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The impact of the Intellectual Property Rights Act for Publicly Funded Research and Development on Technology Transfer Offices at South African Universities

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Abstract

The impact of the Intellectual Property Rights Act for publicly funded research and development on technology transfer offices was studied, using a questionnaire survey and guided interviews of six technology transfer officers. The survey requested technology transfer officers to express the impact level of each of the eleven impact elements on the four stages of intellectual property development – these being intellectual property creation, disclosure, protection and commercialisation. The set of data was weighted for each element, by intellectual property development stage, and analysed using frequency tables. The impact elements of 'structural and resource requirements to commercialise and manage intellectual property', 'intellectual property detection process by the technology transfer officers', and' disclosure process' were ranked as the top three impact elements, in that respective order. Narrative inquiry and theme extraction allowed further elaboration of the impact elements. Comparison with Staphorst's (2010) results showed that the impact elements were different for science councils, pointing to unique requirements by universities in their intellectual property management systems. The results of this analysis clearly indicate that the Intellectual Property Rights Act enforcement and execution will demand a high degree of structural and resource requirements, particularly, and most importantly, at the intellectual property disclosure stage of intellectual property development.

Keywords: Intellectual Property Rights, Bayh-Dole, Technology Transfer Office, Stages of Intellectual Property Development.

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination at any other university. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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08-01-2011

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Date

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Abbreviations and Acronyms

ARIPO	African Regional Industrial Property Association
AUTM	Association of University Technology Managers
BBBEE	Broad-Based Black Economic Empowerment
CHET	The Centre for Higher Education and Transformation
CSIR	Council for Scientific and Industrial Research
DTI	Department of Trade and Industry
IP	Intellectual Property
IPPM	Intellectual Property Protection Mechanism
IPR	Intellectual Property Rights
IPR Act	Intellectual Property Rights from Publicly Financed Research and Development
ISLs	Industry Science Links
NIPMO	National Intellectual Property Management Office
OECD	Organisation for Economic Co-operation and Development Governments
PCT	Patent Cooperation Treaty
R&D	Research and Development
ROI	Return on Investment
SA	South Africa
TIA	Technology Innovation Agency
TRIPS	Trade-Related Aspects of Intellectual Property Rights
TTO	Technology Transfer Office
TTOs	Technology Transfer Offices

TTOR	Technology Transfer Officer
TTORs	Technology Transfer Officers
US	United States
UK	United Kingdom
UITT	University Industry Technology Transfer
VC	Venture Capital
WIPO	World Intellectual Property Organisation
WTO	World Trade Organisation

Chapter 1 – Introduction

1. Introduction to the Research Problem

Universities and tertiary institutions are responsible for a large proportion of intellectual property (IP) creation. The technology transfer of these IP assets into industry is a key contributor to the economic development of nations (Boettiger & Bennet, 2005). Commercialisation of university-based technologies relies heavily upon appropriate policymaking and legislation at government level (Boettiger & Bennet, 2005). In the United States (US), the enactment of the Bayh-Dole Act was intended to facilitate the commercialisation of innovations resulting from research that had been federally funded (Boettiger & Bennet, 2005). The proponents of the Bayh-Dole Act aimed to design incentives for universities, university inventors and private industry, to promote and engage in the commercialisation process (Boettiger & Bennet, 2005). The incentives were hoped to foster the creation of new products and services from research that might otherwise remain forever commercially unexploited (Boettiger & Bennet, 2005).

The Bayh-Dole Act provided for clear ownership of IP and licensing opportunities for industry, thereby stimulating private sector investment in these university innovations (Boettiger & Bennet, 2005). Thirty-one years after the enactment of the Bayh-Dole Act, its effects in the US seem to remain controversial, judging from the disparate results reported in the literature (Boettiger & Bennet, 2005). Up to 2005, it was reported that little had been written about the Bayh-Dole Act in relation to the needs of developing countries such as South Africa (Boettiger & Bennet 2005). In South Africa, a number of

universities are producing world-class research outputs and innovations (McGregor, 2010). In this vein, the Intellectual Property Rights from Publicly Financed Research and Development Act 51 of 2008 (IPR Act) was enacted in order to

"*provide for more effective utilisation of IP emanating from publicly financed research and development, to establish the national IP management office and IP fund, to provide for establishment of technology transfer offices (TTO) at institutions and to provide for matters connected therewith*" (Republic of South Africa, 2008).

In a sense, the IPR Act of South Africa can be seen to be the corresponding Bayh-Dole Act of the US (Staphorst, 2010). According to the IPR Act, its object is to ensure that IP emanating from publicly funded research and development is identified, protected, utilised and commercialised for the benefit of the people of the Republic (Republic of South Africa, 2008). Clearly, the commercialisation aspects provided for by the IPR Act necessitate a functioning technology transfer system between universities and industry. The so-called University-Industry-Technology–Transfer (UITT) system is critically important in enabling the commercialisation of university-based technologies (Republic of South Africa, 2008).

The work of Staphorst (2010) supports that the IPR Act will have a profound effect on University-Industry relations at research councils and broadly on the UITT process. Issues of ownership, licensing and strategy for commercialisation will all be affected in one way or another. It is an object of this research to determine the motivating and impact factors on technology transfer offices in the face of the newly enacted IPR Act 51 of 2008 (Republic of South Africa, 2008).

The IPR Act places a number of conditions on the commercial exploitation of intellectual property emanating from publicly funded research. How this IPR Act influences the technology transfer process at universities is not known, gauging from the paucity of published articles on this subject. Despite the importance of UITT in fostering technological diffusion between universities and industry, to date there has been little systematic analysis of the impact of the IPR Act in this process. Therefore, there is a need to study the impact of the IPR Act on technology transfer processes at TTOs of universities.

2. Research Aims of the Dissertation

This research study focused on gathering the current thinking surrounding regulatory effects on the technology transfer process at South African Universities, in the light of substantial knowledge describing the effects of the Bayh-Dole Act in US UITT. Thereafter, research questions were developed to investigate the impact of the Intellectual Property Rights Act (IPR Act) of South Africa (Republic of South Africa, 2008) on the technology transfer process at university technology transfer offices (TTOs). Other UITT stakeholders such as research councils were excluded from the study, as they are not governed by the Higher Education Act.

3. Scope of the Dissertation

Research conducted on the IPR Act and its effects in South Africa, remains scarce, and is mainly exploratory in nature (Baloyi *et al*., 2009; Staphorst, 2010), and no published articles focused on this specific topic could be found. Fortunately, one thesis (Staphorst, 2010) and one research council report (Baloyi *et al.,* 2009) that pertain to the IPR Act

and its effects in South Africa, were found, and were used in the literature review, as they are highly relevant in the research project. The scope of this research project therefore, is limited to the study "*The impact of the Intellectual Property Rights Act for publicly funded research & development on technology transfer at South African universities*".

4. Contributions of the Dissertation

The research project adds new knowledge that identifies those impact elements within the IPR Act which technology transfer officers (TTORs) consider to have the highest impact on the different stages of IP development. Furthermore, this research identifies the rank order of importance of the 11 impact impact elements within the IPR Act, previously identified by Staphorst (2010) and explored in relation to research councils in South Africa.

5. Organisation of the Dissertation

This dissertation is organised as follows:

- Chapter 1 begins with a description of the research problem addressed by the study, followed by an overview of the context within which the study was performed. It outlines the aims and scope of the research. Finally, the contributions arising from the study are briefly highlighted.

- Chapter 2 presents a literature study and theory review that span the concepts and constructs applicable to the study. This chapter investigates the key themes related to the research problem considered in the study, and presents a thorough

review on technology transfer, Intellectual Property, The Impact of IPR Legislation on UITT and the Academic Motivation for the Study.

- Chapter 3 presents an overview of the research objectives that defined the focus of the study. The research study comprises Part A (quantitative phase) and Part B (qualitative phase).

- Chapter 4 presents the methodologies used during the quantitative and qualitative phases in order to address the research objectives defined in Chapter 3. A discussion on potential research limitations and justifications of the study brings Chapter 4 to a close.

- Chapter 5 presents the results obtained during the quantitative phase of the study, followed by the results for the subsequent qualitative research phase. These results include appropriate descriptive statistics, as well as reliability and validity tests for the data collected. Furthermore, Chapter 5 attempts to answer the research questions posed in Chapter 3.

- Chapter 6 discusses the results presented in Chapter 5, against relevant literature studies that focus on the topics of technology transfer offices and the influence of IPR management strength. Concluding remarks on the core findings of the study, as well as a discussion on some future research areas, constitute Chapter 7. Lastly, the following set of appendices is included in this document:

- Appendix A: The consistency matrix for the study, summarising the research questions with their related literature references and chosen data collection and analysis tools, are presented here.

- Appendix B: This appendix describes the guided interview, followed by the questionnaire survey used as data collection tool during the initial Part A (quantitative) and Part B (qualitative) research phase of the study .

- Appendix C: This appendix includes the information brochure summarising the IPR Act (Republic of South Africa, 2008).

Chapter 2 - Literature and Theory Review

2.1. Introduction

The literature and theory reviewed in this chapter investigates the key themes related to the research problem considered in the study, thereby creating a foundation for the understanding of the academic motivation for the study. The themes considered in this chapter include:

- Technology Transfer: The literature covered in this section presents a brief overview of the role of University Industry Technology Transfer (UITT), as well as the economic growth due to UITT.
- Intellectual Property: The literature covered in this section presents a brief overview of the global politics of intellectual property rights, including the Bayh-Dole Act's background, as well as an extensive review of the IPR Act's background and features.
- The Impact of IPR Legislation on UITT: This section presents a brief overview of the impact of IPR legislation on UITT.
- Academic Motivation for the Study: A discussion on the academic justification for the study concludes the theory and literature review presented in this chapter.

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2.2 Technology Transfer

2.2.1 University Industry Technology Transfer

According to Garduno (2003), universities are playing a vital role in national innovation systems, and are making substantial contributions to innovation through the development of new technologies. Carlsson and Fridh (2002) studied the transfer of intellectual property rights such as patents and licences, from universities to industry, via start-ups of new companies in the United States. Carlsson and Fridh (2002) selected 12 different universities, ranging from top academic institutions to a number of regional institutions. They collected data through mail questionnaires, and followed up through telephone interviews. In addition, they also conducted a statistical analysis of data collected by the Association of University Technology Managers (AUTM) for 170 US universities, hospitals and research institutes, for the period 1991-1996 (Carlsson & Fridh, 2002).

Numerous US universities set up TTOs to facilitate commercialisation of research results (Garduno, 2003). The purpose of their study was to better understand the role of TTOs, their place within the university structure, the procedure of technology transfer, and lastly, the staffing and funding of the office (Carlsson & Fridh, 2002).

Interestingly, the results of Carlsson and Fridh (2002) show that technology transfer from universities to the commercial sector need to be understood in a broader context. They conclude that the primary purpose of a technology transfer programme in

universities is to assist researchers in publishing research results for the public good (Carlsson & Fridh, 2002).

In South Africa, as in most of the developed world, scientists are rated according to their academic outputs – for example, publications in accredited journals and books (Garduno, 2003). The way in which disclosure is to be made by inventing scientists whose research is publicly funded, is addressed in the IPR Act (Republic of South Africa, 2008). The research is set to uncover the impact of the IPR Act on this performance measure – for example, the conflict that may arise when scientists' research first needs to be evaluated for potential patent protection, before it may be published. Furthermore, it will shed light on how this may interfere with the publication process and the attaining of academic prestige.

