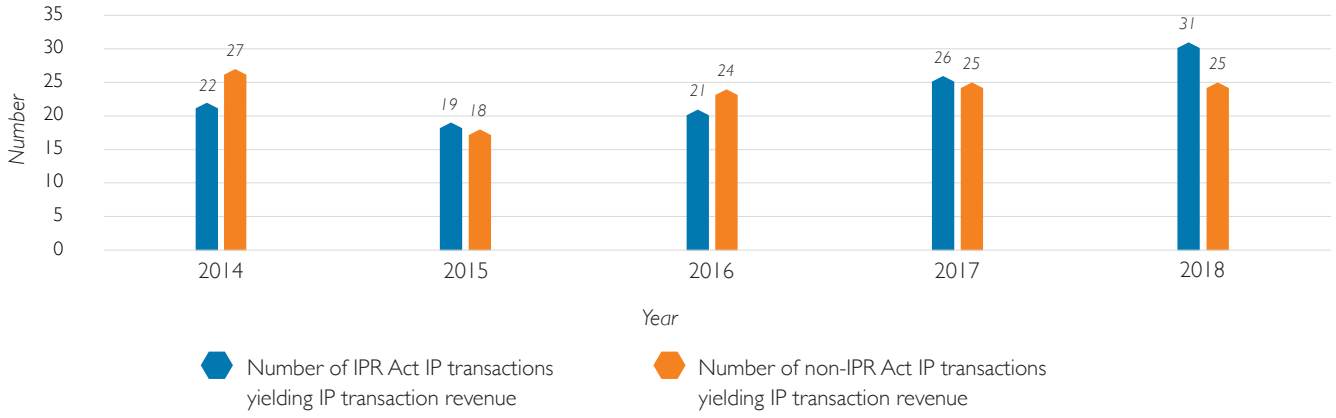


Figure 53: Number of IP transactions yielding IP transaction revenue, 2014 – 2018

Data note: n = 37

Of the total number of respondents, 17 (IPR Act IP: 11 HEIs and six SCs) and nine (non-IPR Act IP: Five HEIs and four SCs) reported that they concluded either a licence or assignment that yielded IP transaction revenue. The total number of IPR Act licences and assignments yielding revenue to institutions shows an encouraging overall increase. The fluctuations in the data can be as a result of many factors that influence the timing of, and amount of revenue generated from, successful commercialisation.

"… for four out of the five years of the survey period, five institutions accounted for 80% or more of the licences concluded."

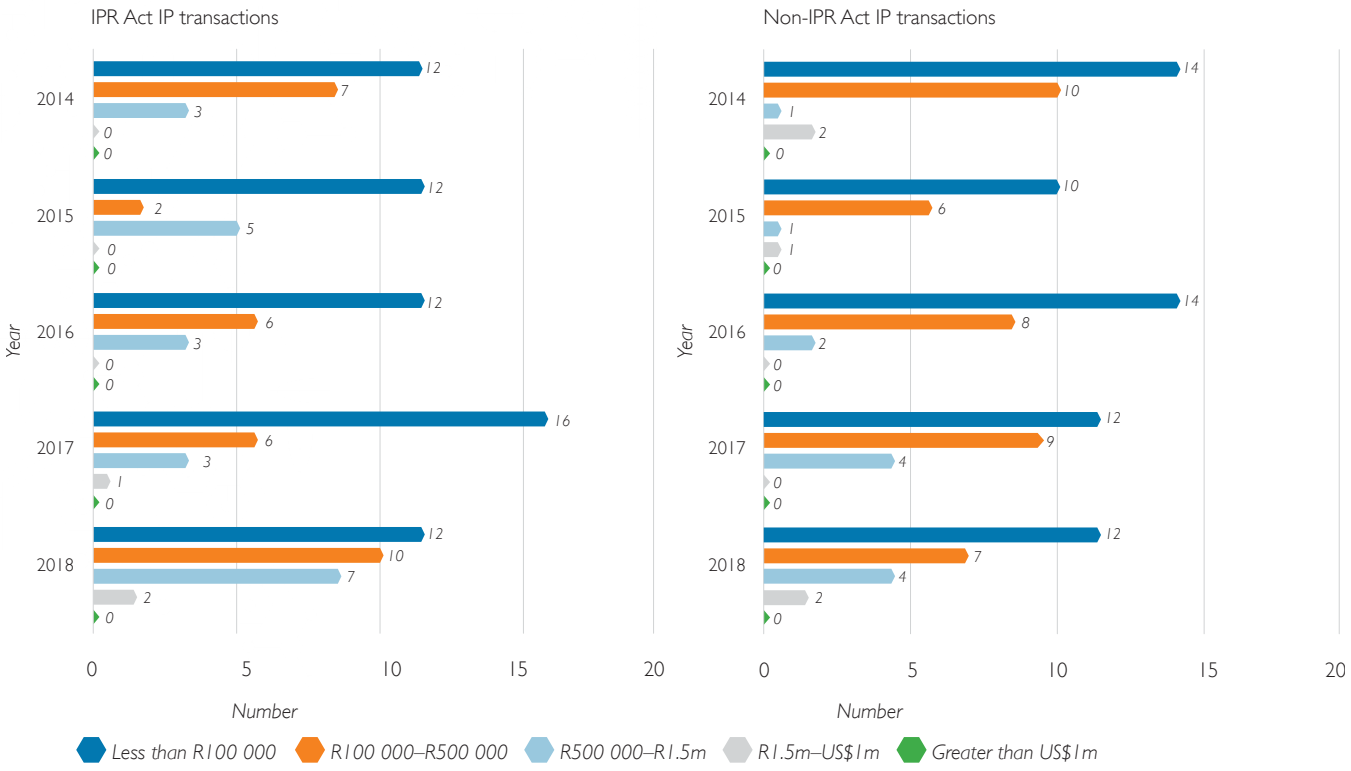


Figure 54: Number of IP transactions yielding IP transaction revenue, 2014 – 2018

Data note: n = 37
Note: The Rand equivalent of US$1 million was calculated using PPP as obtained from the OECD as published at September 2020[18].

Of the IP transactions (both IPR Act IP and non-IPR Act IP) that generated revenue to the institutions, just over 50% yielded less than R100 000. This is similar to trends seen in other countries[19] where a significant proportion of IP transactions yield relatively low revenue to the institution in any given year. It should be noted that this revenue is not necessarily an indicator of total revenue generated by commercial partners (licensees and assignees), and it would be useful to measure this data going forward, to obtain a better understanding of the impact created.

Comparing the baseline survey with this survey, the average number of IP transactions which yielded revenue between 2014 and 2018 almost doubled from that seen between 2008 and 2014, increasing from an average of 25.3 to 47.6 per year.

"Of the IP transactions that generated revenue to the institutions, just over 50% yielded less than R100 000."

"… the average number of IP transactions which yielded revenue between 2014 and 2018 almost doubled from that seen between 2008 and 2014, increasing from an average of 25.3 to 47.6 per year."

18. Rand value of US$1 million: 2014 = R 5.346 million; 2015 = R 5.559 million; 2016 = R 5.861 million; 2017 = R 6.076 million; 2018 = R 6.124 million.
19. AUTM US Licensing Survey Report 2018.

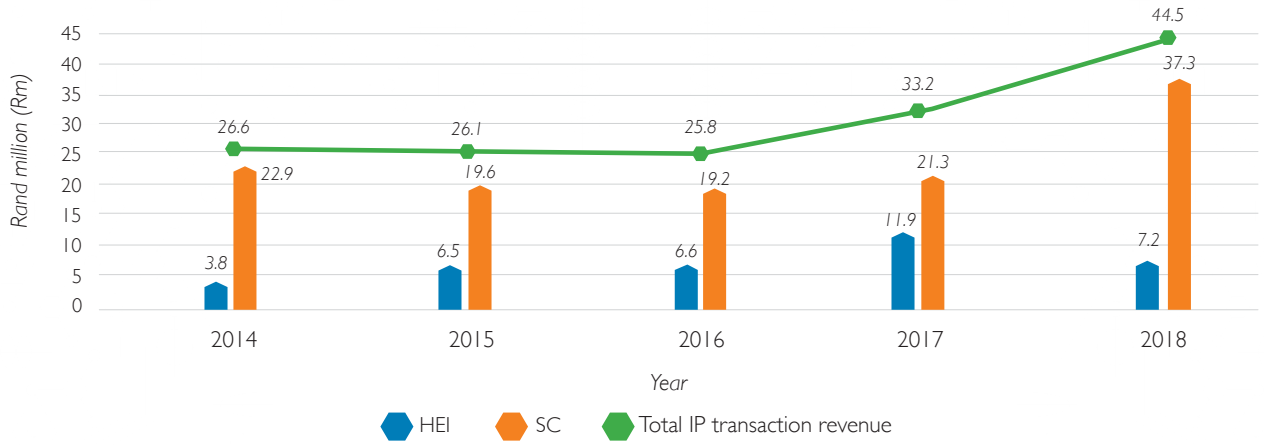


Figure 55: IPR Act IP: Total IP transaction revenue, 2014 – 2018

Data note: n = 37
Note: For a breakdown by types of HEIs, see Section E.

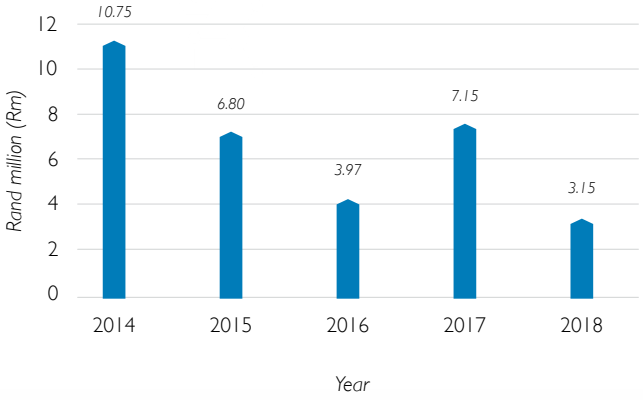


Figure 56: Non-IPR Act IP: Total IP transaction revenue, 2014 – 2018

Data note: n = 37
Note: For a breakdown by types of HEIs, see Section E.

Of the total number of respondents, 12 (IPR Act IP: ten HEIs and two SCs) and five (non-IPR Act IP) respectively reported IP transaction figures over the survey period. The reported total IP transaction revenue to institutions from IPR Act IP transactions has increased by 66.9% over the survey period (see figure 55), while that realised from non-IPR Act IP transactions shows a decreasing trend over the same period. It is noteworthy that two SCs account for the large majority of IPR Act IP transaction revenue.

5.2 IPR ACT INTELLECTUAL PROPERTY TRANSACTIONS

LICENSING

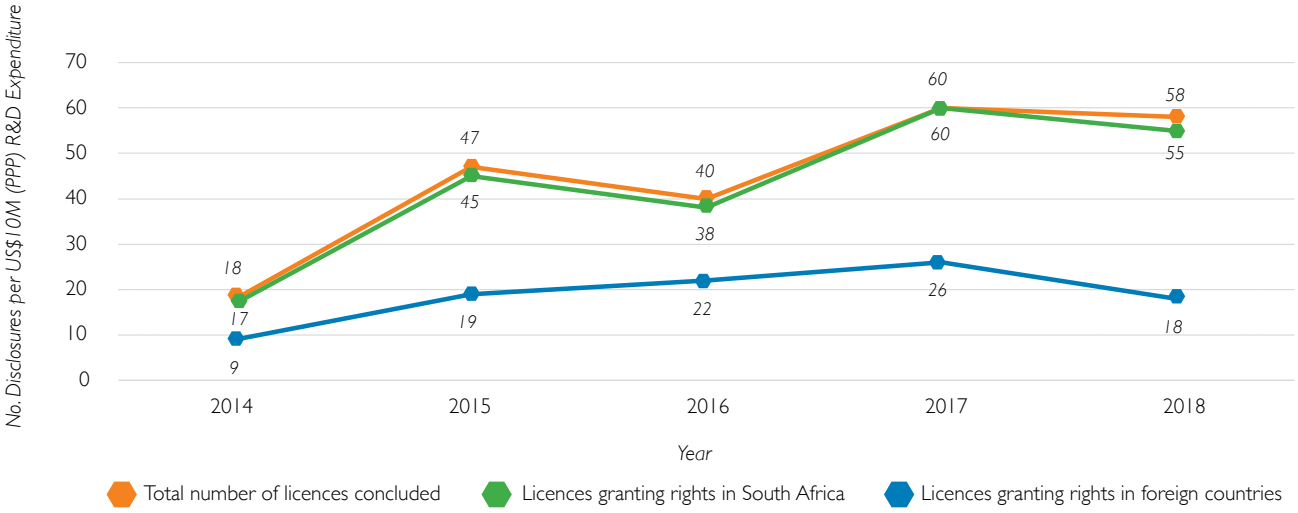


Figure 57: IPR Act IP: Total number of licences concluded, 2014 – 2018

Data note: n = 37

Of the total number of respondents, 15 reported that they concluded either an IPR Act IP licence or assignment over the survey period. It should be noted that a single licence transaction can grant rights in South Africa and a foreign country, thus the sum of these granted rights would not necessarily equal the total number of licences concluded as shown in figure 57.

The total number of IPR Act IP licences concluded over the survey period increased threefold. As indicated before, any IP transaction is a necessary precursor to commercialisation, and therefore this is a very encouraging trend.

"The total number of IPR Act licences concluded over the survey period increased threefold."

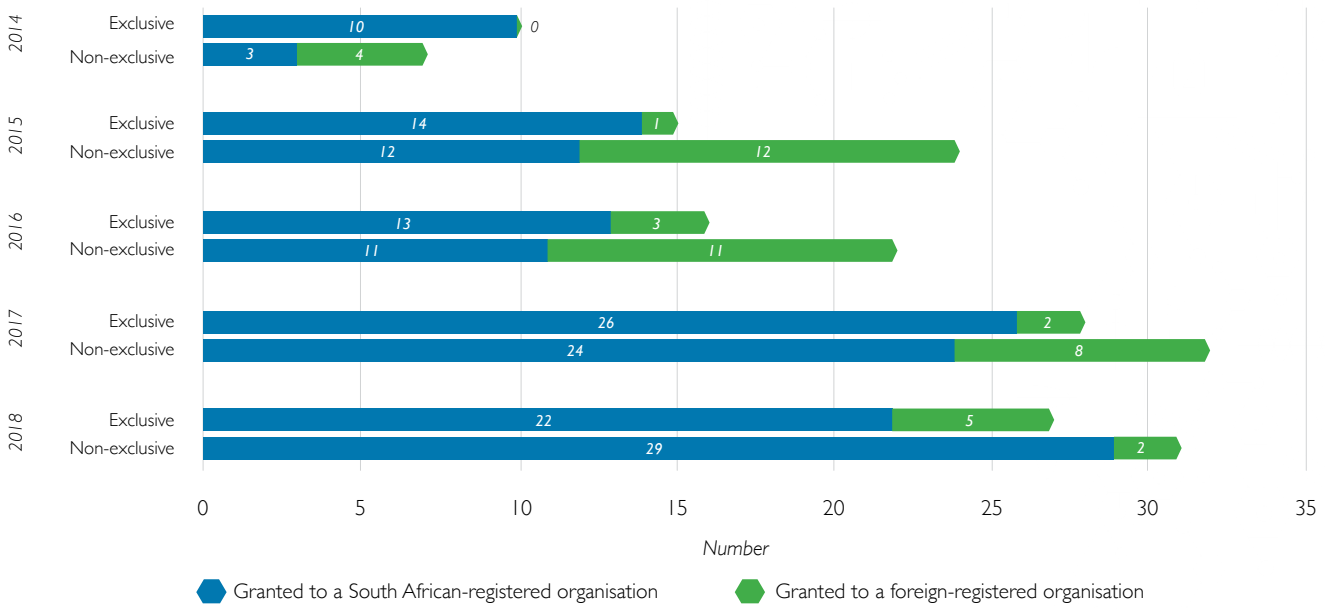


Figure 58: IPR Act IP: Number of exclusive and non-exclusive licences that grant rights in South Africa, 2014 – 2018

Data note: n = 37

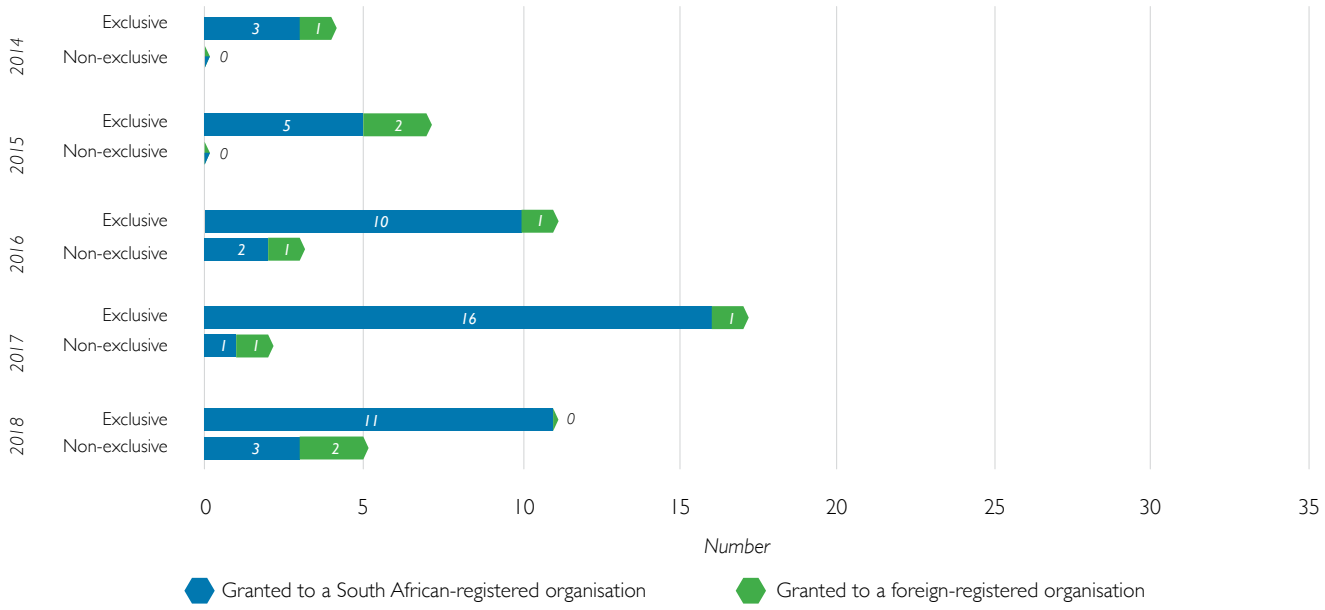


Figure 59: IPR Act IP: Number of exclusive and non-exclusive licences that grant rights in a foreign country, 2014 – 2018

Data note: n = 37

Figures 58 and 59 indicate whether a licence is concluded with a South African- or foreign-registered organisation, broken down into exclusive or non-exclusive licences. Of the total number of respondents, 15 reported concluding licences over the survey period through which rights are granted in South Africa (figure 58) and 13 respondents reported concluding licences over the survey period through which rights are granted in a foreign country (figure 59). The number of licences to South African-registered organisations is substantially higher than foreign-registered organisations, whether exclusive or non-exclusive. Furthermore, whereas non-exclusive licences are predominately granted in South Africa, exclusive licences represent the majority of the licences concluded in a foreign country. This is an interesting finding in light of the IPR Act's preference for non-exclusive licensing.

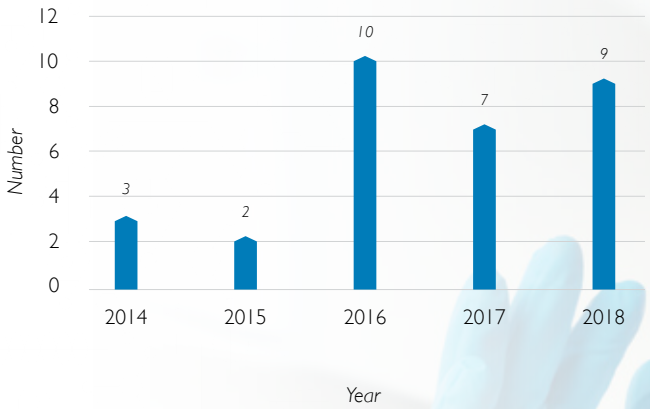


Figure 60: IPR Act IP: Total number of licensed actionable disclosures that became available for consumer (public) or commercial use over the survey period, 2014 to 2018

Data note: n = 37

Of the total number of respondents, six reported that licensed IP became available for consumer (public) or commercial use during the survey period. It is encouraging to see an increase over this period, albeit off a low initial base.

"22% of institutions reported that licensed actionable disclosures in their portfolios became available for consumer (public) or commercial use between 2014 and 2018."

AN OVERVIEW OF INTELLECTUAL PROPERTY TRANSACTIONS WITH SOUTH AFRICAN ORGANISATIONS

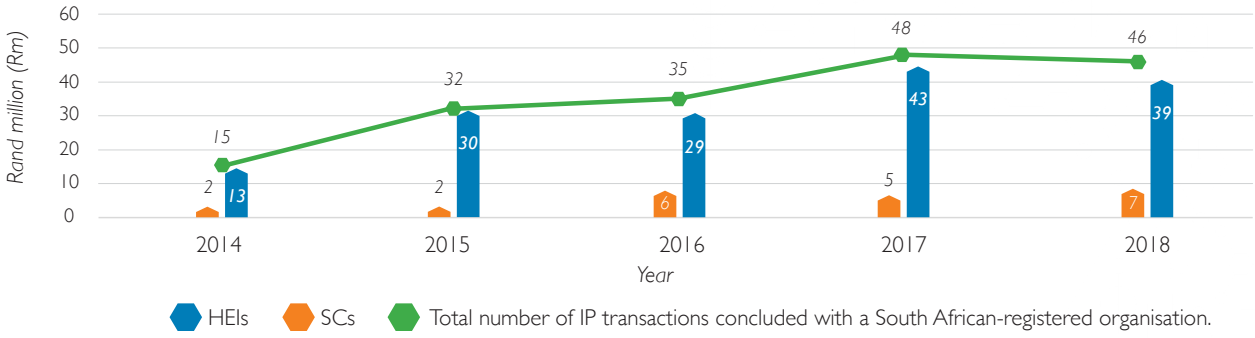


Figure 61: IPR Act IP: Total number of IP transactions concluded with a South African-registered organisation, 2014 – 2018

Data note: n = 33
Note: For a breakdown by types of HEIs, see Section E.

Of the total number of respondents, 12 (nine HEIs and three SCs) reported IP transactions concluded with South African-registered organisations over the survey period. The number of IP transactions concluded with South African-registered organisations has trebled over the survey period.

The survey requested data on the proportion of IP transactions concluded with start-up/spin-out companies, SMMEs (excluding start-up/spin-out companies) and large companies. The data received are too sparse to report.

"The number of IP transactions concluded with South African-registered organisations has trebled over the survey period."

BENEFIT-SHARING

Figure 62: IPR Act IP: Benefit-sharing, 2014 – 2018

Data note: n = 11

As an incentive to promote the development and commercialisation of IP by researchers, which undertaking may not be core to their activities, institutions share a portion of revenue received from commercialisation of IP with IP creators and IP enablers in accordance with their NIPMO-approved IP/benefit-sharing policies.

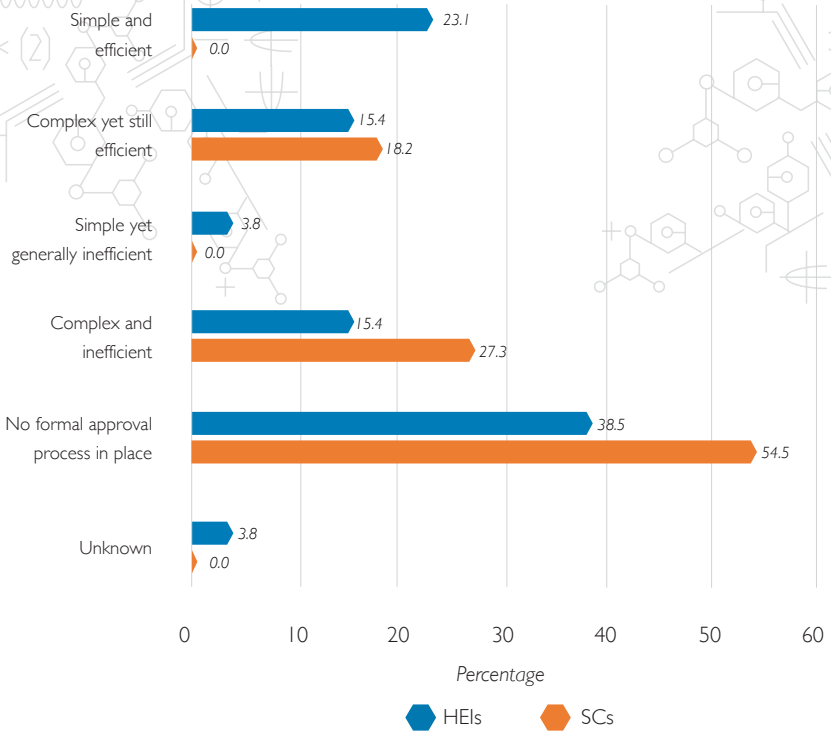
6. START-UPS

This section reports on the number of start-up/spin-out companies formed for the purpose of commercialising IP.

Defined terms used in this section include:

- ACTIONABLE DISCLOSURE
- CASHED-IN EQUITY
- DIVIDENDS
- EQUITY
- INSTITUTION
- IP CREATORS/ENABLERS
- IP TRANSACTION
- IP TRANSACTION REVENUE
- NON-OPERATIONAL
- OPERATIONAL
- REVENUE
- START-UP/SPIN-OUT COMPANIES

(Refer to Section H)



By 2018,

39%

of HEIs have formed start-up/spin-out companies to commercialise actionable disclosures.