Feldman, *et al.* (2002) conducted a study of dispute mechanisms available to universities in managing the commercialisation of intellectual property, considering equity as a technology transfer mechanism that provides an advantage for generating revenue, as well as aligning the interests of universities, industry and faculty. Furthermore, they estimate and present a model that considers the university's use of equity as a function of behavioural factors that relate to the university's previous experiences with licensing, success relating to other institutions, the organisation of the TTO, as well as characteristics relating to university types.

In their study, Feldman, *et al.* (2002) found that, in the past, universities were often left with little choice but to accept equities instead of licensing fees in cases where the licensee was a cash-strapped company. This meant that the university was then tied into an equity reward system with higher risk, when compared to a licence agreement. They found that equity is increasingly seen by academic institutions' TTOs as an attractive mechanism offering advantages in increasing the upside revenue of university technology, as well as improving the alignment between the institution's interests and those of the firm (Feldman, *et al*., 2002).

In their study, Feldman, *et al.* (2002) developed and tested four hypotheses around the effect of direct experience, organisational incentives, and experience relative to a related cohort on the adoption of a new technology transfer mechanism. They concluded that their results were limited by sample size, as well as the absence of attention to changes over time in academic institutions' policies (Feldman, *et al.*, 2002). In the South African context and the IPR Act, it is an objective of the research study to uncover the preferred licensing vehicles for technology transfer – for example, is it purely royalty based, or are there examples where equity participation of the institution is preferred?

2.2.2 Economic growth due to UITT

According to Garduno (2003), both developed and developing countries seek to improve national economic growth through the contribution of university research.

Garduno (2003) also believes that the basic goal of technology transfer, the transfer of technologies developed by university scientists for the private sector, is to increase economic growth through better technology innovation. He also believes that an effective technology transfer system requires proper incentives for all participants (Garduno, 2003). Mueller (2006) believes that the capability to create, identify and exploit knowledge relies on the existing knowledge assets and the absorptive capability of both scientists at universities and of employees at firms. Furthermore, she believes that the existing knowledge assets may not be commercialised to their full degree, and therefore channels for knowledge flow and communication are needed (Mueller, 2006).

In her paper, Mueller (2006) tests the hypotheses that entrepreneurship and university-industry relations are vehicles for knowledge flows, and thus boost economic growth. She reports that the German government and European Commission have introduced various instruments to foster research partnerships and cooperation between universities and private businesses. One of these instruments requires university-industry collaboration, in order that subsidies may be received. As a result, many universities are introducing entrepreneurship education into their curriculum, in order to support the technology transfer process. Santoro and Chakrabarti (2002) posit that university research can be valuable to industrial firms, by providing firms with a number of relationship substitutes that enable the improvement of knowledge and new technologies. Their field of study indicates that more mechanical firms in resource-concentrated industrial sectors use knowledge transfer and research support relationships to build experiences in non-core technological areas (Santoro & Chakrabarti, 2002).

In contrast, Santoro and Chakrabarti (2002) found that smaller, more organic firms, predominantly those in high-technology industrial sectors, focus more on problem solving in core technological areas, through technology transfer and supportive research relationships. They conclude that champions, defined as individuals that exploit structural and personal characteristics to influence organisational dynamics, in order to advance new ideas at the firm, play a key role in these dynamics. They speculate and conclude that much of the contributions of university research centres can be explained in light of social capital theory (Coleman, 1988). Therefore, large companies are interested in associating with top-tier universities for the network effect (Santoro & Chakrabarti, 2002). Typically, UITT relies on the social capital level and interaction between university scientists, TTORs and industry representatives. It would be interesting to determine through the research how this intricate relationship may potentially be affected by the IPR Act, and how it will ultimately impact upon UITT. Research questions werere formulated in a way that will shed light on how aspects of firm size and access to resources affect TTO decisionmaking. For example, would a TTO give preference to negotiating a deal with a large multinational company that has marketing and distribution channels throughout the world, over a deal with a small local company operating in its own country?

Lor, *et al.* (2005) investigated three ways of knowledge flows from an African perspective: North-South, South-North and South-South. They focused their study from a moral, rather than a legal, view of intellectual property. The authors' concern was that there might have been a disturbance between the balance of public good and private interests. In this respect, Lor, *et al*. (2005) believe that on the current knowledge flows,

there are three ethical pillars that serve as a foundation for reflection. They are: the concept of the common good, human rights and social justice. They also study current developments in scholarly publishing and intellectual property rights that affect the North-South knowledge flow, as well as reactions to the increasing discrepancy between rights holders and authors (Lor, *et al*., 2005). They argue that there may be an imbalance in the knowledge flow system that may compromise less developed nations, and that public good and private interests should be balanced.

Thursby and Thursby (2004) examined the data from a survey of firms that regularly license-in from universities. In a sample of 112 firms that had recently licensed university inventions, they identified three main ways in which firms rely on the university faculty. These were:

- identification of inventions to license
- further development of licensed inventions
- sponsored research

Thursby and Thursby (2004) report that both formal as well as informal channels are important in the licensing process. Interestingly, they suggest that the initial licence is typically based on basic research that resulted in a form of breakthrough technology. However, the licensee firm often requires further development research on the initial technology, in order to develop a product or service that can be commercialised. This activity has unfortunate repercussions within faculty, as it may potentially disturb faculty from their core competency – for example, their role in basic research. They noted the importance of the role played by the university faculty in the licensing and development

of new inventions, and how these inventions are used (Thursby & Thursby, 2004). Garduno (2003), however, believes that University TTOs do a great deal to facilitate technology transfer. They encourage and support research participation, defend patent protection for new inventions, evaluate potential inventions for commercialisation, develop marketing plans and strategies, and identify and negotiate potential licensing deals. Lastly, and very importantly, for a TTO to engage properly, universities need to provide TTOs with trained personnel and proper resources to fulfill such a role (Garduno, 2003).

Siegel, *et al.* (2004) conducted structured interviews with 98 UITT stakeholders, including firms/entrepreneurs, TTO staff and university scientists associated with five US research universities. They concluded that there are numerous impediments to the effectiveness in the UITT process. These are cultural and informational barriers among the three stakeholders mentioned above; TTO staffing and compensation or reward practices; and, inadequate rewards for faculty involvement in UITT. A striking revelation of their research was that many faculty members decided to circumvent the formal UITT process. A second surprising finding was that involvement in UITT may actually increase both the quality and quantity of basic research (Siegel, *et al*., 2004), since UITT is most lucrative with breakthrough innovations and patents which are built upon basic, and not applied, research.

Siegel, *et al*. (2004) discovered evidence from their panel data from 1980 to 2000, that their econometric estimators disclosed proof of history dependence for successful technology transfer to occur. They made this discovery, despite the fact that faculty

quality, size, orientation of science and engineering funding, and profit-making capability, were found to be predictors of university spin-off activities.

Siegel, *et al.* (2004) endeavoured to identify factors that predict why some universities excel at generating technology-based spin-offs. Between 1995 and 2001, MIT, University of California system, Stanford University, California Institute of Technology and the University of Washington topped the list for generating the most spin-offs. They identified that successful universities possess high degrees of resource stocks which are relevant in explaining their high degree of success in spin-off activity. In other words, their history and past success constitute a cumulative effect in their previous development.

Furthermore, the presence of star scientists and star engineers dramatically impacts on the generation of breakthrough innovations which feed the pipeline of spin-off activities. These results underpin the importance for a university in recruiting and retaining star scientists and engineers in their faculties. Importantly, a greater proportion of industry-level funding is associated with higher levels of technology transfer (Siegel, *et al*., 2004). Hence, from a policy perspective, the encouragement of greater university-industry collaboration is advocated by the authors. A further finding which is evident is that the likelihood of a university to produce spin-offs is related to the magnitude of resources invested in TTO personnel (Siegel, *et al.,* 2004). They conclude that there is a need for the development of a commercially supportive culture to emerge within universities, to promote and enable academic entrepreneurship to flourish. Furthermore, they highlight the need for active partnership and financial support with industry and government funding agencies, and finally, the recruitment of star scientists, as well as

the development of a suitable commercial infrastructure to valorise academic research (Siegel, *et al.,* 2004). An objective of the present research is to identify how the IPR Act impacts on the IP stages of development.

Debackere and Veugelers (2005) have discovered that various perceptions have been gathered over the past decade as to how effective Industry Science Links (ISLs) can be nurtured through improvement and development of university-based technology transfer offices. In their paper, they study the development of effective university–based technology transfer instruments. More particularly, they study the construction of the suitable balance between centralisation and decentralisation within academia, suitable incentive schemes for research groups, and the application of proper decision and monitoring procedures within the technology transfer office.

They support the decentralisation of management style at universities, in order to grant greater autonomy to the inventors at the institutions, so that they have greater powers in deciding how the proceeds from the IP exploitation activities will be used. Decentralisation is also seen to stimulate the research groups to compete with their inventions in the market for exploitation and innovation (Debackere & Veugelers, 2005). The question arises as to the degree of autonomy of South African academic inventors, and how they may perceive the IPR Act to affect their autonomy (or lack of autonomy).

2.2.3 Technology Transfer and Public Policy

Intellectual property law, and patent law particularly, provides the raw material of the technology transfer system (Garduno, 2003). The creation of new knowledge is the primary product of research (Garduno, (2003). The intellectual property law transforms useful knowledge from a fundamentally non-excludable good into an excludable good, within our economic system, which can be bought, sold and licensed (Garduno, 2003). Patent laws and policy institutions are interventions by government into the marketplace to correct deficiencies of unregulated markets which, if left to themselves, tend to innovate less (Garduno, 2003).

According to Garduno (2003), critics argue that the private return on investment (ROI) afforded by intellectual property is unwarranted, because of other economic incentives to research and technology development – such as being first to market. Furthermore, critics argue that people engage in research due to other, non-economic motivations, such as the quest for knowledge: “research for the sake of research” (Garduno, 2003). They are eager to point out facts such as that in 2000, only half of all South African university licences executed were exclusive licences, while the remainder were licensed non-exlusively. Such a fact, however, serves to boost the argument that intellectual property is necessary to promote research, when one considers that even under non-exclusivity licensing, exclusivity is achieved. This result of non-exclusive licences for the same technology, allows licences to protect their investments through exclusive use of specific sections of the market (Garduno, 2003).

The success of the US technology transfer system can be relatively compared to the strength of the US intellectual property system, but just as important as the economic rights approved by intellectual property law is the extent of scientific inquiry to which intellectual property applies (Garduno, 2003). Thus, the scope of intellectual property protection is a significant characteristic in any national intellectual property regime.

Garduno (2003) states that South African protection of intellectual property rights is advanced in terms of international standards. South Africa is a member of the Paris Convention, the Patent Co-operation Treaty (PCT) and the agreement on trade-related aspects of intellectual property rights. As a result, it ensures national treatment and intellectual property protection that follow international norms (Garduno, 2003).

Although South Africa has observer status, it is not a member of the African Regional Industrial Property Association (ARIPO), which aims to pool regional resources to circumvent duplication of the infrastructures required for intellectual property examination (Garduno, 2003). However, South Africa receives many more patent applications than the number of patents received through ARIPO per year (Garduno, 2003).

The Department of Trade and Industry (DTI) were principally responsible for intellectual property policy in South Africa (Garduno, 2003), but, currently, the National Intellectual Property Management Office (NIPMO) dictates policies pertaining to intellectual property.