By 2018,

18%

of SCs have formed start-up/spin-out companies to commercialise actionable disclosures.

Figure 63: Most appropriate description for the approval processes within your institution to form a start-up/spin-out company, 2018

Data note: n = 37

Approval processes for spin-out companies to commercialise IP may be different to those for entering into IP transactions. As with IP transactions, however, effective and efficient approval processes are important to facilitate commercialisation. The figure above shows that 81.8% of SCs indicated that either they don't have a formal process in place to form a start-up/spin-out company, or that such a process is complex and inefficient, compared to 53.9% of HEIs. The National Development Plan, and other government policy frameworks, highlight the importance of SMMEs in employment creation, and other socioeconomic benefits. In light of this, the lack of, or inefficiencies in, the approval processes for the formation of start-up/spin-out companies, is concerning.

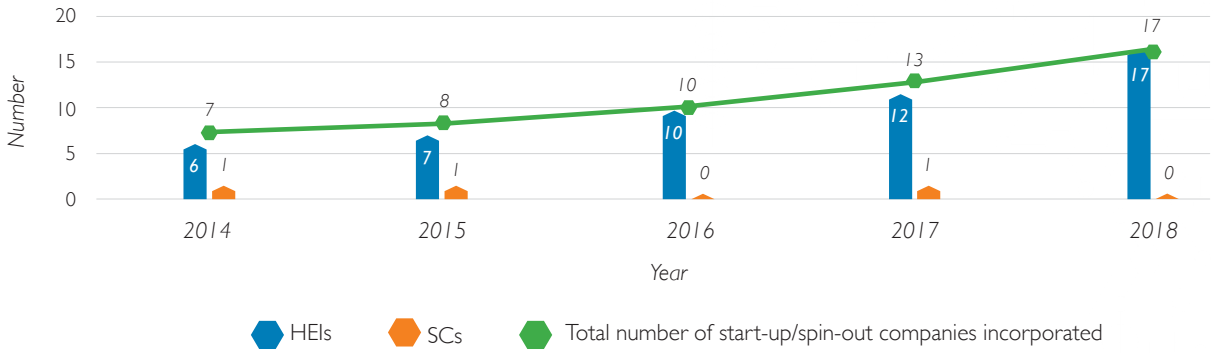


Figure 64: Total number of start-up/spin-out companies incorporated in a financial year, 2014 – 2018

Data note: n = 37

Of the total number of respondents, ten (nine HEIs and one SC) reported having formed start-up/spin-out companies over the survey period.

In figure 64, a total of 55 start-up/spin-out companies were formed by TTFs during the survey period. The number of start-up/spin-out companies increased more than twofold over the survey period, albeit off a low base. On inspection of the data, except for 2015, the same four institutions accounted for 70% or more of the reported number of start-up/spin-out companies incorporated in any year over the survey period. It should be noted that these four institutions had TTFs prior to the implementation of the IPR Act.

Given the importance of SMMEs mentioned above, the low proportion of SCs that reported start-up/spin-out formation, resulting in only three start-up/spin-out companies over the survey period, requires further research to see how formal approval process can be made more effective.

"… 55 start-up/spin-out companies were formed by TTFs during the survey period. The same four institutions accounted for 70% or more of the reported number of start-up/spin-out companies incorporated in any year over the survey period."

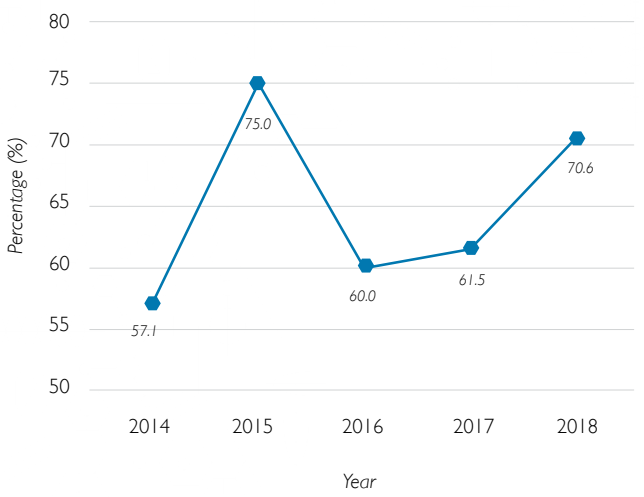


Figure 65: Percentage of start-up/spin-out companies incorporated in a given year that have their primary location in the province where the institution has its headquarters, 2014 – 2018

Data note: n = 37

In figure 65, ten respondents provided data for the percentage of start-up/spin-out companies being located in the same province as the institution's headquarters. Location of these companies in the same province contributes to impact in terms of local economic development. In this regard, the large majority of these companies – at least 57% – being located in the same province, is encouraging.

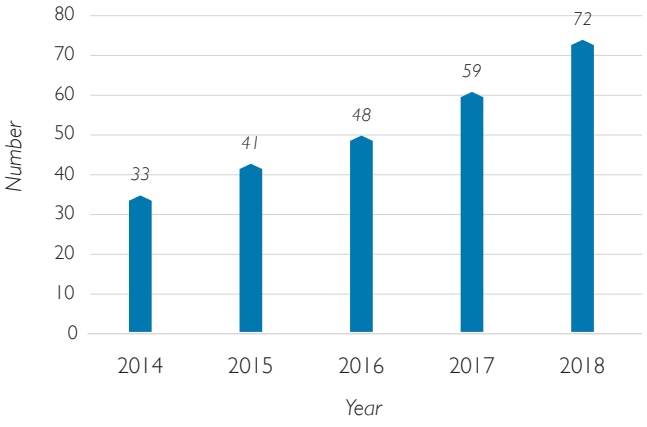


Figure 67: Cumulative number of start-up/spin-out companies formed since 2008 that were operational at the financial year-end, 2014 – 2018

Data note: n = 37

Data provided by the institutions shows that 100 start-up/spin-out companies were formed since 2008, 95% of which were from HEIs. Of these, 72 remained operational as at 2018.

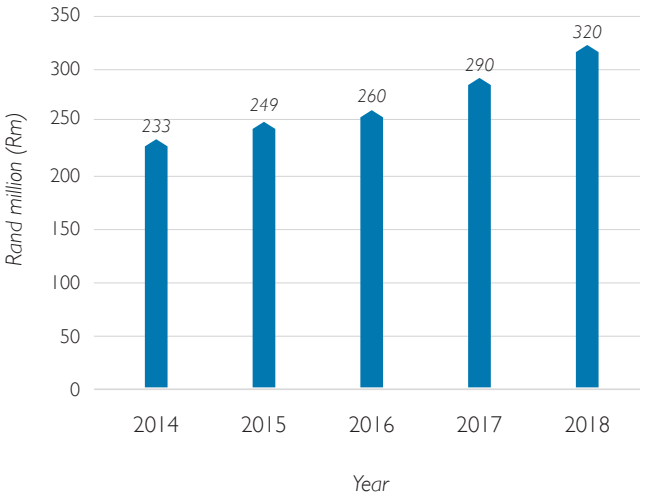


Figure 66: Total FTEs employed by start-up/spin-out companies, 2014 – 2018

Data note: n = 37

Of the total number of respondents, six reported data relating to the number of FTEs employed by start-up/spin-out companies over the survey period. As indicated previously, employment creation is one aspect of socioeconomic impact generated by SMMEs. The 37% increase in the total FTEs employed by all start-up/spin-out companies over the survey period shows a positive contribution to such benefits.

"37% increase in the total FTE's employed by all start-up/spin out companies over the survey period."

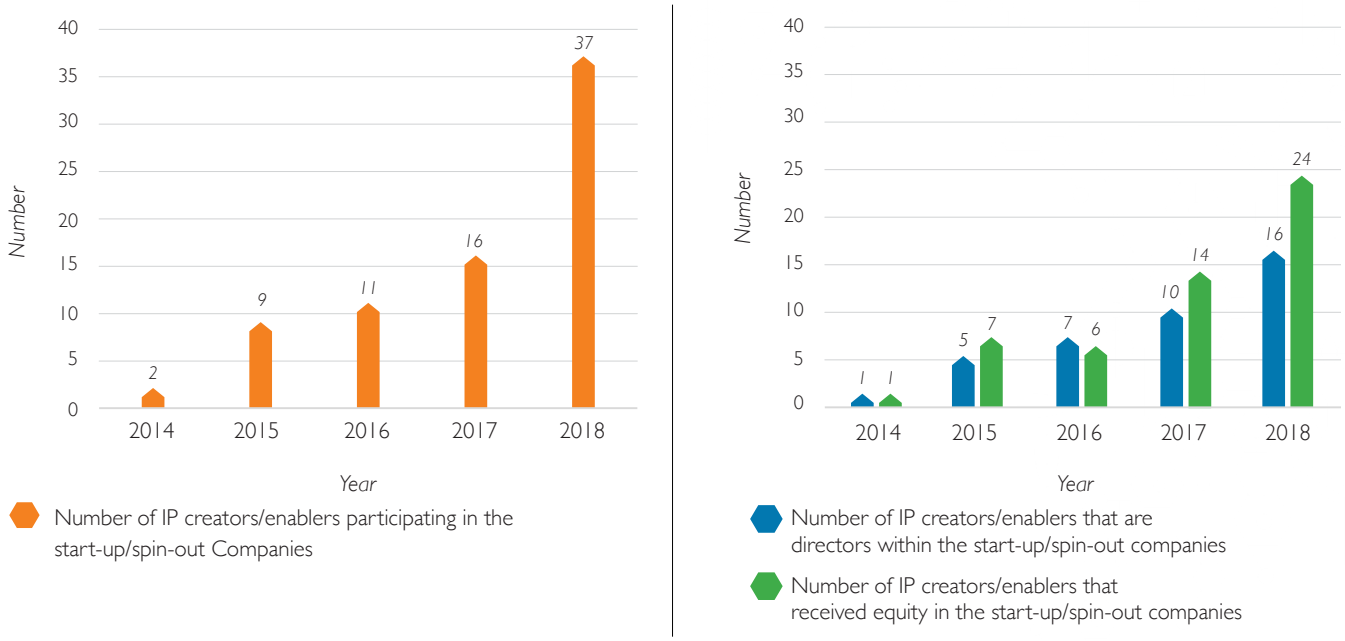


Figure 68: IP creators/enablers participating in start-up/spin-out companies, 2014 – 2018

Data note: n = 37

Of the total number of respondents, eight reported on the number of IP creators/enablers participating in start-up/spin-out companies and seven on the IP creators/enablers' type of participation over the survey period. The total number of IP creators/enablers participating in start-up/spin-out companies has increased significantly over the survey period, albeit off a low base. It should be noted that an IP creator/enabler can be a director, as well as hold equity in the company. Thus the addition of the numbers participating in these ways would not necessarily equal the total number of IP creators/enablers participating.

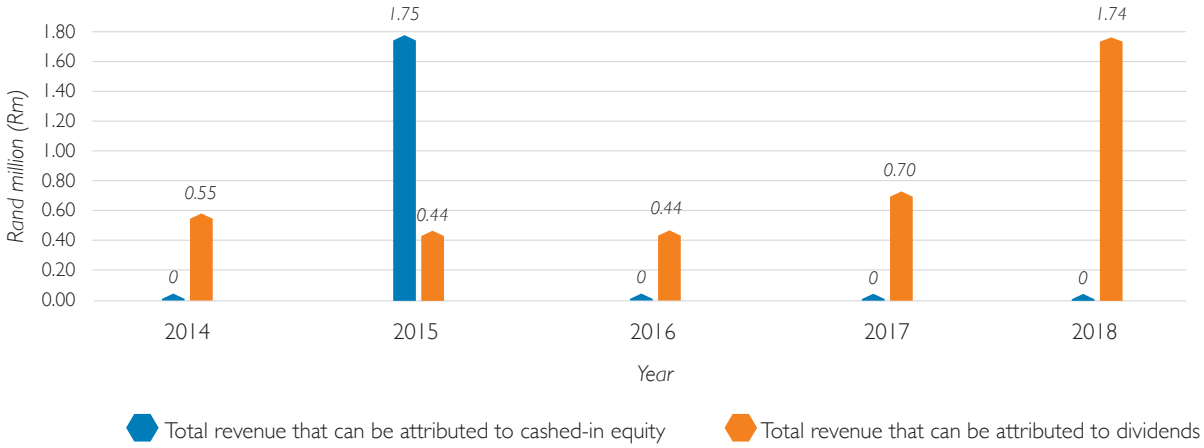


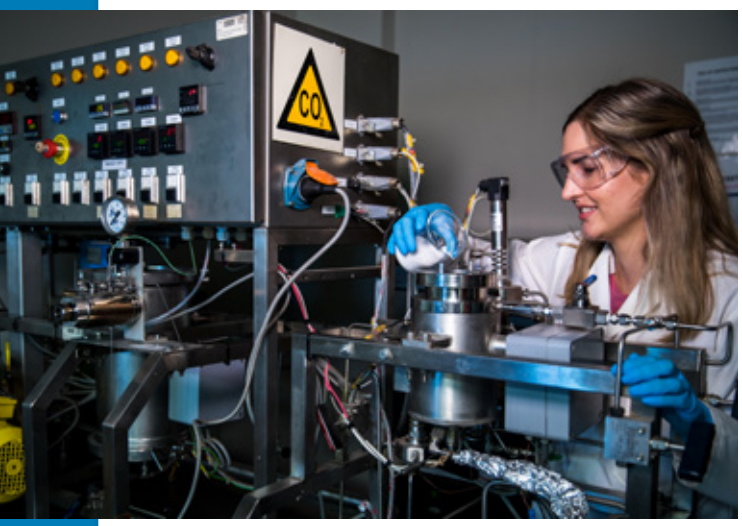
Figure 69: Revenue from start-up/spin-out companies, 2014 – 2018

Data note n = 37

"The total number of IP creators/enablers participating in start-up/spin out companies has increased significantly over the survey period …"

Of the total number of respondents, four indicated receiving revenue from start-up/spin-out companies over the survey period. Revenue from cashed-in equity speaks to the sale of equity in a company. Revenue of R1.75 million received from cashed-in equity was only reported by one institution in 2015.

ENCAPSULATION TECHNOLOGY – CSIR



Patented technology with successful licence

Imagine consuming a supplement, such as a probiotic or vitamin, with the expectation of getting its full health benefits, only to find out that it is ineffective. In order to produce the required health benefits, probiotic strains/bacteria should be present in a viable form at a suitable level during the shelf life of the product and further maintain high viability throughout the gastrointestinal tract when consumed. According to research, many probiotics on the market do not meet the World Health Organisation (WHO)'s recommendations on the concentration of the necessary probiotic bacteria in order to qualify as a product with health benefits. One of the reasons could be that the probiotic strains/bacteria are not protected/packaged in the correct manner.

Currently, some human and animal probiotics have insufficient health benefits due to poor stability, low absorption or ineffective release profiles. This is because active probiotics typically die during manufacturing, transport or storage. In addition, studies have shown that approximately 90% of viable probiotics consumed are degraded in the acidic gastric juices before they reach the intestines.

Encapsulation is a technology that has been used in the pharmaceutical, food and animal-feed sectors to enclose active ingredients, providing an effective barrier against environmental factors such as oxygen, light, stomach acids and free radicals, or to mask an unpleasant taste. The process involves the entrapment of one or several active agents into minute sizes, as well as the entrapment of one or several substances (active agents) into beads of sizes ranging from nanometre to micrometre or millimetre scale. In addition, the characteristics of the wall material can be selected to enhance the aqueous solubility of hydrophobic actives, thus enhancing their bio-accessibility.

Conventional encapsulation processes, such as extrusion, spray-drying and prilling require the use of one or a combination of organic solvents, water, high temperatures and high shearing – all of which can degrade the sensitive actives used in nutraceuticals. These actives include probiotics, phytochemicals, vitamins and enzymes.

Probiotics contain the good bacteria that your stomach craves – they are live bacteria and yeasts that are intended to provide health benefits when consumed. The WHO defines them as live microorganisms that, when administered in "adequate amounts", confer a health benefit on the host. Nutraceuticals are different – they are high-absorbing nutritional supplements that come from food and non-food products, and they are regulated as food and not drugs.

The Council for Scientific and Industrial Research (CSIR)'s innovative encapsulation technology uses supercritical carbon dioxide as a process medium with several benefits, which include that:

- no organic solvents or water is required;
- the final product contains no residual organic solvents;
- anaerobic processing is used, which is ideal for oxygen-sensitive actives as oxygen toxicity is considered a significant factor influencing the viability of probiotic bacteria;
- most materials are processed below actual melting point, which is ideal for thermo-labile actives and energy-saving;
- there is no or minimal activity loss of sensitive bioactive compounds during encapsulation; and
- it is a natural and environmentally-friendly (green) encapsulation process.

The technology piqued the interest of an entrepreneur, Dr Chomba Chuma, whose company distributes various health supplements. He noticed that many probiotic-containing products do not meet the WHO's recommendations of probiotics to impart health benefits, and realised the opportunity of this technology. Since then, the technology has been licensed to his company, Lighthouse Healthcare, which has contributed to meal replacement drinks available to the public under the brand Velobiotics.

The Velobiotics product range, including other probiotic meal replacement brands, i.e. Femina, BioGain and BioSport, addresses the needs of specific population groups, such as women and athletes.

SECTION D: ANALYSIS OF SURVEY RESULTS FOR IPR ACT IP

This section presents a high-level IPR Act IP[20] analysis and international comparison of select indicators. As noted in Section B, due to the differences in indicators reported across the various countries, the legislative framework in which similar surveys are conducted, as well as variations in the underlying definitions for such indicators, the extent of the international comparison presented herein is limited. However, the international comparison is undertaken where applicable to provide context to the South African publicly funded research system.

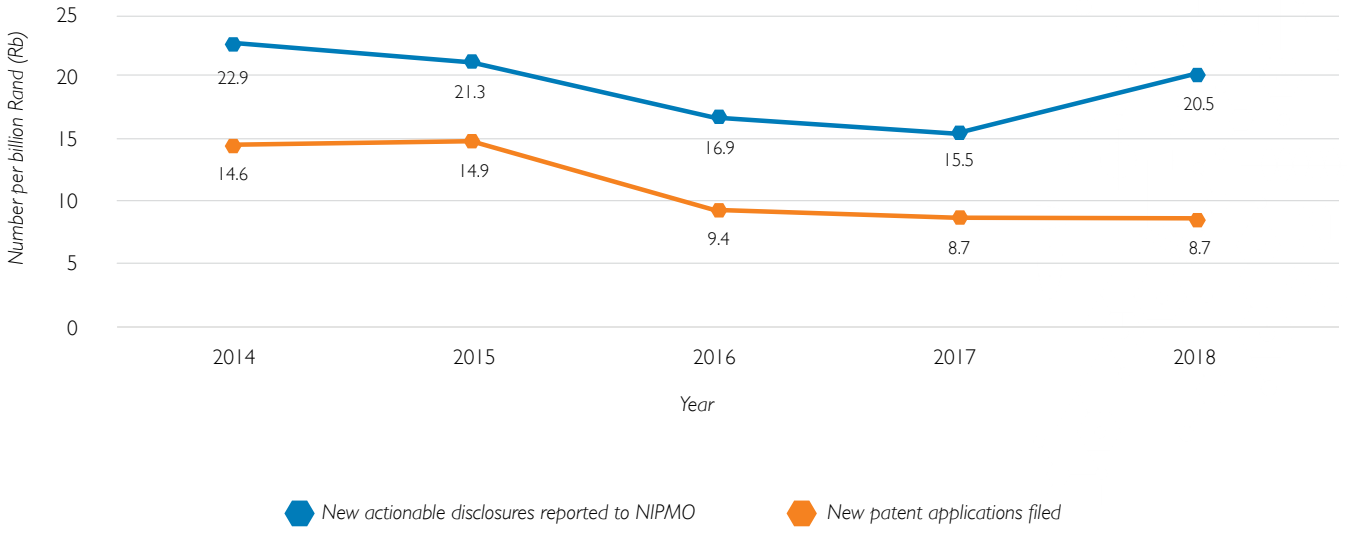


Figure 70: IPR Act IP: IP activities per billion Rand of institutional research and development expenditure, 2014 – 2018

Data note: n = 22 (only 22 institutions provided data for (i) R&D expenditure, (ii) new actionable disclosures, and (iii) new patent applications, for each year, and therefore only these institutions are included in this figure)

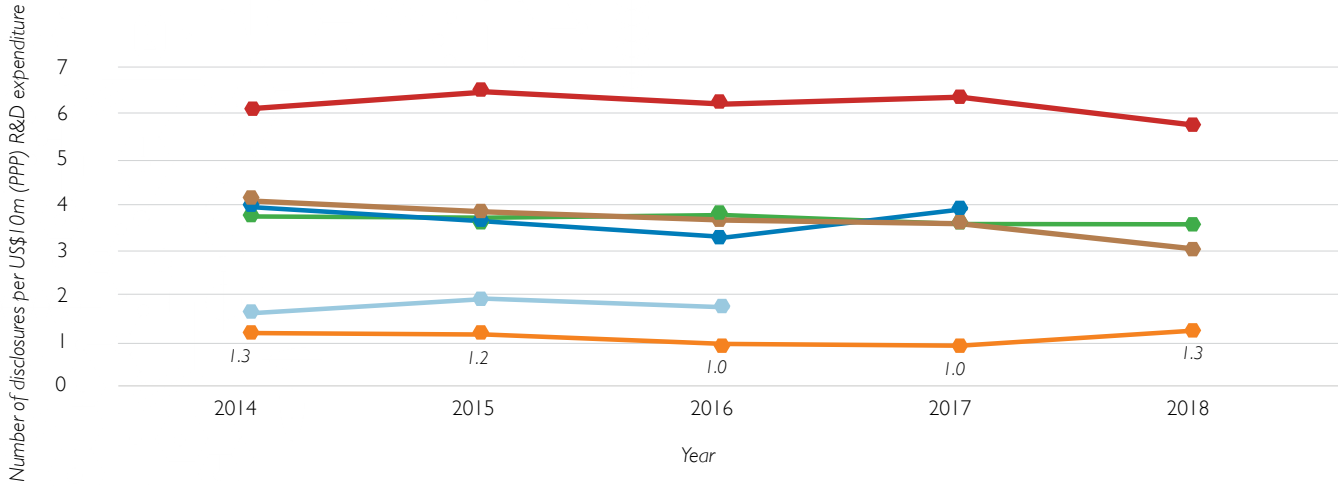
	2014	2015	2016	2017	2018
Total institutional R&D expenditure (R billion)	8.5	9.7	11.0	11.1	11.3
Number of new actionable disclosures reported to NIPMO	196	207	185	173	231
Number of new patent applications filed	125	145	103	97	98

A comparative analysis of key TTF input indicators, per billion Rand of R&D expenditure, can provide insight into whether fluctuations in R&D expenditure impact the creation of IP. New actionable disclosures and new patent applications filed, are indicators of IP creation. Although there can be a delay between incurring R&D expenditure, the creation of IP, the receipt of the disclosure by the TTF and subsequent filing of the patent application, in light of the typical processes in institutions it is reasonable to assume that these steps occur within a year after the IP is created. The results in figure 70 show a declining trend over the survey period. This implies that increases in R&D expenditure – which can be considered an investment into activities that may yield new IP – have not necessarily led to an increase in IP creation. This result requires further investigation, to understand the reasons for the trend.

"increases in R&D expenditure – which can be considered an investment into activities that may yield new IP – have not necessarily led to an increase in IP creation. This result requires further investigation."

20. Non-IPR Act IP data for these indicators was too sparse to support meaningful analysis.

THE SURVEY RESULTS IN AN INTERNATIONAL CONTEXT



	2014	2015	2016	2017	2018
South Africa	1.3	1.2	1.0	1.0	1.3
US	3.8	3.8	3.9	3.7	3.7
Canada	4.0	3.7	3.4	4.0	N/A
Australia	1.7	2.0	1.8	N/A	N/A
Ireland	6.2	6.6	6.3	6.4	5.8
UK	4.2	3.9	3.8	3.7	3.1

Figure 71: International comparison of the number of disclosures received/reported per year per US$10 million research and development expenditure, 2014 – 2018

Data note: Data for Australia and Canada were only available up until 2016 and 2017 respectively. Results for South Africa may be an under reporting due to the fact that data for other countries are based on all disclosures, and data used for South Africa reflects actionable disclosures.

The number of disclosures per US$10 million R&D expenditure[21] enables comparison of the creation of IP in different countries.

In this analysis, results for South Africa as a whole are comparatively lower than those for the other countries. South Africa's results are closest to that of Australia, for the years where data are available.

From inspection of the data it was found that select HEIs and SCs in South Africa reported actionable disclosures per US$10million up to three times the average for South Africa for the survey period. More specifically, one HEI had an average of 2.4, and one SC an average of 4.2, the latter being higher than the average for all countries reflected in figure 71, other than Ireland. These two institutions established a formalised TTF prior to 2010, which may suggest that as other institutions' TTFs develop, IP creation as a result of R&D investment may increase.

Number of respondents (n)

	2014	2015	2016	2017	2018
South Africa	22	22	22	22	22
US	190	200	194	187	196
Canada	39	36	35	34	N/A
Australia	57	62	62	N/A	N/A
UK	163	163	165	165	165
Ireland	23	25	24	25	25

"A South African SC had an average 4.2 disclosures per US$10 million R&D expenditure, higher than the average for all comparison countries, other than Ireland."

21. Currency conversions calculated using the PPP as published by the OECD as at September 2020.

RUGBY WHEELCHAIR PROJECT GIVES HOPE TO UNEMPLOYED YOUTH WITH DISABILITIES

Innovator Jared McIntyre turned adversity into opportunity, developing a rugby wheelchair that could be manufactured locally, and giving South Africans with disabilities access to an empowering sport.