Bozeman (2000), in his study, endeavours to review, synthesise and criticise the voluminous, multidisciplinary literature on technology transfer. First, he begins by

examining a set of conceptual issues – particularly, the ways in which the analytical doubts surrounding technology transfer concepts impact research and theory. He posits that in general, the development of commercialising IP is very difficult, highly risky, takes a long time, costs more than planned, and usually fails (Bozeman, 2000). It would be important to uncover whether the South African IPR Act in any way hinders, or conversely, facilitates, the commercialisation of South African-generated IP.

2.3 Intellectual Property

2.3.1 Global Politics of Intellectual Property Rights

Lanoszka (2003) claims that one of the most important characteristics of the developing international economic order is the treatment of Intellectual Property Rights. The influence that the World Trade Organisation (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) will have on economies, is a major concern for developing countries. Furthermore, TRIPS highlights an intellectual property rights approach whereby private owners of the inventions can limit access, based on commercial concerns (Lanoszka, 2003). Another problem identified is that manipulative business practices have potential only to the degree that monopoly positions are accepted. Lastly, numerous developing countries lack the resources, as well as sufficiently developed and suitable competition rules, to face the challenges set by the TRIPS Agreement (Lanoszka, 2003).

2.3.2 The Bayh-Dole Act: Background on History and Purpose

Recently, countries such as China, Brazil, Malaysia, India and South Africa have produced legislation emulating the US Bayh-Dole Act (So, *et al.*, 2008). Although all of these countries, some with developing economies, created Bayh-Dole-like IPR Act legislation to encourage the patenting of publicly financed Research and Development (R&D), and incentivise the commercialisation of these patents through exclusive licensing agreements, some of the emulation initiatives also aim to generate revenues for public sector research institutions (So, *et al.*, 2008). Emulation of the Bayh-Dole Act is encouraged by increases in patenting and licensing that many believe are attributable to the Bayh-Dole Act (So, *et al.*, 2008).

There appear to have arisen two schools of thought regarding the effects of the Bayh-Dole Act (1980) on US technology transfer and IP commercialisation. Henderson, *et al.* (1998) published evidence that the Bayh-Dole Act (1980) resulted in significant growth in University-Industry-Technology-Transfer (UITT), as well as in research collaboration in the US, since its enactment in 1980 (Henderson, *et al.*, 1998). Later, Mowery and Sampat (2005) studied the outcome of the Bayh-Dole Act on university-Industry collaboration and technology transfer in the US. They highlight the history before 1980, and investigate the degree to which these events are entrenched in the incentives created by the unusual scale and structure of the US higher education system. These researchers found that a number of Organisation for Economic Co-operation and Development (OECD) governments expressed extensive interest in the Bayh-Dole Act. However, they posit that emulation of the Bayh-Dole Act anywhere in the OECD will

most probably only be partially successful, in the face of significant underlying differences between tertiary institutions of the USA and those of the developing world outside the OECD, which includes South Africa.

The work of Mowery and Sampat (2005) has a strong relevance to the present research, as it has been noted herein that the SA government has enacted the IPR Act as a way which can be seen to emulate the Bayh-Dole Act (Staphorst, 2010). In the US, there has been a long history of close interaction between industry and inventive universities. Many of the technological problems encountered by industry have been solved through collaborative research between university faculties and industry (Mowery & Sampat, 2005).

However, Mowery and Sampat (2005) suggest that their findings show that the Bayh-Dole Act appears to have been neither necessary nor sufficient for much of the post-1980 growth in university patenting and licensing in the US. They therefore doubt that the emulation of the Bayh-Dole Act in other economies will trigger significant growth in patenting by universities, and licensing, or UITT (Mowery & Sampat, 2005). This hypothesis has strong implications for the present research, as this research is endeavouring to understand the implications of the IPR Act on university technology transfer processes from the perspective of the TTOs.

Leydesdorff (2010) indicates that the Bayh-Dole Act of 1980, in the USA, was enthusiastically promoted by the OECD as a recipe for the commercialisation of

university research, and the law was replicated by a number of national governments. However, since the early 2000s, patenting in universities has been on the decline in the most advanced economies, both as a percentage and in absolute terms. Interestingly, patents and spin-offs are not counted in university rankings (Leydesdorff, 2010). This means that star scientists are more incentivised to publish their work and gain recognition, than to patent their work.

A large range of dynamics have been seen, that have been studied by scholars of technology transfer in a UITT context. The recent promulgation of the IPR Act (Republic of South Africa, 2008) in South Africa will have an effect on the UITT dynamics, and the present research has endeavoured to uncover some specific impact factors, focused mainly on the attitude towards the IPR Act, that will influence the process of technology transfer in South Africa.

Thursby, *et al*. (2009) discovered, in a sample of 5811 patents on which US faculty are listed as inventors, that 26% of these patents are exclusively assigned to firms, instead of the faculty, as is dictated by US university policies or the Bayh-Dole Act. Furthermore, they discovered that patents assigned to firms are less elementary, proposing that these patents have resulted from faculty consulting.

A striking finding by Thursby, *et al*. (2009) is that a higher inventor share in royalties from licences actually increases the probability of IP assignment to the university. Physical science and engineering faculties are more successful in assigning their

patents with established firms, than the biological sciences faculties (Thursby, *et al*., 2009).

2.3.3 The South African IPR Act – Background and Features

According to the World Intellectual Property Organisation (WIPO), universities and R&D institutions in Africa have been incompetent in their relations with (mainly government) sponsors of R&D activities (Maredia, 2001). This can be accredited to the fact that most universities and R&D institutions in Africa do not have proper IP policies in place with which to protect their interests within collaborative research activities (Maredia, 2001). Therefore, the South African government has recently decided to intervene through a legislative attempt to strengthen IPR protection for publicly financed R&D, by means of the IPR Act (Republic of South Africa, 2008).

The primary purpose of the IPR Act (Republic of South Africa, 2008) is to provide legislative mechanisms to protect IP emanating from publicly financed R&D, by requiring that it be identified, protected, utilised and commercialised for the advantage of the people of South Africa, whether it be for a social, economic, military or any other benefit (Republic of South Africa, 2008). The IPR Act was, in essence, derived from the Bayh-Dole Act (Mowery & Sampat, 2005).

Furthermore, the IPR Act states that preference for licensing must be given to non-exclusive licensing, Broad-Based Black Economic Empowerment (BBBEE) entities, and small enterprises, and to parties that seek to commercialise the IP in a manner that provides optimal benefits to the economy and quality of life to the people of the Republic

of South Africa (Republic of South Africa, 2008). The IPR Act also provides so-called "march in rights" for Government, in cases where IP remains underutilised or un-commercialised (Republic of South Africa, 2008). The phrase '***march in rights***' in the present case refers to the rights granted by the Act to NIPMO, to demand the assignment of rights to any intellectual property if a recipient fails to make a disclosure to NIPMO as provided for in the Act.

In addition, the IPR Act provides for the co-operation between private entities/firms or organisations and institutions. A firm can therefore become a co-owner of the IP if there has been, for example, a contribution of resources such as background IP or money (Republic of South Africa, 2008). Furthermore, a firm can co-own IP if there was joint IP creatorship. Importantly, if a firm provides funds for the IP creation on a "*full cost basis*" as defined in the IPR Act, then the Act shall not apply, since it will be deemed that the R&D is not publicly financed (Republic of South Africa, 2008). ***Full cost basis*** is defined in the IPR Act as "the full cost of undertaking research and development as determined in accordance with international financial reporting standards, and includes all applicable direct and indirect cost as may be prescribed". Furthermore, the features of the IPR Act and the influence on UITT are listed the IPR Act in Republic of South Africa (2008) and it includes the following:

- Ownership of IP emanating from public funds shall vest with the recipients of the funds, unless otherwise negotiated.

- Institutions must establish an office of technology transfer (TTO).

- The establishment of a National Intellectual Property Management Office (NIPMO) that promotes the objects of the IPR Act, including the statutory protection, management and commercialisation of the IP referred to the NIPMO.
- Intellectual property creators at the institutions – for example, research professors, are granted a specific right to a proportion of the revenues that accrue to the institution from the commercialisation of the IP. This includes, for example, a proportion of the royalty revenues flowing from a licensing agreement, referred to as benefit sharing.

2.4 The Impact of IPR Legislation on UITT

Staphorst (2010) performed qualitative research to identify impact domains within the legislative framework making up the IPR Act, which could potentially influence research alliances with publicly financed research and development organisations. His work expanded the initial exploratory study of Baloyi, *et al*. (2009). The results showed that the choice of intellectual property rights ownership, state walk-in rights on undeclared intellectual property, and benefit-sharing policies for the creators of intellectual property, were the highest ranked impact domains (Staphorst, 2010).

He also performed a quantitative study, to try and verify the validity of his value-mediated governance mode model that included the highest ranked impact domains identified, during the qualitative research phase, as formative indicators for the perceived intellectual property rights regime strength uncertainty factor. This phase revealed that the impact domains identified during the first phase could be used as

formative indicators of the perceived intellectual property rights regime strength, and, in addition, that stronger perceived regimes are positively related to the preference for quasi-hierarchy research alliance governance modes (Staphorst, 2010).

Furthermore, his research established that the expected value of a research alliance, which was shown to be positively influenced by the strength of the perceived intellectual property rights regime, acted as a mediating factor on the relationship between the perceived intellectual property rights regime strength and the preferred research alliance governance mode (Staphorst, 2010). The high ranking impact domains identified in Staphorst's research (Staphorst, 2010), namely that of the choice of intellectual property rights ownership, state walk-in rights on undeclared intellectual property, and benefit-sharing policies for the creators of intellectual property, was incorporated into the research and contextualised specifically for University TTORs. Table 1 shows the 11 impact elements identified for the current research project, which was adopted from Staphorst (2010).

Table 1: The 11 ranking impact elements of extracted impact domains from Staphorst (2010)

1. Choice of IPRs ownership
2. State walk-in rights on IP not declared
3. Benefit-sharing policies
4. Offshore IP registration process
5. Requirement for non-exclusivity in IP transactions
6. Preference in commercialisation rights to SMEs and BBBEE firms
7. IP detection process by TTO
8. NIPMO reporting process

9. NIPMO reaction time
10. IP disclosure process
11. Structural and resource requirements to manage and commercialise IP

Thursby, *et al.* (2001) conducted a survey on licensing, at 62 research universities. In their survey, they considered factors such as income splits, marketing, stage of development, licence policies, characteristics and roles of the inventor/scientist in licensing, and the goal of licensing. Furthermore, they studied the connection between licensing outcomes and as well as the objectives of the TTO and the characteristics of the technologies.

Interestingly, most inventions generated by university research are typically disclosed at the early stages of development, requiring the licensee firms to undertake additional development before they can bring these technologies to market (Thursby, *et al.,* 2001). TTOs cited that royalties and fees generated through licensing agreements are priorities as objectives, and less important are equity shares in the licensee firm. The size of the royalty percentage also grows with the more advanced stage of technology development (Thursby, *et al.,* 2001).

Thursby, *et al.* (2001) concluded that royalties are usually larger with faculties of higher quality and the greater portion of licences that are accomplished at the latter stages of development. Typically, inventions are assigned to the university. However, the university inventor is rewarded through royalty income sharing, pocketing as much as 30% of the revenue stream. Medical schools topped the list for the most inventions

disclosed, and engineering and science schools followed closely behind. It is an objective of the present work to obtain qualitative information from the TTOR regarding the IPR Acts' benefit sharing levels – for example, 20% of revenue streams comprised of royalties for the first R1 million, and thereafter 30% of revenues exceeding R1 million.