Wheelchair rugby is a fast-paced, full-contact team sport for athletes with functional impairments in their limbs. It is a Paralympic sport, with thousands of participants from more than 40 countries, combining elements of rugby, basketball and ice hockey to create a rewarding experience for players and spectators alike. Since contact between wheelchairs is an integral part of the sport, players must have specially built chairs to enable them to block and hold their opponents during play. These come at a price, which often makes it difficult for especially learners and youth with disabilities to compete in the sport. Until recently, this was compounded by the lack of South African manufacturers of sports equipment for parasports, which meant that rugby wheelchair prices were at the mercy of foreign exchange fluctuations.

All of this changed when Jared McIntyre decided to develop a cost-effective rugby wheelchair that could be manufactured locally. The idea was born out of necessity, as McIntyre, an accomplished gymnast, had suffered a spinal injury from a diving accident while he was studying for a business management qualification at the Central University of Technology (CUT). McIntyre approached the Product Development Technology Station (PDTS) at CUT and CUT Innovation Services for assistance, and the project was launched. At the PDTS assistance was given through Major Project Grant Funding provided by the Technology Innovation Agency.

It is at the PDTS where the team of engineers were able to mimic the mechanical properties of the imported wheelchair by using generally available mild steel and adapting critical dimensioned components. Utilising readily available manufacturing processes, they were able to develop a fully functional prototype chair. The first prototype was then tested for about 12 months in a professional training setting with the Mustang Wheelchair Rugby Club.

Non-registrable intellectual property was developed, including technical documentation, specifications of product aspects and components, data sheets, manufacturing standards, user guides and manuals, all of which are protected through inherent copyright.

What sets the project apart is not just a locally designed and manufactured wheelchair, but the fact that disabled unemployed youth were trained to manufacture the wheelchairs. This employment creation and skills development opportunity brings youth into the mainstream of the economy through the provision of accredited training. And by enabling more young people with disabilities to participate in wheelchair rugby, the project is supporting the development of parasports in South Africa.

McIntyre, who recruits members for his wheelchair rugby club from the Tswellang School for the Disabled in Bloemfontein, says that through the partnership with CUT *"we adapted our manufacturing process to suit children with disabilities and adults who previously had limited participation in the sport."*

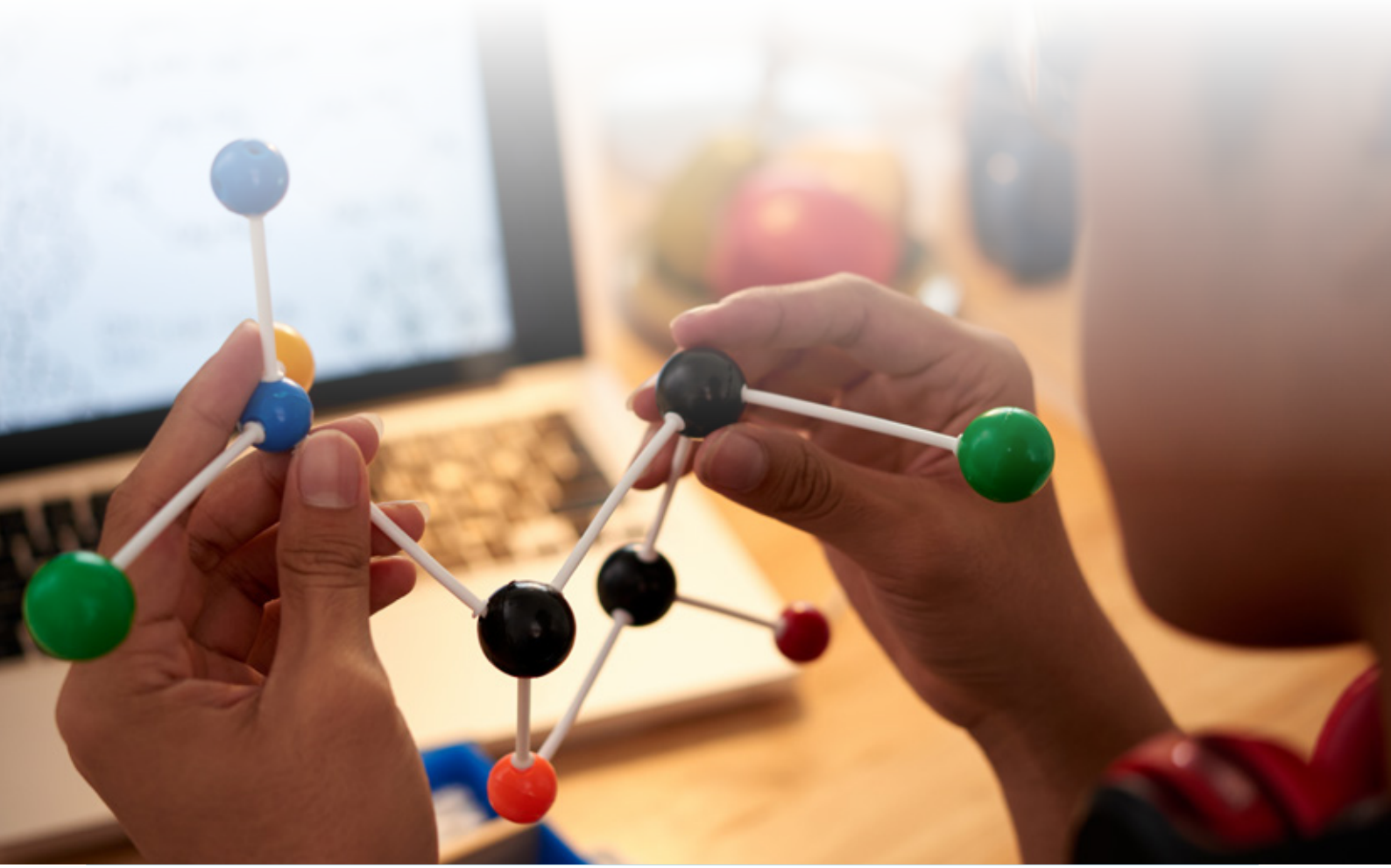
SECTION E: SELECTED AGGREGATED GRANULAR SURVEY DATA

1. SELECTED AGGREGATED DATA BY TYPE OF HEI

Number of individuals			
Years of experience	Traditional universities	Comprehensive universities	Universities of technology
0 to 1	9	1	11
2 to 4	23	5	8
5 to 7	22	4	4
8 to 10	5	1	4
11 to 13	5	1	3
14 to 16	2	2	1
17 to 19	1	–	1
20 and more	3	–	1
Unknown	1	7	–
n	12	7	7
Individuals	71	21	33

Table 2: Years of experience by HEI type, 2018

Data note: n = 26



Traditional universities (%)								
Field	PhD	Master's	Honours	Bachelor's	Diploma	Other	Unknown	Total
Unknown	–	–	–	1.0	–	–	1.0	1.9
Other	–	1.0	1.0	1.0	–	13.3	–	16.2
Humanities	–	1.0	1.0	1.9	–	–	–	3.8
Other social sciences	–	–	–	1.0	–	1.0	–	1.9
Law	1.0	2.9	1.9	6.7	1.0	–	–	13.3
Educational sciences	–	1.0	–	–	–	–	–	1.0
Business/commerce	1.0	7.6	1.9	2.9	1.9	3.8	–	19.0
Agricultural sciences	–	1.9	–	–	–	–	–	1.9
Medical and health sciences	–	1.0	–	–	–	–	–	1.0
Engineering and technology	1.9	4.8	1.0	1.9	1.0	–	–	10.5
Life sciences	2.9	11.4	3.8	1.9	1.0	–	–	21.0
Physical sciences	1.9	4.8	–	1.9	–	–	–	8.6
Comprehensive universities (%)								
Field	PhD	Master's	Honours	Bachelor's	Diploma	Other	Unknown	Total
Unknown	–	–	–	–	–	–	–	–
Other	–	–	–	–	–	6.3	–	6.3
Humanities	–	–	3.1	–	–	–	–	3.1
Other social sciences	–	–	–	–	–	–	–	–
Law	–	–	6.3	6.3	–	3.1	–	15.6
Educational sciences	–	–	–	–	–	–	–	–
Business/commerce	–	25.0	–	–	6.3	3.1	–	34.4
Agricultural sciences	–	–	–	–	–	–	–	–
Medical and health sciences	–	3.1	3.1	–	–	–	–	6.3
Engineering and technology	–	3.1	3.1	–	3.1	6.3	–	15.6
Life sciences	3.1	6.3	3.1	3.1	–	–	–	15.6
Physical sciences	–	3.1	–	–	–	–	–	3.1
Universities of technology (%)								
Field	PhD	Master's	Honours	Bachelor's	Diploma	Other	Unknown	Total
Unknown	–	–	–	–	–	–	–	–
Other	2.3	–	–	9.1	2.3	2.3	–	15.9
Humanities	–	–	–	–	2.3	–	–	2.3
Other social sciences	–	–	–	–	–	–	–	–
Law	–	6.8	–	11.4	–	–	–	18.2
Educational sciences	–	–	–	4.5	–	–	–	4.5
Business/commerce	2.3	2.3	2.3	11.4	11.4	6.8	–	36.4
Agricultural sciences	–	–	–	–	–	–	–	–
Medical and health sciences	–	–	–	–	–	–	–	–
Engineering and technology	4.5	2.3	–	–	–	–	–	6.8
Life sciences	4.5	9.1	–	2.3	–	–	–	15.9
Physical sciences	–	–	–	–	–	–	–	–

Table 3: Percentage distribution of staff qualifications (up to three fields per individual) by field and highest qualification for HEIs by HEI type, 2018

Data note: n = 26 (125 individuals) (traditional universities: 71; comprehensive universities: 21; universities of technology: 33)

SECTION E: SELECTED AGGREGATED GRANULAR SURVEY DATA
(CONTINUED)

	Traditional universities (%)				Comprehensive universities (%)				Universities of technology (%)			
	More than 1 FTE required	1 FTE required	0.5 FTE required	No gap	More than 1 FTE required	1 FTE required	0.5 FTE required	No gap	More than 1 FTE required	1 FTE required	0.5 FTE required	No gap
Administration skills (including financial management)	8.3	33.3	8.3	50.0	42.9	14.3	–	42.9	–	16.7	16.7	66.7
Business development skills – fundraising (technology and business development)	16.7	41.7	16.7	25.0	42.9	28.6	14.3	14.3	–	33.3	33.3	33.3
Business development skills – attracting commercial partners	25.0	33.3	16.7	25.0	28.6	42.9	14.3	14.3	–	50.0	16.7	33.3
Business development skills – negotiating and deal structuring	25.0	33.3	16.7	25.0	28.6	14.3	28.6	28.6	–	66.7	–	33.3
Skills for establishing start-up/spin-out companies and incubators	25.0	33.3	16.7	25.0	14.3	42.9	14.3	28.6	–	33.3	33.3	33.3
Skills for management of a fund (e.g. Seed Fund (TIA and non-TIA) management)	8.3	16.7	25.0	50.0	–	57.1	14.3	28.6	–	16.7	–	83.3
IP management skills	–	25.0	25.0	50.0	–	14.3	28.6	57.1	–	16.7	16.7	66.7
Legal skills (excluding IP management)	8.3	33.3	16.7	41.7	14.3	42.9	–	42.9	–	16.7	–	83.3
Marketing and communications skills	8.3	8.3	33.3	50.0	–	14.3	57.1	28.6	–	33.3	33.3	33.3
Project management skills	–	41.7	16.7	41.7	–	57.1	–	42.9	–	16.7	33.3	50.0
Science and engineering skills	8.3	–	25.0	66.7	42.9	14.3	–	42.9	–	16.7	16.7	66.7

Table 4: Percentage skill FTE required by HEI type, 2018

Data note: n = 19 (traditional universities: 9; comprehensive universities: 6; universities of technology: 4)

	2014	2015	2016	2017	2018
Total IP expenditure by traditional universities	30.4	31.5	36.0	34.3	34.0
Total IP expenditure by comprehensive universities	1.2	1.3	3.4	5.0	5.4
Total IP expenditure by universities of technology	1.3	2.1	2.5	2.5	2.2

Table 5: Total IP expenditure by HEI type, 2018

Data note: n = 22 (traditional universities: 10; comprehensive universities: 5; universities of technology: 7)

	2014	2015	2016	2017	2018
Total TT operations expenditure by traditional universities	18.8	24.3	26.6	33.8	45.5
Total TT operations expenditure by comprehensive universities	12.4	21.0	15.5	18.5	20.9
Total TT operations expenditure by universities of technology	2.9	2.3	3.5	3.0	3.1

Table 6: Total TT operations expenditure by HEI type, 2018

Data note: n = 22 (traditional universities: 10; comprehensive universities: 5; universities of technology: 7)

	2014	2015	2016	2017	2018
Traditional universities	120	120	102	97	151
Comprehensive universities	25	33	22	28	46
Universities of technology	25	41	23	29	24

Table 7: IPR Act IP: Total number of new actionable disclosures reported to NIPMO by HEI type, 2014 – 2018

Data note: n = 22 (traditional universities: 10; comprehensive universities: 5; universities of technology: 7)

		Total number of new patent applications filed	Filed as SA provisional patent application	Filed as SA complete patent application as a first filing	Filed in any other jurisdiction (including PCT filings) as a first filing
2014	Traditional universities	90	61	4	25
	Comprehensive universities	17	10	5	2
	Universities of technology	21	12	8	1
2015	Traditional universities	120	87	2	31
	Comprehensive universities	10	7	–	3
	Universities of technology	19	9	10	–
2016	Traditional universities	75	43	1	31
	Comprehensive universities	13	12	–	1
	Universities of technology	15	12	2	–
2017	Traditional universities	80	41	1	38
	Comprehensive universities	16	12	2	2
	Universities of technology	19	13	6	–
2018	Traditional universities	68	31	4	33
	Comprehensive universities	22	18	3	1
	Universities of technology	7	6	–	1

Table 8: IPR Act IP: Total number of new patent applications by HEI type, 2014 – 2018

Data note: n = 22 (traditional universities: 11; comprehensive universities: 5; universities of technology: 6)

	2014	2015	2016	2017	2018
Traditional universities	30	55	69	94	127
Comprehensive universities	–	3	4	7	9
Universities of technology	7	12	14	16	17

Table 9: IPR Act IP: Total number of patent families by HEI type, 2014 – 2018

Data note: n = 18 (traditional universities: 11; comprehensive universities: 3; universities of technology: 4)

	2014	2015	2016	2017	2018
Traditional universities	3.8	6.3	6.6	11.9	7.2
Comprehensive universities	–	0.2	–	–	–
Universities of technology	–	–	–	0.02	0.03

Table 10: IPR Act IP: Total IP transaction revenue by HEI type in millions of Rands, 2014 – 2018

Data note: n = 10 (traditional universities: 7; comprehensive universities: 1; universities of technology: 2)

	2014	2015	2016	2017	2018
Traditional universities	10.7	5.3	3.9	7.0	2.7
Comprehensive universities	–	–	–	–	–
Universities of technology	–	–	–	–	–

Table 11: Non-IPR Act IP: Total IP transaction revenue by HEI type in millions of Rands, 2014 – 2018

Data note: n = 4 (traditional universities: 4; comprehensive universities: 0; universities of technology: 0)

	2014	2015	2016	2017	2018
Traditional universities	13	22	22	36	37
Comprehensive universities	–	–	–	–	–
Universities of technology	–	8	7	7	2

Table 12: IPR Act IP: Total number of IP transactions executed with a South African-registered organisation, 2014 – 2018

Data note: n = 9 (traditional universities: 7; comprehensive universities: 0; universities of technology: 2)

2. JURISDICTIONAL DISTRIBUTION DATA OF PATENTS GRANTED

	2014	2015	2016	2017	2018
US	11	14	28	27	21
Brazil	3	–	1	1	3
UK	6	6	22	14	13
Germany	3	3	21	12	15
Netherlands	3	3	11	5	9
Belgium	1	2	3	1	2
ARIPO	3	7	4	7	5
India	1	3	2	2	3
China	5	12	16	18	18
Russian Federation	3	2	4	4	5
South Korea	4	5	3	–	1
Japan	5	3	5	7	5
Other	18	32	55	76	62

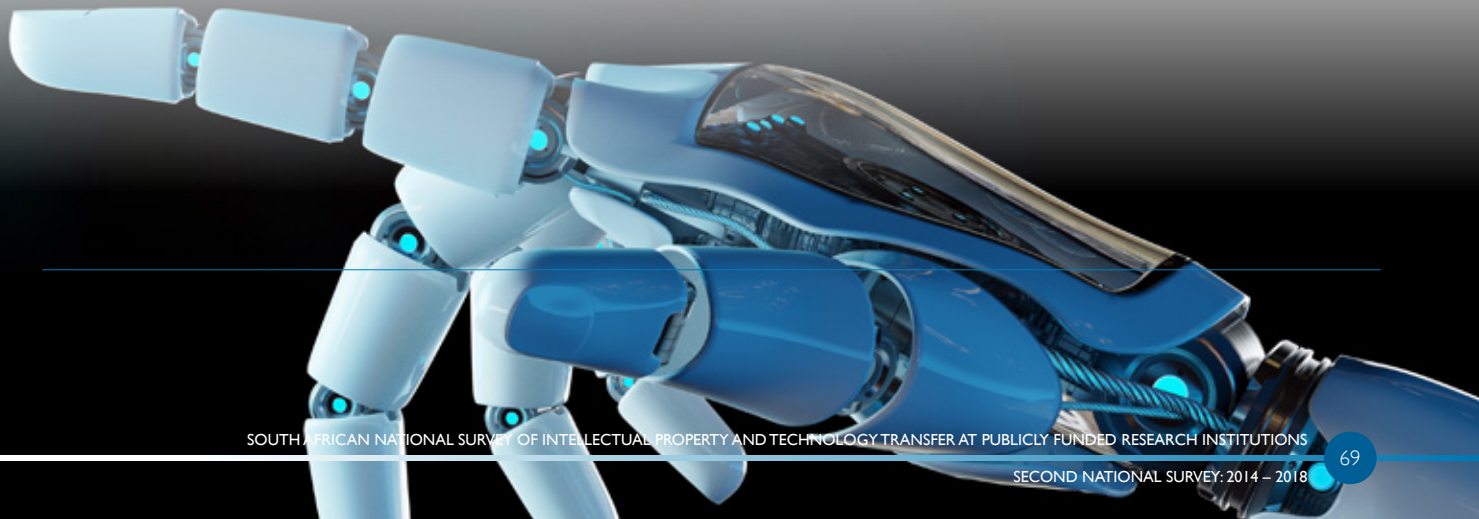
Table 13: IPR Act IP: Jurisdictional distribution of patents granted, 2014 – 2018

Data note: n = 28

	2014	2015	2016	2017	2018
US	18	17	8	10	–
Brazil	3	–	1	–	2
UK	7	5	7	7	2
Germany	7	6	8	7	4
Netherlands	5	3	–	3	1
Belgium	3	2	–	1	2
ARIPO	2	6	2	–	–
India	4	5	2	1	2
China	9	12	5	2	–
Russian Federation	2	2	–	–	–
South Korea	2	2	1	–	–
Japan	9	2	3	1	–
Other	18	42	29	37	13

Table 14: Non-IPR Act IP: Jurisdictional distribution of patents granted, 2014 – 2018

Data note: n = 33



SECTION F: TECHNOLOGY TRANSFER VALUE CHAIN

In its broadest sense, TT is the process of translating promising ideas into products, processes and services in the economy. More specifically, in a South African institutional context, framed within the IPR Act, TT involves the identification, protection and putting into use (also referred to as commercialisation) of promising technology concepts emanating from research activities, for the benefit of society. This definition resonates with South Africa's policy intent to improve the regulatory environment for the identification and utilisation of IP, and to increase exploitation of research results for economic gain and improvements of living standards of citizens.

The TT process is made up of many activities which can be depicted in many ways. For the purposes of simplicity, and to provide a useful framework for appreciating the results reported in Section C of this Report, we depict it here as a sequence of steps, detailed below as steps (a) to (i). In reality TT is a fluid and dynamic process which very rarely follows a linear course.

a) **Knowledge creation:** Research is undertaken and in some instances a research result(s) with potential commercial application may be identified, such as an invention.

b) **Disclosure:** Submitting a disclosure to the TTF is the important first step in the process of documenting a new IP creation (such as an invention) and facilitating the further activities in the development of the technology, its protection and commercialisation.

Some or all of the following three steps – steps (c) to (e) – can occur after disclosure and initial evaluation thereof.

c) **IP Protection:** In support of the likely commercialisation strategy, the TTF may pursue patent or other intellectual property protection of the new disclosure. The TTF will work with IP creators and IP attorneys to draft and file a patent, registered design, or plant breeders' right application. Another protection approach is to maintain confidentiality and treat the technology as a trade secret. It should be appreciated that registered protection is not an end goal but should instead be viewed as a means to facilitate commercialisation, whether for social and/or commercial benefit.

d) **Fundraising and technology development:** The TTF in partnership with the IP creators will raise funds to support further development and testing of the technology, conducting market and techno-economic studies, and other activities that may enable attracting partners to commercialise the technology.

e) **Marketing:** The TTF in partnership with the IP creators will identify opportunities and market technologies to potential commercial partners. These partners have the expertise to translate discoveries into new products, processes and services, or are entrepreneurs with the right experience and credentials to create a company that will undertake such translation.

f) **IP Transaction:** This is an agreement entered into in order to grant a third party the right to develop and/or commercialise the technology (licence) and/or to transfer ownership to such party (assignment). In some instances, an option is granted that gives such party the first right to negotiate a suitable assignment or licence arrangement at a later stage. Licences can be exclusive (only one party can exercise the rights granted) or non-exclusive (more than one party can access similar rights). An IP transaction is entered into with the chosen party(ies), which can be an existing company or a start-up/spin-out company. For an existing company, a due diligence may be conducted prior to negotiating and executing the IP transaction. For a start-up company, the TTF facilitates the formation and registration of the start-up company, may take equity in the company, and enters into a suitable IP transaction with the newly formed company. The start-up company may require incubation and capital raising support, which the TTF can facilitate or support directly, depending on its capabilities and available support mechanisms.

g) **Product Development:** After an IP transaction is concluded, companies typically invest significant resources to translate the IP creation/invention/technology into a useful product, process or service, which can generate revenue for the company. As part of this the IP creators may be tasked to assist the company through transferring their knowledge of the technology, and/or as technical experts to guide product development, and/or may elect to become directly involved as employees of the start-up company.

h) **Impact:** Impact may be created through the use of the technology in a new/improved product, process or service, inter alia through:

- jobs, exports, increased tax revenue, etc. created in the economy;
- social impact in terms of improved quality of life, health and safety, etc.;
- revenue to the institution, through royalties paid, dividends earned or equity sold, a portion of which income is shared with the IP creators as per an institution's IP policy; and/or
- indirect impact to the institution, e.g. through securing of additional research with industry partners due to successful TT.

i) **Assessment/Evaluation:** There is ongoing assessment and evaluation conducted, especially during disclosure, marketing, fundraising and protection activities. The technology and its commercial prospects are evaluated on many factors including IP protection (such as patentability), market prospects in relation to competing technology solutions, commercial potential and possible partners with whom to work. IP creators and the TTF work closely together to ensure all parties are up to date with all developments. Go/no-go decisions are made and technologies can be abandoned at any stage if the prospects are not favourable.

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SECTION H: DEFINITIONS OF TERMS

0.5 PROFESSIONAL: A professional person whose duties included support of TECHNOLOGY TRANSFER ACTIVITIES at least 50% of the time. This person may or may not have been located in a formally established TTF at that time.

ACTIONABLE DISCLOSURE: IP which has been reported to NIPMO on an IP7 Form as described by NIPMO in Practice Note 5.1 of 2017. This will include all IP for which the institution elects to obtain statutory protection and IP that cannot be protected through statutory registration but has potential to: (a) address socioeconomic needs; or (b) be commercialised; or (c) the recipient elects to retain ownership.

ASSIGNMENT(S): A transaction whereby all rights and title to, as well as interest in that IP is transferred to another party.

AVAILABLE: LICENSED ACTIONABLE DISCLOSURES that are sold as a product and/or service to the public or are placed into commercial use by a company, e.g. as part of a manufacturing process. A LICENSED ACTIONABLE DISCLOSURE is considered AVAILABLE if it was placed into use during that year, i.e. evidenced by royalties generated for the first time or licensee diligence reporting.

CASHED-IN EQUITY: This is the amount received from the sale of shares held in a START-UP (also termed equity holding), resulting in a cash transfer to the institution, less the cost basis, if any, at which the equity was acquired. Excluded are DIVIDENDS, any type of analysis or process whereby a value for the equity holdings is determined but a cash transaction does not take place through the sale of these holdings. An internal sale (e.g. to the endowment) will constitute cashing-in if the transaction results in cash being made available for internal distribution, and such amount must be included.

CLINICAL TRIALS: Before new drugs, vaccines, devices or treatments can be introduced onto the market, they must be tested systematically on human volunteers to ensure that they are both safe and effective. Clinical trials are divided into four standard phases, three of which take place before permission to manufacture is granted. For the purposes of international comparison, by convention, clinical trial phases 1, 2 and 3 can be treated as R&D.

CO-OWNED: Co-ownership is where another party is a co-applicant, co-assignee, co-patentee, or the like, or where an agreement is in place between two or more parties that inter alia regulates co-ownership of the IP.

DIVIDENDS: A dividend is the distribution of reward from a portion of a company's earnings (profits), in cash, to holders of shares entitled to receive dividends. Excluded are rewards not in the form of cash, e.g. additional shares of stock, or other property.

EQUITY: An institution acquiring an ownership interest in a company (e.g. shares or the right to receive shares).

EXCLUSIVE: The reporting of a licence as EXCLUSIVE or NON-EXCLUSIVE should follow the terms of the licence agreement. If a licence is designated as EXCLUSIVE in the licence agreement, it should be reported as an EXCLUSIVE licence in this Survey. EXCLUSIVE licences include licences that are designated as EXCLUSIVE by field of use, territory, or otherwise, but excludes sole licences, which are reported as NON-EXCLUSIVE LICENCES. Sole licence in this instance refers to a licence wherein the licensor reserves some or all rights to use the IP for their own use, e.g. the licensor reserving the right to use the IP for research and teaching.