D'Este and Patel (2007) found that many scholars in the United Kingdom (UK) have argued that a tremendously important mechanism for generating technology spillovers depends on university-industry research collaborations. These collaborations help to realise the full social returns of R&D investments, as well as to address innovative market failures (Siegel & Zervos, 2002).

Furthermore, there is a flourishing body of empirical literature showing that the level of academic-commercial activities, the likes of patenting and licensing, as well as the generation of spin-out companies, are increasing (Friedman, 2003). Moreover, these activities are accompanied by an increase in research joint ventures, or joined scientific publications (Calvert, 2003).

D'Este and Patel (2007) studied three issues:

- The magnitude to which knowledge transfer activities are increasingly spread across the academic community
- The diversity of channels in which University-Industry interactions most usually occur
- What factors influence individual researchers to interact with the industry?

The results of D'Este and Patel (2007) show that researchers interact with the industry, using a variety of channels, and five broad categories are highlighted. These categories are: the creation of new physical facilities, consultancy and contract research, joint research, training, and meetings and conferences. Over 40% of their respondents in a survey are involved in at least once in four (out of five) categories of interaction. Interestingly, there is a much higher interaction within the engineering disciplines, when compared to the mathematics and physics disciplines. Furthermore, they found that interactions with industry are evenly spread across the UK regions.

Their results also showed that in the variety of university-industry interactions that a researcher engages in, individual characteristics of the researchers were more important than the characteristics of universities or their departments. The IPR Act is a regulatory instrument that requires inventing scientists, whose work is publicly funded, to disclose their work to the TTO before it is published. An objective of the research is to determine the perceived level of co-operation by university scientists to comply with these specific disclosure requirements. Specifically, the turnaround time by the TTO to complete the evaluation of the researchers' data may be an important impact factor for compliance with the IPR Act.

2.5 Academic Motivation for the Study

The success of the US technology transfer process, and the success of the Bayh-Dole Act, has encouraged South African policymakers to introduce a legislation system – the "IPR Act" that would give universities in South Africa title to Intellectual Property Rights

on the inventions that their researchers create from government funding (Garduno, 2003). Furthermore, the motivation for this study stems from the fact that no previous studies could be found on the impact of the IPR Act on TTOs at South African universities.

Chapter 3 - Research Objectives and Questions

3.1 Introduction

The purpose of this research paper was to identify the impact of the impact domains of the IPR Act identified by Staphorst (2010). Table 1. was investigated with relation to the four stages of the broader technology creation and transfer process at TTOs (Moodysson, 2008).

The four stages include:

1. IP creation
2. IP declaration
3. IP protection
4. IP commercialisation

3.2 Research Objective

An analysis was done to compare whether the resulting impact domains are related to the impact domains uncovered by Staphorst (2010) for research councils, namely:

- Intellectual property rights ownership
- State walk-in rights on undeclared Intellectual property
- Benefit-sharing policies for the creators of Intellectual Property.

Literature sources relating to the research questions, as well as data collection tools and analysis methods used during the testing of the questions, are summarised in the consistency matrix of Table 11. (see Appendix A).

The research has three areas of enquiry. These are: impact element severity ranking – Part A.1, the impact element importance ranking – Part A.2, and the qualitative study - Part B pertaining to the guided interview sessions.

The element severity ranking Part A.1 for this study endeavoured to find the severity of importance of each of the 11 impact elements. The impact element importance ranking, Part A.2, endeavoured to identify the top three ranking elements. The qualitative study, Part B, endeavoured to enquire interviewees to elaborate on the top three ranked elements.

The central research question is: (See Section B.3 of Appendix B as guideline).

- **Research Question 1**

  Which impact elements of the new IPR Act has/will influence/d the technology transfer process at your institution in terms of:

- **IP creation?**
- **IP disclosure?**
- **IP protection?**
- **IP commercialisation?**

Chapter 4 - Research Methodology

4.1 Introduction:

This chapter details the research study's Part A and Part B research process, consisting of a quantitative phase, followed by a qualitative phase. It describes the population, unit of analysis, sampling plan, data collection tools and data analysis tools for the research study. A brief overview of potential research limitations and justification essential in the study's methodology concludes this chapter.

4.2 Research Method

The research instruments have endeavored to collect quantitative Part A and qualitative Part B evidence during the interview process. The primary goal of this study was to determine the impact of the IPR Act on the Technology Transfer process in South Africa from the universities' TTO perspective, which is represented by the TTOR. The research instruments were a questionnaire (Part A) and a guided interview (Part B) of TTORs of publicly funded universities and universities of technology.

The study examined the publicly funded universities (including universities of technology) in South Africa, and their technology transfer processes at the university TTO level. Inclusion criteria for these tertiary institutions were that they must be publicly funded. A major reason for examining universities is that such institutions are required to have an Intellectual Property Management Office (IPMO) as stated in the IPR Act

(Republic of South Africa, 2008), thus making it easier to collect data for the questionnaire and guided interview.

4.3 Population

Due to the nature of research questions defined for the study (see Chapter 3) the population was identical for Part A and Part B. The population consisted of all of the universities identified by McGregor (2010). The Centre for Higher Education and Transformation (CHET) combined '***six input and three output variables***' and clustered institutions in relation to how they presented against the variables. The distance institution, the University of South Africa (Unisa) was excluded because its huge student numbers and low success rates spoiled the statistics (McGregor, 2010). The '**input variables**' were: percentage of headcount enrolment in science, engineering and technology; masters and doctoral enrolments; student-to-staff ratios; permanent staff with doctoral degrees; private and government income; and, student fee income. The '**output variables**' were student success rates, graduation rates and weighted research output units per permanent staff member (McGregor, 2010).

Post-apartheid differentiation was driven by the formula, and then by restructuring and mergers of tertiary institutions in South Africa from 2000, slashed the number of institutions from 36 to 23 – including 11 research universities, six universities of technology and six 'comprehensive' universities that combine formative and vocational higher education (McGregor, 2010). McGregor (2010) lists a number of distinct university clusters within the university population. "Research universities" are universities that engage in extensive research activity, "universities of technology" are a

unique institution within the family of institutions offering higher education, and "comprehensive universities" are institution of higher education, usually comprising a liberal arts and sciences college, and graduate and professional schools that confer degrees in various fields (Google, 2011).

In the 'red' cluster, she identifies five research-intensive universities, which have been producing the bulk of postgraduates and future academics and had high student success and graduation rates, high proportions of academic staff with PhDs, high research outputs, high income, and low staff-student ratios (McGregor, 2010).

In the 'green' cluster, she lists nine universities that scored in the middle on the variables, and included former research-intensive institutions whose performance in terms of research, success rates, postgraduates and staff qualifications declined following mergers with historically disadvantaged institutions, as well as three formerly disadvantaged universities and three 'comprehensive' universities (McGregor, 2010).

In the 'blue' cluster, she lists eight institutions (the ninth, Unisa, was excluded, due to extremely high numbers of students and low success rates) including two rural historically disadvantaged universities and six universities of technology. They had relatively lower postgraduate enrolments, success and graduation rates, qualified staff, research outputs and income, but high enrolments in science, engineering and technology, and high staff-student ratios. The clusters fulfilled very different, but equally important, functions (McGregor, 2010).

The three clusters were revealed by the analysis of the universities, using nine input and output variables (McGregor, 2010). The three clusters of universities that were identified performed vastly different purposes in terms of student intake and success, staff qualifications, research outputs, and income, among other things (McGregor, 2010).

Table 2: Clusters within the South African University Population according to McGregor, 2010.

Red Cluster	Green Cluster	Blue Cluster
University of Cape Town*	***University of the Free State****	Cape Peninsula University of Technology
University of Pretoria*	***University of KwaZulu-Natal****	Central University of Technology
Rhodes University	North-West University	Durban University of Technology
University of Stellenbosch*	University of Fort Hare	Mangosuthu University of Technology
University of the Witwatersrand	University of Limpopo	***Tshwane University of Technology****
	University of the Western Cape	Vaal University of Technology
	University of Johannesburg	University of Venda
	Nelson Mandela Metropolitan University	Walter Sisulu University for Technology and Science
	University of Zululand	University of South Africa

The star symbol indicates Universities (shown in *italics*) that were interviewed.

4.4 Unit of Analysis

Due to the nature of the research questions defined for the study (see Chapter 3) the unit of analysis was identical for Part A and Part B. Therefore, the TTO at each of the sampled universities was the primary unit of analysis for the research project. The TTO was represented by the TTOR.

4.5 Sample size and sampling plan

A convenience sample was selected out of 23 universities (Table 2), as an even spread between the red, green and blue clusters from the geographic provinces of Gauteng, the Free State, the Western Province and KwaZulu-Natal, as they were the first to accept to respond to the survey and to be interviewed. Institutions that are publicly funded, and that are required by the IPR Act to have an Intellectual Property Management Office (IPMO) (Republic of South Africa, 2008) were identified, and their TTORs were contacted in order to obtain written consent to participate in the study. The aim was to approach university TTORs in order to obtain information relating to the level of impact that the 11 identified impact elements from the IPR Act have on the TTO process. Due to the nature of the research questions defined for the study (see Chapter 3), the sample size and sampling plan were identical for Part A and Part B, hence one to three universities from each cluster and geographic region were earmarked for the questionnaire (Part A) and guided interview (Part B) participation by the respective TTOR. Henceforth, data saturation had already occurred when the fifth respondent's interview response was analysed, indicating that a sufficient sample size was achieved (Guest *et al*., 2006).

The TTORs are employed by the institutional Intellectual Property Management Offices (analogous to Technology Transfer Offices – TTOs). The selected SA TTORs were engaged in guided interviews, comprising four major questions (Part A) and four associated sub-questions (Part B) (Appendix B) .

4.6 Data Collection Process and Research Instrument

Zikmund (2003) states that qualitative research methods emphasise the value of individual experiences and views as encountered in real-life situations. He elaborates that the nature of qualitative enquiry means that large amounts of "rich" and "deep" data are produced, often from a variety of sources. It is important to note that while this research methodology did not seek to reduce data to statistical evidence, the qualitative data nevertheless required systematic analysis through methods such as word analysis, reading of larger units (*metaphors*), the physical manipulation of texts, secondary data analysis and triangulation (Welman, *et al*., 2005). This was done to ensure rigor and validity in the conclusions that were derived. Since the study required this deep, but rigorously analysed, perspective on the potential impact domains in the IPR Act that might influence the technology transfer process at universities, a qualitative exploratory approach, based on primary respondent data, was highly appropriate (Staphorst, 2010).

The interviews were conducted using an interview guide (Part B) and a survey guide (Part A) (See section B.3 and B.4 of Appendix B) as a guideline. The research project has four major questions, and each question has a Part A (interview guide) and a Part B (questionnaire). In order to accurately capture data generated during interviewees'

responses to each question in the interview guide, the data-capturing process consisted of a voice recording of the narrative during the interview, with transcription thereof post-interview by the researcher (Zikmund, 2003).