FOREIGN-REGISTERED ORGANISATIONS: These are organisations that are not registered with the Companies and Intellectual Property Commission (CIPC) in South Africa.

FTE: Full-Time Equivalent. See use in definitions for, TT FTE and OTHER FTE.

INSTITUTION(S): As defined in the IPR Act.

IP CREATORS: As defined in the IPR Act.

IP ENABLERS: A person who has contributed significantly to the reduction to practice of an invention and who is not an IP Creator.

IP EXPENDITURE: Includes the amount spent by an institution in external legal fees for securing and maintaining IP rights. Excluded from these fees are LITIGATION EXPENDITURE.

IP EXPENSE REIMBURSEMENTS: The amounts received from IP TRANSACTION REVENUE by the institution for IP EXPENDITURE. Included in this category are amounts paid via lump-sum payments of costs incurred in prior years when a new licence is signed and regular reimbursements of new costs incurred after the licence is signed. This amount does not include NIPMO IP Fund rebates.

IP TRANSACTION REVENUE: The gross revenue received that is due to your institution only as consideration in an IP TRANSACTION such as licence issue fees, payments under options or on assignment, milestones or minimum payments (also referred to as annual minimums), running royalties and termination payments. It excludes research funding, amount of equity received when cashed in, dividends and a valuation of equity not cashed-in.

IP TRANSACTION(S): A LICENCE, OPTION or ASSIGNMENT or combination of these, as applicable, that is executed with the purpose of that ACTIONABLE DISCLOSURE or non-IPR Act disclosure being commercialised. Where more than one ACTIONABLE DISCLOSURE or non-IPR Act disclosure is included in an IP TRANSACTION, an IP TRANSACTION will be counted for each of the ACTIONABLE DISCLOSURES that are included.

LARGE COMPANIES: Enterprises with more than 200 employees.

LICENCE(S): A transaction whereby part or all of the rights to an ACTIONABLE DISCLOSURE, are granted to another party, whether on an EXCLUSIVE or NON-EXCLUSIVE basis, and that is executed with the purpose of that IP being commercialised. However, this excludes the licensing of background IP for research purposes.

LICENSED ACTIONABLE DISCLOSURES: These are ACTIONABLE DISCLOSURES that are the subject of a duly executed LICENCE, OPTION or ASSIGNMENT which may or may not have become a product that was sold either to the public or to industry, or process that was put into commercial use.

LITIGATION EXPENDITURE: All litigation expenses associated with the defence of an ACTIONABLE DISCLOSURE.

NEW PATENT APPLICATIONS: The first filing of patentable subject matter. NEW PATENT APPLICATIONS do not include continuations, divisionals, or reissues, and do not include continuations in part (CIPs). A provisional patent application in any jurisdiction/region/country will be counted as new if it does not claim priority from any other patent application (therefore a refilling of a lapsed/withdrawn provisional application is counted as new).

NEW PLANT BREEDERS' RIGHTS APPLICATIONS: The first filing of an application for a plant breeders' right (includes plant variety rights and US plant patent applications and community plant breeders' rights applications).

NEW REGISTERED DESIGN APPLICATIONS: The first filing of an application for a registered design, and includes US and Australian design patent applications, as well as European Union (European Community) design applications. Furthermore, both aesthetic and functional registered design applications are included and counted separately.

NEW TRADE MARK APPLICATIONS: The first filing of a trade mark regardless of the number of classes in which application was filed, i.e. each distinct trade mark in any number of classes is a new trade mark for the purposes of determining NEW TRADE MARK APPLICATIONS. NEW Trade mark APPLICATIONS are limited to those associated with an ACTIONABLE DISCLOSURE, and do not include trade marks such as those used by the institution, or its subsidiaries, for branding, etc.

NON-EXCLUSIVE: The reporting of a licence or option as EXCLUSIVE or NON-EXCLUSIVE should adhere to the terms of the licence agreement. If a licence is designated as NON-EXCLUSIVE or sole in the licence agreement, it should be reported under NON-EXCLUSIVE licences to this Survey. Sole licence in this instance refers to a licence wherein the licensor reserves some or all rights to use the IP for their own use, e.g. the licensor reserving the right to use the IP for research and teaching or for commercial purposes.

NON-TIA SEED FUND: This is funding received from sources other than the Technology Innovation Agency (TIA) and available for the early-stage development of IP or post proof of concept (Technology Readiness Level (TRL) 3). The objective of the funding is to assist inventors in achieving critical development milestones for their IP that are needed to attract further funding. The funds are typically used to mature IP that is in the TRL 3 to 7 range and with individual project budgets of under R1 million.

OPERATIONAL: A company that possesses sufficient financial resources and expends these resources to make progress towards stated business goals. The company must also be diligent in its efforts to achieve these goals. A company that has been acquired and no longer operates independently should still be counted as OPERATIONAL if the licence is still active and in compliance.

OPTION(S): A transaction whereby a party is granted an option to negotiate on a first-right-of-refusal basis of certain rights or title to an ACTIONABLE DISCLOSURE or non-IPR Act disclosure (and its associated registered IP, if applicable) and that is executed with the purpose of that IP being commercialised which will specifically include an IP TRANSACTION concluded. An OPTION can also be a right granted subject to certain conditions being met. An OPTION grants the potential licensee a time period during which the licensee may evaluate the ACTIONABLE DISCLOSURE or non-IPR Act disclosure and negotiate the terms of a LICENCE agreement.

OTHER FTE: Person(s) (including permanent and fixed-term staff) involved in the TTF as either full or fractional FTE allocations whose duties and responsibilities are to provide professional, administrative, or staff support of TECHNOLOGY TRANSFER ACTIVITIES that are not otherwise included in TT FTE. Such duties might include management, compliance reporting, and licence maintenance, negotiation of research agreements, contract management, accounting, material transfer agreement activity, and general office activity. General secretarial/administrative assistance to the TTF may also be included in this category.

PATENT FAMILY(IES): A suite of corresponding patent(s) and/or patent application(s) relating to a particular invention, which may have been filed in one or more jurisdiction/region/country that draws on the same priority application/s.

PATENT(S) GRANTED: Patent rights granted in a particular jurisdiction/country/region.

PLANT BREEDERS' RIGHTS FAMILY(IES): A suite of corresponding plant breeders' rights and/or plant breeders' rights application(s) relating to a particular plant variety, which may have been filed in one or more jurisdiction/region/country, that draws on the same priority application/s (includes plant variety rights and US plant patent applications and community plant breeders' rights applications).

PLANT BREEDERS' RIGHTS GRANTED: Plant breeders' rights granted in a particular jurisdiction/country/region and include plant variety rights and granted US plant patents and community plant breeders' rights.

REGISTERED DESIGN(S) GRANTED: Registered design rights granted in a specific jurisdiction/country/region and include granted US and Australian design patents and community designs.

RESEARCH AND DEVELOPMENT EXPENDITURE: Expenditure of the institution in support of its research and development activities, which may be funded from different sources, excluding expenditure on CLINICAL TRIALS.

REVENUE: Invoiceable income (turnover) from sales of products or services, accounted as such in the income statement. This excludes capital investments, loans, etc. secured by the company that are accounted for in the balance sheet.

RUNNING ROYALTIES: Royalties earned on and tied to the sale of products or services based on the licensed or assigned IP before any disbursement to any other funding partners (e.g. Technology Innovation Agency, private company, etc.). Excluded from this number are licence issue fees, payments under options, termination payments, the amount of annual minimums not supported by sales, DIVIDENDS and CASHED-IN EQUITY.

SA COMPLETE PATENT APPLICATIONS: A complete patent application filed in accordance with the laws of South Africa, specifically the South African Patents Act (No. 57 of 1978), at the Companies and Intellectual Property Commission (CIPC) and excludes a PCT filing.

SA PROVISIONAL PATENT APPLICATIONS: A provisional patent application filed in accordance with the laws of South Africa, specifically the South African Patents Act (No. 57 of 1978), at the Companies and Intellectual Property Commission (CIPC), providing a priority date for the application.

SMMEs: Small, Medium and Micro Enterprises. Enterprises with less than 200 employees.

SOUTH AFRICAN-REGISTERED ORGANISATION(S): An organisation that is registered with the Companies and Intellectual Property Commission (CIPC) in South Africa.

START-UP/SPIN-OUT COMPANY(IES): A newly incorporated company that has been incorporated at the Companies and Intellectual Property Commission (CIPC) for the initial purpose of commercialising an ACTIONABLE DISCLOSURE through rights granted to the company by the institution via an IP TRANSACTION. These companies are often referred to as start-ups, spin-offs or spin-out companies and do not include an existing company that has had other business interests who later enter into an IP TRANSACTION to also commercialise an ACTIONABLE DISCLOSURE.

TECHNOLOGY TRANSFER ACTIVITIES: Those activities associated with the identification, documentation, evaluation, protection, marketing, assigning and licensing of technology (including trade marks but not an institution's insignia) and IP management, in general. It encompasses all other activities also associated with the day-to-day operations of a TECHNOLOGY TRANSFER FUNCTION (TTF), including assisting with the negotiation of research agreements, Material Transfer Agreements, reporting of inventions to funders/sponsors, compliance with the IPR Act, and all other duties performed by the TTF.

TECHNOLOGY TRANSFER FUNCTION: The function (be it an individual(s), a dedicated office, a regional office, etc.) that manages and performs the TECHNOLOGY TRANSFER ACTIVITIES at the institution. For some TTF it is also referred to as a technology transfer office, technology licensing office or office of technology transfer.

TECHNOLOGY TRANSFER: See TECHNOLOGY TRANSFER ACTIVITIES.

TECHNOLOGY(IES): A TECHNOLOGY is the embodiment of an idea that results from the creative work performed by a faculty, students or staff during research or teaching that is deemed to form part of the portfolio managed by the TTF. Multiple TECHNOLOGIES can arise from a single DISCLOSURE or a single TECHNOLOGY can be the result from a number of DISCLOSURES. A TECHNOLOGY is the embodiment of a single innovative idea, irrespective of how many (i) protection filings (being patents, trade marks, designs, plant breeders' rights or copyrights), or (ii) disclosures may be associated with/included in the TECHNOLOGY.

SECTION H: DEFINITIONS OF TERMS (CONTINUED)

TIA SEED FUND: This is funding received from the Technology Innovation Agency (TIA) and available for the early-stage development of IP or post proof of concept (Technology Readiness Level (TRL) 3). The objective of the funding is to assist inventors in achieving critical development milestones for their IP that is needed to attract further funding. The funds are typically used to mature IP that is in the TRL 3 to 7 range and with individual project budgets of under R1 million.

TRADE MARK(S) GRANTED: Includes trade mark rights granted in a particular jurisdiction/region/country associated with a specific ACTIONABLE DISCLOSURE.

TT FTE: Person(s) (including permanent and fixed-term staff) involved in the TTF whose duties are specifically related to licensing, IP registration and maintenance processes as either full or fractional FTE allocations. Licensing examples include licensee solicitation, technology valuation, marketing of technology, licence agreement drafting and negotiation, and start-up activity efforts. Note that these exclude OTHER FTEs.

TT OPERATIONS EXPENDITURE: The expenses associated with the operation of the TTF, such as human resource costs, office infrastructure, consultants, marketing. It excludes IP EXPENDITURE, LITIGATION EXPENDITURE, TIA SEED FUND and NON-TIA SEED FUND.

SECTION I: METADATA AND METHODOLOGY

The second South African national survey of IP and TT at publicly funded research institutions was undertaken to systematically establish the capacity and overall activity of IP and TT at institutions included under Section 1 of the IPR Act. This second survey project encompassed the collection and analysis of five years of data spanning from the 2014/15 financial year to the 2018/19 financial year.

The second survey project commenced in September 2019 with fieldwork conducted from January 2020 to September 2020.

The capacity and overall activity of IP and TT was established in order to assist the South African government, through the DSI and NIPMO as a Specialised Service Delivery Unit (SSDU), in monitoring the progress made in terms of creating capacity in South Africa to manage IP and TT, as well as the associated outputs, outcomes and impacts.

SURVEY DESIGN AND PLANNING

To allow for comparison with the findings of the inaugural baseline survey project undertaken for the financial years 2008/9 to 2014/15, the survey questionnaire was structured so as to obtain data on the inputs, activities, outputs and outcomes as substantially covered by the inaugural baseline survey project, while further obtaining data which allowed for comparison with foreign TT, or knowledge transfer (KT), survey findings, including:

- the AUTM Licensing Survey for the US and Canada;
- the Higher Education – Business and Community Interaction Survey for the UK;
- the FORMICT Report on IP Policies of Scientific and Technological Institutions and Innovation for Brazil;
- the National Survey of Research Commercialisation (NSRC) for Australia; and
- the KTI Annual Knowledge Transfer Survey Report for Ireland.