4.7 Method of Data Analysis

Data obtained from the quantitative study in Part A of the research questions, were analysed for descriptive statistics. During the interviews, detailed notes and tape recordings were generated, which effectively represented the raw data for Part B of the research questions. This raw data was processed into write-ups which were further analysed. Tape recordings were transcribed to text, and processed similarly to the handwritten notes by the researcher, following the techniques described in Welman, *et al*. (2005). Following the conversion of raw data to text, the procedure of theme identification commenced, following the techniques of Welman, *et al*. (2005). The techniques employed included:

1. Word analysis (Welman, *et al*., 2005) –
    a. This consists of identifying keywords in the raw data that occur with higher frequency. The method was used to analyse the narrative captured from the raw data pertaining to Questions 1, 2, 3 & 4 in the interviewer guide (see Appendix B). The method was further used to determine the relative frequency with which the themes identified within the IPR Act by Staphorst (2010) were cited by the respondents as having a definitive impact on the universities' technology transfer process (Staphorst, 2010).

b. *Keywords* in context, and *indigenous terms* – identifies the indigenous characteristics of the language of TTOs (Welman, *et al*., 2005). Attempts were successfully made to identify important words, and the meaning thereof, attached to the TTO sample. Simple observations were used to see in which context *keywords* were used, in order to understand the concepts described during the TTO interviews.

2. Intentional analysis of linguistic features (*metaphors*) (Welman, *et al*., 2005) – any metaphors or analogies that the TTO made were identified as far as possible, and not interpreted literally, but the TTO was asked to explain the analogy or metaphor they had used.
3. Secondary data analysis – The primary data obtained in the research was reviewed and questioned in the light of the secondary data available (Welman, *et al*., 2005); in this case, the work of Staphorst (2010) was consulted.

After all the information was compiled and processed, it was processed into manageable and understandable texts. These texts were then categorised and associated to the underlying themes and impact elements (Welman, *et al*. 2005).

4.8 Testing for Reliability and Validity

Reliability and validity is the extent to which the research findings accurately represent what is really happening at the TTO office (Welman, *et al*., 2005). The research instrument should therefore measure the variables it is intended to measure. Welman, *et al.* (2005) refer to this requirement as the construct validity of the data obtained on a measuring instrument. Using more than one measure of the same construct was therefore advisable to validate the research instrument, and was akin to the technique of triangulation used in navigation (Welman, *et al.,* 2005). According to Denzin (1978), the technique of triangulation can be used to attain reliability and validity by eliminating research bias and increasing the truthfulness of qualitative propositions. Staphorst (2010) citing Guion (2002) refers to five types of triangulation:

1. Data triangulation
2. Investigator triangulation
3. Theory triangulation
4. Methodological triangulation
5. Environment triangulation

In the present case, investigator triangulation was used. The qualitative data collected using the unstructured interviews in Part A, were triangulated by using another data analyst, by transcribing two of the respondent's interviews recorded, and performing theme extraction. Confirmation of data among investigators, without prior discussion or

collaboration with one another, lends greater reliability and validity to the observations (Denzin, 1978).

4.9 Limitations of the research

By interviewing the TTO officer, other stakeholders, including inventing researchers and industry representatives, were excluded. These stakeholders are an integral part of the technology transfer process; hence, a limited and one-sided view was obtained.

The following potential limitations were identified in the study:

- The study was limited to universities and universities of technology; thus, research councils such as the Council for Science and Industrial Research (CSIR) and the Agricultural Research Council were excluded.
- It is possible that the impact domains identified by Staphorst (2010) might not correspond closely to universities and universities of technology.
- Possibility of interviewer bias – locality, geographical and financial constraints for travel were an issue.
- The small sample size of n=6 precluded the use of more powerful statistical tools used with larger sample sizes.

4.10 Justification

Innovations arising from publicly financed institutions are an important source of potential intellectual property that can be leveraged and exploited by private industry to

boost economic growth (Republic of South Africa, 2008). The Intellectual Property Rights Act 51 was enacted in 2008 in order

"*to provide for more effective utilisation of intellectual property emanating from publicly financed research and development; to establish the National Intellectual Property Management Office and the Intellectual Property 'and; to provide for the establishment of offices of technology transfer at institutions; …*" (Republic of South Africa, 2008).

The potential issues arising from this Act, with regard to its impact of the IPR Act on South African universities' technology transfer offices are not entirely known. Furthermore, differences in the motives, actions, and organisational cultures of the key stakeholders, underscore the potential importance of organisational and managerial factors in UITT (Republic of South Africa, 2008). Another goal of this field research was to improve the understanding of these differences, so that a set of organisational and managerial practices that may be relevant to overcoming barriers to the technology transfer process from the perspective of the TTO, could be identified (Republic of South Africa, 2008).

Chapter 5 - Results

5.1 Introduction

In this chapter, the results obtained using the data analysis methodologies defined in (See section 4.2.5) for the impact element severity ranking Part A.1, the impact element importance ranking Part A.2, and the qualitative study Part B pertaining to the guided interview sessions, are presented.

- Results for the severity ranking, 'which of the 11 impact elements of the IPR Act listed in impact on the four stages of the innovation process namely creation, disclosure, protection and commercialisation', frequency tables are presented in order to answer research questions 1, 2, 3 and 4 for Part A.1 (See section 5.2). These identified impact elements for university TTOs were then compared to the impact elements (impact domains) uncovered by Staphorst (2010) for research councils in South-Africa, to determine the degree of matching or mismatching of the impact elements between universities and research councils.

- Results for the impact element importance ranking (Part A.2), which seeks to identify the top three ranking impact elements among the 11 impact elements studied, are presented in Figure 1. (See section 5.2.3.5)

- Results for the qualitative study (Part B) pertaining to the guided interviews (See section 5.3), are presented in Table 7.

5.2 Part A.1 Results

5.2.1 Sample Characteristics

A total of N=6 TTOs were sent the survey (See section B.4 in Appendix B), and all of them responded to the request for completion. The response rate was therefore 100%. It was evident from the data collected, that data saturation had occurred when the fifth respondent had submitted their survey response, indicating that a sufficient sample size was achieved (Guest, *et al*., 2006).

5.2.2 Frequency Analysis

Tables 3, 4, 5 and 6 shows the frequency analysis of the responses received from the TTOs at the six identified institutions. The frequency tables show the frequency of responses for each element with respect to the IP development stage. Each categorical variable of severity was arbitrarily assigned a numerical score as follows:

Nil =0

Low =1

Medium=2

High =3.

The assumption was made that these categories were ‘equally’ spaced between each other. The category frequencies for each respective IP development stage

were then multiplied by the score, and the values used to determine trends in the data.

5.2.3 Results of the Research Questions

The following subsections present the results obtained for research questions 1, 2, 3 and 4.

5.2.3.1 Results for Research Question 1

The research survey results for Question 1 are presented in Table 3. None of the 11 impact elements had a particularly high impact for the creation stage. High frequencies were reported for the nil and low impact strength categories. Element 11, 'of structural and resource requirements to manage and commercialise IP' showed the highest frequency of 50% for a medium impact.

Table 3: Frequency table showing frequency responses for the creation stage of IP development.

	Creation Stage				
	nil	**low**	**medium**	**high**	**Weighted Score**
Element 1	66.67%	16.67%	16.67%	0.00%	0.50
Element 2	66.67%	16.67%	16.67%	0.00%	0.50
Element 3	16.67%	50.00%	0.00%	**33.33%**	**1.50**
Element 4	50.00%	50.00%	0.00%	0.00%	0.50
Element 5	66.67%	33.33%	0.00%	0.00%	0.33
Element 6	50.00%	50.00%	0.00%	0.00%	0.50
Element 7	33.33%	50.00%	0.00%	16.67%	1.00
Element 8	33.33%	33.33%	16.67%	16.67%	1.17
Element 9	33.33%	50.00%	0.00%	16.67%	1.00
Element 10	33.33%	50.00%	0.00%	16.67%	1.00
Element 11	0.00%	33.33%	**50.00%**	16.67%	**1.83**

5.2.3.2 Results for Research Question 2

The research survey results for Question 2 are presented in Table 4. Element 7 of 'IP detection process by TTO' scored the highest frequency of 83.33% for high impact strength. Element 10 of 'IP disclosure process', Element 11 of 'structural and resource requirements to manage and commercialise IP' and Element 8 'NIPMO reporting process', all scored higher than the other impact elements.

Table 4: Frequency Table showing frequency responses for the disclosure stage of IP development.

Frequency table by level	Disclosure			
	nil	**low**	**medium**	**high**
Element 1	33.33%	33.33%	33.33%	0.00%
Element 2	33.33%	0.00%	50.00%	16.67%
Element 3	0.00%	50.00%	16.67%	33.33%
Element 4	33.33%	50.00%	16.67%	0.00%
Element 5	16.67%	66.67%	16.67%	0.00%
Element 6	50.00%	50.00%	0.00%	0.00%
Element 7	0.00%	0.00%	16.67%	**83.33%**
Element 8	0.00%	16.67%	**33.33%**	**50.00%**
Element 9	16.67%	50.00%	0.00%	33.33%
Element 10	0.00%	0.00%	**50.00%**	**50.00%**
Element 11	0.00%	16.67%	**33.33%**	**50.00%**

5.2.3.3 Results for Research Question 3

The research survey results for Question 3 are presented in Table 5. Element 11 of 'structural and resource requirements to manage and commercialise IP'' had the highest impact, followed by Element 8 'NIPMO reporting process'. Element 4 'offshore IP registration process' and Element 2 'state walk-in rights', which were equal in strength, also ranked relatively high for the protection stage of IP development.

Table 5: Frequency table showing frequency responses for the protection stage of IP development.

Frequency Table by level	Protection				
	nil	**low**	**medium**	**high**	**Weighted Score**
Element 1	0.00%	50.00%	16.67%	33.33%	1.83
Element 2	16.67%	16.67%	16.67%	**50.00%**	**2.00**
Element 3	0.00%	33.33%	33.33%	33.33%	2.00
Element 4	0.00%	33.33%	16.67%	**50.00%**	**2.17**
Element 5	0.00%	50.00%	33.33%	16.67%	1.67
Element 6	33.00%	50.00%	16.67%	0.00%	0.83
Element 7	16.67%	16.67%	33.33%	33.33%	1.83
Element 8	0.00%	16.67%	33.33%	**50.00%**	**2.33**
Element 9	16.67%	50.00%	0.00%	33.33%	1.50
Element 10	0.00%	33.33%	**50.00%**	16.67%	1.83
Element 11	0.00%	16.67%	16.67%	**66.67%**	**2.50**

5.2.3.4 Results for Research Question 4

The research survey results for question 4 are presented in Table 6. The strongest element from weighted scores was element 11 'structural and resource requirements to manage and commercialise IP', followed by element 4 'offshore IP registration process', and element 5 'requirement for non-exclusivity in IP transactions'.