The input data included: institutional R&D and clinical trial expenditure; OTT staffing capabilities and requirements (capacity, skills, experience and qualifications); organisational structure of OTTs; support, policies, processes, functions and factors impacting TT at OTTs; expenditure related to securing, maintaining and commercialising IP; IP expenditure reimbursements; TT operations expenditure; litigation expenditure; and seed funding.

The activity data included: the nature, number and reporting of disclosures; IPR Act and non-IPR Act-related IP protection, portfolios and management; the number and type of IP transactions; and the number of start-up/spin-out companies incorporated to commercialise institutional IP.

The output and outcome data included: IP registrations; IP transaction revenue; institutional IP creator/enabler benefit-sharing; start-up/spin-out company employment and IP creator/enabler interests; institutional revenue from start-up/spin-out companies; and select social impact case studies.

A copy of the survey questionnaire comprising the survey structure and data requests can be obtained free of charge from: https://nipmo.dst.gov.za/resources/south-african-national-survey-of-intellectual-property-and-technology-transfer-at-publicly funded-research-institutions-2014-to-2018.

FRAME, SAMPLE SELECTION AND FIELDWORK PERIODS

The second survey project was limited to the 37 publicly funded research institutions as per the IPR Act, comprising 26 HEIs and 11 statutory institutions per Schedule 1 of the IPR Act, as at September 2019, collectively referred to as SCs. A list of the participating institutions is provided in Table 15.

HEIs
Cape Peninsula University of Technology
Central University of Technology
Durban University of Technology
Mangosuthu University of Technology
Nelson Mandela Metropolitan University
North-West University
Rhodes University
Sefako Makgatho Health Sciences University
Sol Plaatje University
Stellenbosch University
Tshwane University of Technology
University of Cape Town
University of Johannesburg
University of KwaZulu-Natal
University of Limpopo
University of Mpumalanga
University of Pretoria
University of South Africa
University of the Free State
University of the Western Cape
University of the Witwatersrand
University of Venda
University of Zululand
University of Fort Hare
Vaal University of Technology
Walter Sisulu University
SCs
Agricultural Research Council
Council for Geoscience
MINTEK
Council for Scientific and Industrial Research
Human Sciences Research Council
National Health Laboratory Services
National Research Foundation
South African Bureau of Standards
South African Medical Research Council
South African Nuclear Energy Corporation
Water Research Commission

Table 15: List of participating institutions

Where relevant, and as provided in Section E, a categorisation of the HEIs was applied according to traditional universities, comprehensive universities and universities of technology. Table 16 provides the HEIs by type of HEI.

Traditional universities
North-West University
Rhodes University
Sefako Makgatho Health Sciences University
Stellenbosch University
University of Cape Town
University of KwaZulu-Natal
University of Limpopo
University of Pretoria
University of the Free State
University of the Western Cape
University of the Witwatersrand
University of Fort Hare
Comprehensive universities
Nelson Mandela Metropolitan University
Sol Plaatje University
University of Johannesburg
University of Mpumalanga
University of South Africa
University of Venda
University of Zululand
Universities of technology
Cape Peninsula University of Technology
Central University of Technology
Durban University of Technology
Mangosuthu University of Technology
Tshwane University of Technology
Vaal University of Technology
Walter Sisulu University

Table 16: List of HEIs by type of HEI

The OTTs of the institutions were identified as respondents, and thereby served as the source of primary data, and where no OTT had been established, the Directorate responsible for the TTF was identified as respondent, and thereby served as the source of primary data.

The reference period for the SCs was the financial (fiscal) year ending 31 March, and for the HEIs it was the calendar year. The fieldwork period was 20 January 2020 to 19 September 2020.

FIELDWORK, QUALITY INDICATORS OF SURVEY COVERAGE, ANALYSIS AND VALIDATION

For purposes of the second survey project fieldwork, the structure and contents of the survey questionnaire, including the associated abbreviations and definitions, was prepared by the DSI in consultation with NIPMO, SARIMA and KISCH IP. The survey questionnaire was electronically regenerated in an Enterprise Feedback Management system with accompanying data management framework adhering to the South African Market Research Association (SAMRA) Memorandum of Incorporation and Rules, further complying with the internationally accepted Code of Conduct for marketing research, social research and opinion polling research.

An instance of the electronic survey questionnaire was generated for each participating institution in the Enterprise Feedback Management system, each instance synchronised to a centralised database for backend data management and monitoring. Specific data items in the institution-specific instances of the survey questionnaire were partially prepopulated with institution-specific modifiable data from NIPMO as reported by the institutions to NIPMO in accordance with the IPR Act. Accordingly, each instance of the survey questionnaire contained, where available, partially prepopulated data for the institution associated with that specific instance.

Each instance of the electronic survey questionnaire was configured to prevent a user from submitting an invalid response to a question. In defining a valid response in the system, response categories were established, and response criteria were implemented as follows:

- for text responses, an option was presented to the user to select "Unknown", "Not Applicable" or to provide a text or alphanumeric input as a valid response, and only where a response was optional was a blank response considered as a valid response in the system;
- for integer responses, an option was presented to the user to select "Unknown", "Not Applicable" or a non-negative integer value selected from a predefined logical range of integer values, and a blank, negative integer value, non-integer value or text value was an invalid response in the system;
- for date responses, an option was presented to the user to select "Unknown", "Not Applicable" or a date selection from a predefined logical year date range, and a blank, non-date value, date value outside the predefined range or text value was an invalid response in the system; and
- for numerical responses with the possibility of non-integer responses, an option was presented to the user to select "Unknown", "Not Applicable" or to provide a positive numerical value within a predefined logical range, and a blank, negative numerical value or text value was an invalid response in the system.

The electronic survey questionnaire did not allow for negative value responses to any question.

The electronic survey further made use of qualifying "Yes"/"No" questions via radio buttons which were used to automatically present questions for which a response was required from the user.

The electronic survey questionnaire was further structured in multiple sections, with navigation from a section restricted where an invalid response was present. To mitigate response data loss, each institution-specific instance of the survey questionnaire in the Enterprise Feedback Management system passed the sectional data to the centralised database once a user navigated away from a section. Where navigation was restricted due to an invalid response in a section, the sectional data was not passed to the centralised database, the invalid response was highlighted in the section and the user was prompted to correct the invalid response.

Once the data prepopulation and data validation configuration was completed, a selection of survey questionnaire instances were selected for internal online testing by the DSI and NIPMO, and any inconsistencies on survey functionality was corrected.

Once internal testing was completed and cleared, four pilot institutions were sent their institution-specific instances of the survey questionnaire and pilot testing was done during November 2019. The purpose of the pilot testing was to test that the electronic survey questionnaire was fully functional in that:

- the questions are clear and understandable;
- the associated instructions, abbreviations and definitions document which was to accompany the survey questionnaire was sufficiently clear and understandable;
- key qualifying questions functioned correctly so as to expand and collapse selected questions based on the user's input;
- sufficient directions were provided to users who required any assistance in completing the survey questionnaire; and
- that the survey questionnaire allowed a user to complete the survey questionnaire over time, allowing users to save, exit and return to and submit the questionnaire as needed and without data loss.

All four pilot institutions provided comprehensive feedback which was incorporated as needed into the final survey questionnaire functionality.

In January 2020, institution-specific instances of the electronic survey questionnaire were generated and sent to the Directors of the participating OTTs. The initial period stipulated for data capturing by the respondents was three months, but this period was extended to nine months due to the declaration of the National State of Disaster by the South African government as a result of the outbreak of the COVID-19 disease, in order to provide all respondents with sufficient time to access institutional resources in order to complete the survey questionnaire. During the nine months of fieldwork, remote support and follow-up was done on a case-by-case basis (based on the findings of a weekly review of the centralised database) via e-mail, telephone and virtual meetings. By 19 August 2020, 100% participation was secured. A breakdown of the number of valid responses received per section is provided in Table 17.

Section	Number of valid responses per section
Section 1: Institution and its context	37
Section 2: Technology transfer function	37
Section 3A: IP portfolio (only IPR Act)	37
Section 3B: IP portfolio (outside scope of IPR Act)	37
Section 4A: IP transactions (only IPR Act IP transactions)	37
Section 4B: IP transactions (outside scope of IPR Act)	37
Section 5: IP impact	37
Section 6: Qualitative input	22

Table 17: Number of valid responses received per section of the survey questionnaire

Once a final valid response was received from an institution, the complete submission was reviewed and logical data validation was executed. This logical data validation included assessments of whether:

- a response to a question made logical sense within the context of the question;
- where values were provided, that the values were within the range of possibility, where relevant using confirmed international and local data sources;
- where a total value was reported together with values for constituent parts, the sum of the constituent parts equalled corresponding total values;
- where financial figures were reported, that rounding and multiples were accounted for; and
- where time-sensitive data was provided, that timelines and values accorded with the prescribed time period.

After the logical data validation was concluded, a one-on-one consultation was undertaken with each institution based on irregular data items identified. Where an institution was not available for a consultation, the irregular data items identified were conveyed via e-mail and were addressed via e-mail exchange. Out of the 37 respondents, two respondents were not available for verification and/or correction of irregular data items, and accordingly such data items, and further items dependent thereon were changed to "Unknown" in order to avoid a skewing of the aggregated results.

During the consultation/e-mail exchange, each data item was considered, and where substantiated the data item was maintained, and where found to be as a result of an error, the necessary corrections were made. Where necessary, the institution was afforded a further period in which to seek and provide the correct information through their instance of the survey questionnaire.

The DSI has access to the raw anonymised data, metadata, aggregated data and spreadsheets thereof.

DATA PROCESSING AND MISSING DATA

The full data set comprised of the final data export from the centralised database as well as hardcopy responses recorded during the one-on-one consultations. Further to the validation done during fieldwork and subsequent follow-up activities based on irregular data items identified, a final validation process was performed, with the DSI, NIPMO and SARIMA as the principle validators. The final data validation process required limited further response data from the participating institutions, and such institutions were contacted separately.

In analysing the final data, it is to be appreciated that it is not uncommon that not all data requested by the survey questionnaire was available to every respondent. To account for this, a pre-set "Unknown" option was provided for as a valid response. Where a value was indicated as "Unknown", the respondent was asked to provide a reason therefore, and the most common reasons were either that the value was not captured in the institutional information system or that the value was not obtainable from the institutional information system. Where a respondent provided a "Unknown" response to a question, and this data could not be reliably obtained otherwise, the respondent's data for that question was excluded from the analysis where necessary in order to maintain the accuracy of any findings based thereon. Furthermore, where a respondent provided a "Unknown" response to a specific financial year within a question, the respondent's data for all years in question, even for those years in which a valid response was provided by the respondent, was excluded. This was done to ensure that time series data presented in this Report was not influenced by incomplete data within select years in the time series. A consequence hereof is that the results presented in this Report are likely to be underestimates where the sample size reported for the specific result is less than 37 for all respondents, less than 26 for HEI respondents or less than 11 for SC respondents.

EXTERNAL DATA USAGE

The use of data sources other than the OTTs or the Directorate responsible for the TTF as the source of primary data was limited as much as possible. Accordingly, there were only select instances wherein external data was used in this Report.

The GDP deflator was used to establish constant 2014 prices. The GDP deflator is calculated by using GDP in current values for a reference year to GDP that has been based to 2014 prices. This is used to convert currency values of quantities in this Report in current prices to constant prices based to 2014. The annual percentage GDP deflator values in Table 18 were used as sourced from the World Bank Data for South Africa.

Reference year	2015	2016	2017	2018
Annual %	5.171	7.206	5.267	3.917

Table 18: GDP deflator values (annual percentage values)

The Purchasing Price Parity (PPP) as published by the OECD in 2020 was used for currency conversions between the Rand, other foreign currencies and the US Dollar. The PPP provide rates of currency conversion that attempt to equalise the purchasing power of different currencies, by eliminating the differences in price levels between countries. As per the OECD notes on PPP, the basket of goods and services priced is a sample of all those that are part of final expenditures: final consumption of households and government, fixed capital formation, and net exports. This indicator is measured in terms of national currency per US Dollar. The PPP rates used in this Report are provided in Table 19.

Currency	2014	2015	2016	2017	2018
ZAR	5.572	5.826	6.161	6.427	6.52
CAD	1.23	1.248	1.207	1.205	1.198
AUD	1.452	1.474	1.45	1.466	1.451
GBP	0.698	0.692	0.689	0.682	0.687

Table 19: PPP values used in international comparative analysis

Due to data consistency issues experienced with respect to IPR Act-related plant breeders' rights applications, the Plant Variety Journals as published quarterly by the South African Department of Agriculture, Land Reform and Rural Development (formerly the Department of Agriculture, Forestry and Fisheries) were referenced in order to validate and/or correct such data inconsistencies.

Finally, IP data services were used in the logical data validation stage where respondent data appeared questionable with respect to IP activities. In such instances, and depending on the nature of the data, the following sources were referenced:

- the CIPC IP online service;
- Clarivate Analytics' Derwent Innovation;
- Questel Orbit Intelligence; and
- various national IP databases.

No data from these sources were used in the final full data set as these sources were only used to substantiate irregular data items, where possible, for correction by the respondent based on their institutional records.

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