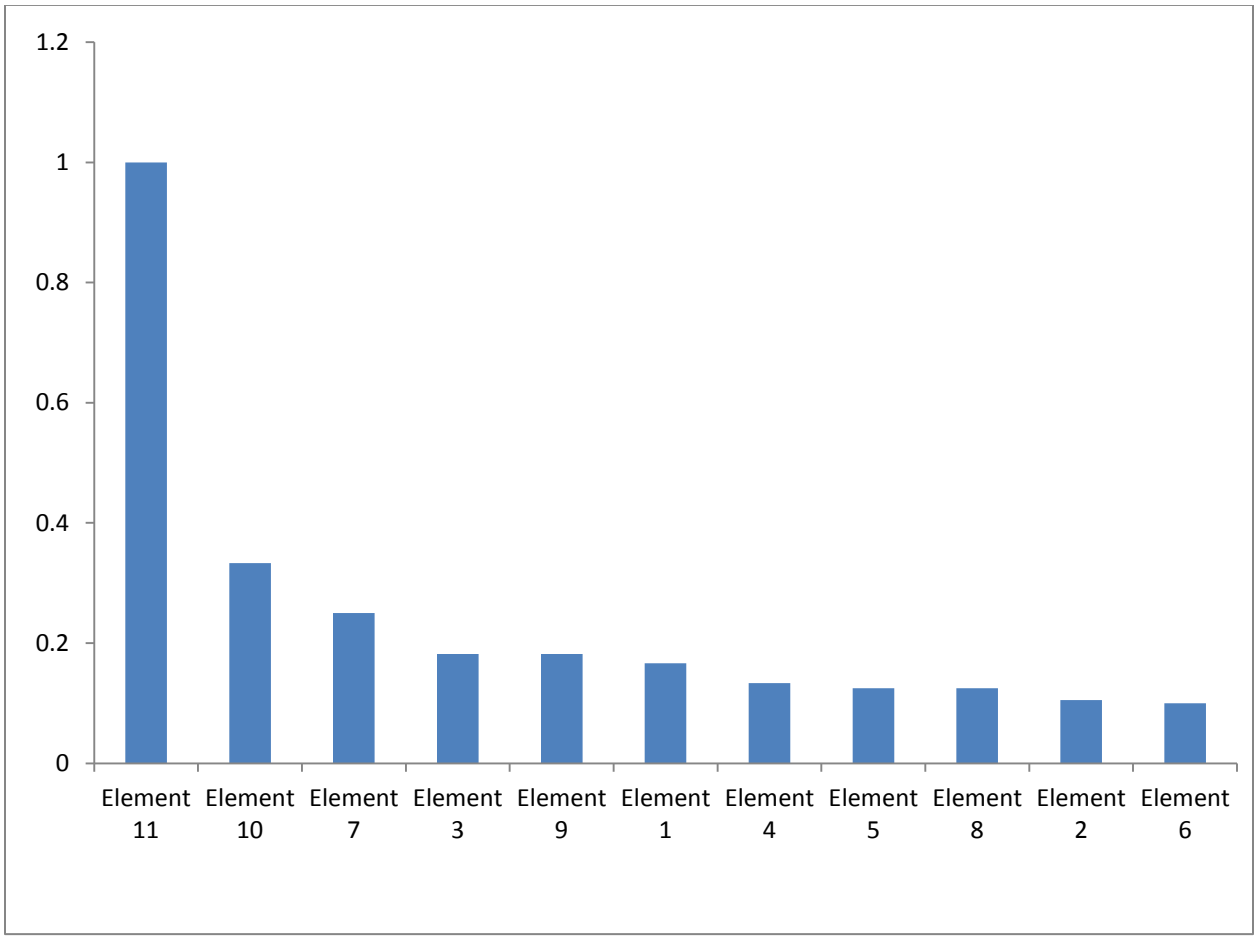
Table 6: Frequency table showing frequency responses for the commercialisation stage of IP development.

Frequency Table by level	Commercialisation				
	nil	**low**	**medium**	**high**	**Weighted Score**
Element 1	0.00%	16.67%	66.67%	16.67%	2.00
Element 2	16.67%	16.67%	66.67%	0.00%	1.50
Element 3	0.00%	16.67%	16.67%	**66.67%**	**2.50**
Element 4	0.00%	0.00%	33.33%	**66.67%**	**2.67**
Element 5	0.00%	0.00%	33.33%	**66.67%**	**2.67**
Element 6	0.00%	16.67%	33.33%	50.00%	2.33
Element 7	16.67%	16.67%	33.33%	33.33%	1.83
Element 8	0.00%	16.67%	33.33%	50.00%	2.33
Element 9	16.67%	16.67%	0.00%	**66.67%**	**2.17**
Element 10	0.00%	33.33%	33.33%	33.33%	2.00
Element 11	0.00%	0.00%	16.67%	**83.33%**	**2.83**

5.3.1 Part A.2 Results - Impact Elements in Order of Importance

The results for Part A.2 are presented in Figure 1, which shows the rank order of the 11 impact elements in order of decreasing importance of the IPR Act. The top three impact elements identified from this table are Element 11 'structural and resource requirements to manage and commercialise IP', followed by Element 10 'IP disclosure process', followed by Element 7 'IP detection process by TTO'.

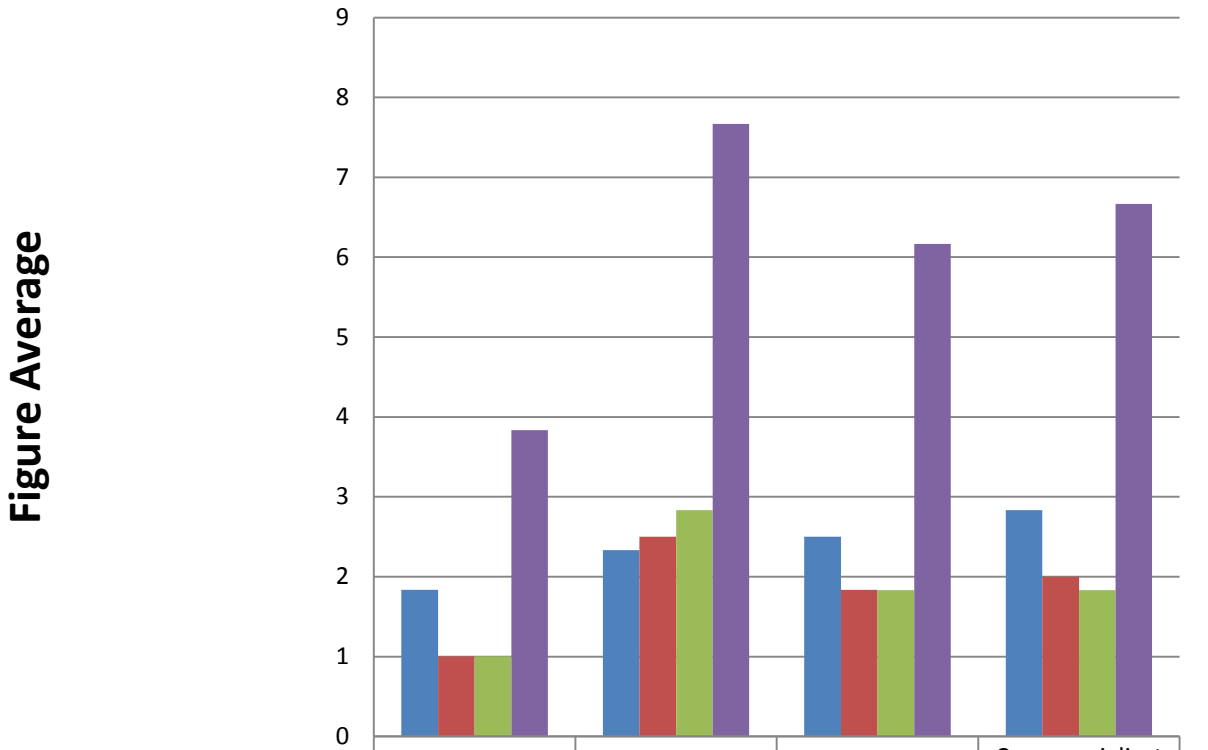
Figure 1: Rank order of the Impact elements in order of decreasing importance.



5.3.2 Impact of the top three impact elements on the stages of IP development

The results for the top three impact elements are presented in Figure 2. It is evident from this table that the top three impact elements have the highest overall impact on the disclosure stage, followed by the commercialisation stage of IP development.

Figure 2: **Top Three Impact elements.**



	Creation	Disclosure	Protection	Commercialisation
Weighted element 11 (Rank 1)	1.8334	2.3333	2.5002	2.8333
Weighted element 10 (Rank 2)	1.0001	2.5	1.8334	1.9998
Weighted element 7 (Rank 3)	1.0001	2.8333	1.8332	1.8332
Weighted Overall Average	3.8336	7.6666	6.1668	6.6663

5.4 Part B Results

Results for Part B

Respondents were asked during the narrative inquiry process, to elaborate on the top three impact elements of the IPR Act which they had cited in Part A.2 as having the greatest impact in terms of the four stages of development. Results for Part B are presented in Table 7 for each respective respondent.

Table 7: Themes Extracted from Narrative Inquiry

	Top 3 impact element for each respondent & element number	**Themes Description (Brochure Section)**	**Selected Response Quotations**
Respondent 1	**11** Structural and resource requirements to manage and commercialise IP	15	"We need more staff in order to manage and commerialise IP according to the Ac"
	7 IP detection process by TTO	5	"It is very important for TTOs to build relationships with researchers in order to detect new IP"
	10 IP disclosure process	5 & 7	"IP disclosure requires the co-operation of researchers"
Respondent 2	**11** Structural and resource requirements to manage and commercialise IP	15	"It is very difficult to get skilled staff that can do the job that is required"
	3 Benefit sharing policies (inventor takes 20%)	10	"We as University give 40% benefit share, and we find that inventors are still not happy with only 40%"

	1 Choice by TTO for IP ownership i.e. whether to obtain statutory protection or refer to NIPMO	4	"It is a very expensive process to protect IP, therefore we need more available funds"
Respondent 3	**10** IP disclosure process	5	"If we don't build/maintain relationships with inventors/IP creators, it is very difficult to detect and disclose IP"
	9 NIPMO reaction time	9	"We are not sure whether NIPMO have the required resources to do what they need to do to be on time"
	11 Structural and resource requirements to manage and commercialise IP	15	"We need more support and funds from government to manage and commercialise IP"
Respondent 4	**11** Structural and resource requirements to manage and commercialise IP	15	"It is essential for us to get more skilled staff, in order to be more efficient"
	9 NIPMO reaction time	9	"NIPMO do not have the resources at the moment to complete their tasks, but hopefully will improve in the near future"
	10 IP disclosure process	5 & 7	"IP disclosure dependts upon adequate policy making at the university level"

Respondent 5	**11** Structural and resource requirements to manage and commercialise IP	15	"Since TTOs are still new, we are trying to etablish ourselves, but we have limited resources in order to be effective yet"
	7 IP detection process by TTO	5	"It becomes very difficult to detect IP if we do not maintain relationships with our researchers"'
	1 Choice by TTO for IP ownership i.e. whether to obtain statutory protection or refer to NIPMO	4	"It is sometimes very difficult because IP protection is very expensive and a very long process"
Respondent 6	**11** Structural and resource requirements to manage and commercialise IP	15	"We are still new in the TTO process, and still lack sufficient resources required to proper manage and commercialise IP"
	10 IP disclosure process	5 & 7	"The process of filling in the forms of IP disclosure requires assistance and time resources"
	5 Requirement for non-exclusivity in IP transactions	11	"It is very difficult for us as TTOs to negotiate licence agreements with the private sector entities on an exclusive basis given the preference for non-exclusive licences in the IPR Act"

5.5 Reliability and validity

Reliability and validity for the study was tested, using the investigator triangulation approach (See Section 4.2.6). This involved comparing the qualitative data collected using the guided interviews in Part B (Appendix B) which were triangulated by using another data analyst, by transcribing two of the six respondents' interviews recorded, and performing theme extraction. Confirmation of data among investigators, without prior discussion or collaboration with one another, lends greater reliability and validity to the observations (Denzin, 1978). Table 8 presents the response comparison of Part B of the study. It is evident that the selected responses from the researcher of respondents 1 and 2, captured via Part B of the guided interview during the narrative inquiry, correlated well with the selected responses from the second data analyst of respondents 1 and 2. Hence, it is safe to assume that an acceptable level of reliability and validity was achieved during this study.

Table 8: Investigator triangulation through response comparison of Part A of the research process, using a second data analyst.

	Top 3 Impact elements for each Respondent	**Themes Description (Brochure Section)**	**Associated Element**	**Selected Response Quotations**
Respondent 1	**Structural and resource requirements to manage and commercialise IP**	**15**	**Element Number 11**	"Research is the first stage of innovation – universities end here and councils take it further"
	IP detection process by TTO	**5**	**Element Number 7**	"It is very important for TTOs to build relationships with inventors in order to detect new IP"

	IP disclosure process	**5 & 7**	**Element Number 10**	"The biggest challenge in the university environment is we have a large academic output and only 20% is disclosed- we need to raise the level of invention disclosure"
Respondent 2	**Structural and resource requirements to manage and commercialise IP**	**15**	**Element Number 11**	"Commercialisation doesn't take place at the university or research councils- but at the interface with industry"
	Benefit sharing policies (inventor takes 20%)	**10**	**Element Number 3**	"Inventors expect more than just 20% benefit share"
	Choice by TTO for IP ownership i.e. whether to obtain statutory protection or refer to NIPMO	**4**	**Element Number 1**	"Need access to IP experts to evaluate new IP - costs money"

Chapter 6 – Discussion of Results

6.1 Introduction

In this chapter, the quantitative results for Part A (See Section 5.2.1.1) of the research study and the qualitative results for Part B (See Section 5.3) are discussed in more detail. Firstly, Part A's answers to the research question posed under the central research question (See Section 3.2) are discussed. Thereafter, the outcomes of Part B's evaluation of the research questions posed under the central research question (See Section 3.2), are discussed.

6.2 Discussion on Results Part A.1

A total of six universities were sampled, using convenience sampling with a 100% response rate, and were represented by the TTOR. Part A.1 of the research design allowed the collection of categorical data, representing the strength of the impact of Staphorst's (2010) impact elements on the IP development stages. The weighted scores for each of the impact elements were used to identify impact elements with high impact on the four stages of IP development – these stages being: IP creation, IP disclosure, IP protection and IP commercialisation. The results of this analysis clearly indicate that the IPR Act enforcement and execution will demand a high degree of structural and resource requirements, particularly, and most importantly, at the IP disclosure stage of IP development. O'Shea, *et al*. (2005) support this finding, and a key finding of their study supports that each university has different resource stocks available, and these resource combinations are shown to be a relevant factor in

explaining inter-university variation in spin-off activity. 'Resource Stocks' is defined as the total means available to a company for increasing production or profit, including plant, labour, and raw material assets.

The findings of O'Shea, *et al*. (2005) further support a path dependency argument that current choices of technologies, products and operations are heavily influenced, probably even constrained, by the cumulative effect of previous development (Arthur, 1989). L¨uthje and Franke (2003) propose that university heads should be advised to intensify their activities to implement educational, research and resource programmes, to enable a culture of academic entrepreneurship to emerge within universities. The study of O'Shea, *et al*. (2005) shows that the size and nature of financial resources allocated to universities influence academic entrepreneurship. They examined the ratio of industrial support to total research support, in an attempt to capture the applied nature of research of universities, and found a significant positive effect with this variable. Their results suggest that a greater proportion of industry-level funding is associated with higher levels of technology transfer.

According to Carlsson and Fridh (2002), the larger the TTO, the broader the in-house expertise, and the more aggressive the pursuit of patents and licences. The steps to transfer or commercialise a technology sign-off authority on non-disclosure agreements, material transfer agreements, and licences, reside within the TTO. According to D'Este and Patel (2007), there is a burgeoning empirical literature showing an increasing level of academic commercial activities, such as patenting and licensing, and generation of spin-out companies (Friedman & Silberman, 2003; Thursby & Kemp, 2002; Zucker, *et*

al., 1998). This has been accompanied by an increase in research joint ventures (Hall, *et al*., 2001), and in joint scientific publications (Calvert & Patel, 2003). Despite increasing understanding of the role of universities in technology transfer, there is still fragmentary evidence on: (1) the extent to which knowledge transfer activities are becoming increasingly spread across the academic community; (2) the variety of channels in which university-industry interactions most typically occur; and (3) the factors influencing individual researchers to interact with industry (D'Este & Patel, 2007).

6.3 Discussion on Results Part A.2

This research project has aimed to identify and quantify, where possible, the level of impact of Staphorst's (2010) impact elements, previously identified, on the TTO process at South African universities, sampled from the three different university clusters identified by McGregor (2010). Analysis focused on identifying whether this research study's resulting top three impact domains are related to the top three impact domains uncovered by Staphorst (2010) for research councils, namely:

- Intellectual property rights ownership
- State walk-in rights on undeclared Intellectual property to NIPMO
- Benefit-sharing policies for the creators of Intellectual Property

The present research project identified the following top three impact elements of the IPR Act:

- Structural and resource requirements to manage and commercialise IP

- IP disclosure process
- IP detection process by TTO

The findings of O'Shea, *et al*. (2005) suggest that in order for policymakers to encourage academic entrepreneurship, a comprehensive systems approach to the identification, protection and commercialisation of university intellectual property needs to be undertaken (Arrow, 1962). In summary, O' Shea, *et al*. (2005) support

- The need for the development of a commercially supportive culture to emerge within universities to enable academic entrepreneurship to flourish.
- The need for active partnership and financial support with industry and government funding agencies.
- The recruitment and development of science and engineering academic stars.
- The development of a commercial infrastructure to enable the valorisation of academic research to occur.

A further finding of the study of O' Shea, *et al*. (2005) also provides convincing evidence that the magnitude of resources invested in TTO personnel increases spin-off activity. O' Shea, *et al*. (2005) also found that the greater the size of the TTO offices, the greater the likelihood of the university to produce spin-offs. These results are relevant, because they clearly confirm the relevant role of tangible and intangible resources in accounting for university spin-off activity.

According to Debackere (2005), creating the appropriate mix of *incentive mechanisms*, targeted to the research groups as well as to the individual researchers (allowing them to participate in the rewards and the proceeds from their transfer activities), is a critical success factor. As the exploitation of research findings requires extra effort and risk-taking on behalf of the academic researchers themselves, these efforts should be recognised and rewarded properly.

Table 9: Comparison between Staphorst (2010) and present study

Rank	Element number and Ranking of Current Study	Staphorst's (2010) Element Ranking
1	11 Structural and resource requirements to manage and commercialise IP	Choice by TTO for IP ownership i.e. whether to obtain statutory protection or refer to NIPMO
2	10 IP disclosure process	State walk-in rights on IP not declared to NIPMO
3	7 IP detection process by TTO	Benefit sharing policies (inventor takes 20%)

6.4 Discussion on Results Part B

Narrative inquiry further elucidated the finding from Part A, where all interviewees mentioned, with high frequency, the need for adequate funds, manpower and

infrastructure, in order to manage the TTO process within their own university structures. The element of structural and resource requirements was closely associated with the impact elements of IP disclosure and IP detection. It was generally agreed that these two latter impact elements themselves require substantial degrees of resources. For example, the process of IP detection at universities requires the active exchange of information between researchers whose main activities are centred on IP creation, and those of the TTOs whose main activities are centred on IP detection, protection, and commercialisation. Arthur (1989) as well as L¨uthje and Franke (2003) support this research study's finding that the information exchange between a large number of IP creators and IP developers, namely the TTO office, requires a TTO office that is suitably equipped with infrastructure, skilled manpower and capital (O'Shea, *et al*., 2005).

The use of outside service providers, particularly those of patent attorneys, was frequently cited by the interviewees as a critical resource for the execution of the obligations in terms of the IPR Act. IP detection requires the inputs of IP experts that can ascertain the level of inventiveness and novelty of new IP. This resource was cited by the interviewees as being particularly costly. The interviewees further alluded to the fact that only selected IP could be screened by outside patent firms, due to financial constraints and limited budgets. The element of IP disclosure was seen to require the cooperation of IP creators at the institution, whose core function typically centres on the teaching of students and the publication of research papers.

It was widely reported by the interviewees that a conflict exists at the level of IP creation, between the need for scientists to publish and the need to maintain confidentiality of the new IP up to the time of filing of patents. It was further recognised that in order to improve the capture of valuable IP in the form of patents before public disclosure through scholarly research articles, personal relationships between the TTO and individual scientists would have to be encouraged and fostered. O'Shea, *et al.* (2005) support improved incentives for academics to participate in the entrepreneurial process. The creation of radical innovations is an important factor in supporting a university's R&D pipeline. In this respect, the presence of star scientists and engineers affect university spin-off activity as they have leading-edge knowledge, with critical expertise and ability to create radical innovations (Schumpeter, 1950). Consistent with the work of Powers and McDougall (2005) and DiGregorio and Shane (2003), their study's result highlights the critical importance of investing, recruiting and retaining top-ranked science and engineering faculty.

These relationships were seen to be an important aspect of encouraging IP disclosure by the scientists. Furthermore, these relationships were recognised to be highly resource demanding. The time and effort to manage and maintain information flows between the universities' IP creators and the TTO office, was recognised as a major constraint in achieving the objectives of the IPR Act. The Element of 'Structural and resource requirements to manage and commercialise IP' was observed to become increasingly important along the IP stages of development. Generally speaking, interviewees suggested a low impact during IP creation, and agreed that IP creators

require some level of resources, in the form of laboratories, capital and manpower, to produce IP. The impact of the element 'Structural and resource requirements to manage and commercialise IP' increased in strength at the IP disclosure stage, and even more so at the IP protection stage, and was highest at the commercialisation stage.

Narrative inquiry revealed that access to financial capital had the major impact at the IP protection stage, relating mainly to patent costs. One interviewee stated that "an international Patent Cooperation Treaty (PCT) filing can cost more than R1,5 million". As an example, one university's TTO office disclosed that the university was actively commercialising more than 50 patents, and the total sum expended in the commercialisation process via patenting and licensing, ran into many millions of rands. At another university, 36 patents were disclosed as active in the pursuit of commercialisation, and to date, none had been successfully commercialised. The element of structural and resource requirements had the highest impact strength at the IP commercialisation stage. Interviewees reported that the process of actively marketing and promoting the universities' IP, engaging with potential licensors – these regularly being international companies – the cost of international air travel and time spent engaging interested parties draws upon large amounts of resources. Often, many meetings and many stages of negotiation and legal contracts such as confidentiality agreements and term sheets, had to be achieved before the conclusion of a successful deal.

It was striking that despite the creation of many dozens of patents by some of the institutions interviewed, only a tiny fraction of these had been successfully licensed to third parties. Debackere and Veugelers (2005) support that structural arrangements should be complemented with the necessary processes at the level of the interface or liaison unit. The management and monitoring of contract research in the area of industrial innovation is a critical issue. This includes the necessary know-how and processes for legal, financial and human resource management issues that can cater for the volume of research contracts generated via the TTO. The central staff of professionals has to support this process (Debackere & Veugelers, 2005). Co-ordination processes, including meetings and proper training for researchers to be effective in technology transfer, have to be in place. An active knowledge management policy, including a patent-funding mechanism and professional intellectual property management, is yet another element in the day-to-day operational processes of the TTO unit (Debackere & Veugelers, 2005).

A great deal of attention should be paid to training and educating researchers across the university, so that they become acquainted with the many intricacies of the process of managing their knowledge portfolios (Debackere & Veugelers, 2005). The availability of, and access to, seed funding, including a process to monitor the transition from invention to business plan to company start-up, so as to assist academic entrepreneurs in creating their enterprise, taking into account up-to-date principles and best practices on corporate governance, is important (Debackere & Veugelers, 2005). A TTO office should assist the entrepreneurs – first, in coaching them to develop their business plan,

and then into growing the business plan into a solid business model (Debackere & Veugelers, 2005). Finding a proper funding structure, as well as the right management team, figures high on the agenda of such a venture unit, and access to the physical infrastructure of an incubation centre proves to be an asset in assisting the entrepreneurial process (Debackere & Veugelers, 2005).

The two impact elements of IP disclosure and IP protection both exerted the highest influence at the IP disclosure stage. The aggregated average weighted score for the top three ranked impact elements showed that collectively, these impact elements exerted the highest impact at the second and fourth stages of IP development. These stages, namely IP disclosure and IP commercialisation, were therefore identified in this study as stages within which the IPR Act as a whole exerts the highest influence from the perspective of the university TTOs.

The research of D'Este & Patel (2007) reveals that university researchers interact with industry using a variety of channels:

- *creation of new physical facilities*
- *consultancy and contract research*
- *joint research*
- *training*
- *meetings and conferences*

D'Este and Patel (2007) posit that individual characteristics are much more important than those of their departments or universities – in particular, previous experience of

collaborative research plays a very significant role, and those researchers with a record of past interactions are more likely to be involved in a greater variety of interactions with industry at a given point in time. Their results also suggest that past policies which have mainly been targeted at universities, are likely to have a limited impact on university-industry interactions. If they are to succeed, such policies need to take better account of individual characteristics of the researchers engaged in university-industry interactions (D'Este & Patel, 2007).

In 1980, the USA Congress passed the Bayh-Dole Act in an attempt to improve UITT. This Act instituted a uniform patent policy which removed many restrictions on licensing, and allowed universities to own patents arising from federal research grants (Siegel, *et al*., 2004). Proponents of the Bayh-Dole Act hoped that university ownership and management of its IP would stimulate improved commercialisation of new technologies, boost economic activity and stimulate greater entrepreneurial activity (Siegel, *et al*., 2004). In response to this legislation, US universities established TTO offices to manage and protect their IP. Siegel, *et al*. (2004) point to the many indicators that support a positive impact of the Bayh-Dol Act on UITT. They cite that the number of patents granted to USA universities increased from 300 in 1981 to 3661 in 1999, and licences increased 12-fold between 1991 and 2004. In a similar vein, the SA government instituted the IPR Act in 2008 that seeks to ensure that IP emanating from publicly funded research and development is identified, protected, utilised and commercialised for the benefit of the people of South Africa. Since 2008, only three years have passed, and therefore experience within this arena may be considered to be lacking. This is reflected by the paucity of published articles regarding the IPR Act of

South Africa. South African university management of intellectual property through a technology transfer office may therefore be considered a relatively new phenomenon. The data of Siegel, *et al*. (2004) has highlighted the importance of managerial behaviours and skills in facilitating effective UITT. They cite a number of organisational and managerial factors, being:

- reward systems for UITT
- staffing practices in the TTO
- designing flexible university offices on technology transfer
- devoting additional resources to UITT
- working to eliminate cultural and informational barriers that impede the UITT process

In this vein, the present work has identified the following impact elements which show various degrees of relation to the above:

- structural and resource requirements to manage and commercialise IP
- IP disclosure process
- IP detection process by TTO

Element 11 ranked in the first rank position, correlates with Siegel, *et al*.'s (2004) 'devoting additional resources to UITT', and is related to the present work's element ranked 2 and 3, relating to IP disclosure process and IP detection process by TTO. The previous work of Staphorst (2010) (Table 11) identified, from a Research Council perspective, the three top ranking impact elements in the SA IPR Act to be:

- choice by TTO for IP ownership i.e. whether to obtain statutory protection rights
- state walk-in rights
- benefit sharing

Bozeman (2000) states: “In general, the process of commercializing intellectual property is very complex, highly risky, takes a long time, cost much more than you think it will, and usually fails. Anyone studying technology transfer understands just how complicated it can be.”

Chapter 7 – Conclusion and Future Work

7.1 Concluding remarks

This study attempted to measure the impact of Staphorst's (2010) impact domains on the four stages of IP development as experienced by university TTOs. The initial study by Staphorst (2010) laid the foundation for the study of the IPR Act's impact on aspects of intellectual property development in South Africa. The study of Staphorst (2010) was focussed on identifying 'The Impact of Intellectual Property Rights from Publicly Financed Research and Development on Governance Mode Decisions for Research Alliances' from the perspective of South African research councils. The IPR Act has only recently been enacted, in December 2008, and there is therefore a paucity of available published works and scholarly works in this area. Staphorst's (2010) work therefore represents a pivotal study from which to build research strategies in related areas. Carlsson and Fridh (2002) state that technology transfer from universities to the commercial sector is a matter of finding the proper balance between the basic functions of teaching and research within the universities, on the one hand, and providing service to the wider community, on the other.

McGregor (2010) has pointed to the existence of three distinct clusters of South African universities. She has quantified the existence of 23 universities and clustered them according the level of research outputs (Table 2). The work of McGregor (2010) is highly relevant to the present research, because it is generally accepted that universities with high levels of academic outputs typically generate higher levels of IP. It

was important, therefore, to sample all three clusters, in an attempt to obtain a general picture incorporating all clusters. Since this was an initial, investigative, in-depth survey in order to obtain initial exploratory data relating to the research questions posed, a small sample size of n=6 of the total population of N=23 universities was chosen. This small sample size precludes the use of powerful parametric and non-parametric statistical techniques, and instead, the effort was focused on the use of basic descriptive statistics to identify trends in the data, and typical qualitative research techniques focused upon narrative inquiry methodologies to gain insights through inductive and deductive reasoning into the research problem.

This study consisted of two distinct research phases – Part A and Part B, with the overall objective of identifying impact elements of the IPR Act (South Africa's new Bayh-Dole-like IPR legislative framework, consisting of the IPR Act) (Republic of South Africa, 2008) that impact most heavily on the stages of IP development at universities in South Africa.

Part A of the study aimed to quantitatively identify the impact of Staphorst's (2010) impact elements on the four stages of IP development, from the perspective of the TTO. The second stage entailed narrative inquiry to interrogate TTOs on the top three ranking impact elements. Triangulation for data validity was performed by comparative analysis of the first and second phase data, which resulted in a satisfactory result.

These top three impact elements were then discussed in relation to university TTO activities, as well as in relation to Staphorst's (2010) top three ranking impact elements pertaining to science councils.

7.2 Part A conclusion

During Part A of the study, which attempted to identify and rank impact elements within the IPR Act from publicly financed R&D data was collected *via* a quantitative online survey among six TTOs from SA universities. The survey, essentially in the form of a Likert scale that allows TTOs to express the impact level of each of the 11 impact elements on the four stages of IP development, generated a set of data that was weighted for each element, by IP development stage, and analysed using frequency tables. The results of this analysis clearly indicate that the IPR Act enforcement and execution will demand a high degree of structural and resource requirements, particularly, and most importantly, at the IP disclosure stage of IP development.

Interviewees were also asked to rank the importance of each of the 11 impact elements according to level of impact or severity that each element exerts upon IP development stages. This research project clearly identified the following top three impact elements of the IPR Act:

- structural and resource requirements to manage and commercialise IP
- IP disclosure process
- IP detection process by TTO

Hence, it can be concluded that a possibility for these three elements identified by the respective TTO's, is that the IPR Act is still a relatively new law, and TTOs are still in the early stage of development. This situation might change in the future as they grow in knowledge and more resources are available.

7.3 Part B Conclusion

Part A of this study was followed by a narrative inquiry, Part B, and generation of interview transcriptions data processing methodology consisted of theme extraction.
Part A revealed the top three ranking impact elements, and interviewees were asked to elaborate on these three elements, in order to analyse these findings. Comparison with Staphorst's (2010) results showed that the impact elements were different for science councils. Staphorst's (2010) impact elements are regarded as areas in the new legislative framework that could influence operations, infrastructure and resources at the CSIR, in general. The 11 potential impact domains identified during Phase One in Staphorst's (2010) work were then ranked in terms of their relative severity levels, using a weighted frequency analysis.

Hence, it can be concluded that there is a definite variance between research councils and university TTOs on how they perceive the impact of the IPR Act. As mentioned earlier, it might be possible that university TTOs are still in the early phase of establishment and growth, while research councils might have more manpower and resources available. Therefore, different observations exist between these two parties.

7.4 Future Work

The present study may be considered as one of the first works on the topic of the impact of the IPR Act (2008) on the university IP development process. The study was designed to obtain perspectives on the topic from the perspective of the TTOR. Further studies are necessary to obtain opinions and perspectives from other stakeholders of publicly funded research. These include the researchers who are responsible for IP creation, faculty administration, and even outside service providers such as patent attorneys. Ideally, the entire population of SA universities, comprising all 23 tertiary institutions identified by McGregor (2010), should be interrogated in all three clusters. Data resulting from such an endeavour could be stratified, in order to look for differences between institutions according to their particular circumstances – for example, level of funding, or star scientists that they employ.

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Appendix A – Consistency Matrix

The following Table presents the study's consistency matrix. (Staphorst, 2010)

Table 10: Consistency matrix

Research Questions	Literature Review	Data Collection Tools	Analysis Methods
Research Question 1 (See Appendix B.3)	Staphorst (2010); (2008); Republic of South Africa (2009);	Questionnaire and Guided Interview. Question 1	Word Analysis, Reading of larger units, (*metaphors*), The physical manipulation of texts, Secondary data analysis, Triangulation.
Research Question 2 (See Appendix B.3)	Republic of South Africa (2009); Staphorst (2010); Baloyi, *et al.* (2009); Republic of South Africa (2009);	Questionnaire and Guided Interview. Question 2	Word Analysis, Reading of larger units, (*metaphors*), The physical manipulation of texts, Secondary data analysis, Triangulation.
Research Question 3 (See Appendix B.3)	Republic of South Africa (2009); Staphorst (2010); Thursby (2001) ; Siegel et al., (2004); Thursby et al., (2009)	Questionnaire and Guided Interview. Question 3	Word Analysis, Reading of larger units, (*metaphors*), The physical manipulation of texts, Secondary data analysis, Triangulation.
Research Question 4 (See Appendix B.3)	Republic of South Africa (2009); Staphorst (2010);	Questionnaire and Guided	Word Analysis, Reading of

	Mowery & Sampat (2005); Bozeman, (2000); Carlsson & Fridh (2002); Siegel et al., (2004)	Interview. Question 4	larger units, (*metaphors*), The physical manipulation of texts, Secondary data analysis, Triangulation.

Appendix B – Preliminary Interview Guide and Questionnaire

B.1 Overview

The following preliminary interview guide will be used during the interviews of the research project. Each interview will consist of 4 research questions.

B.2 Informed Consent Letter

The following paragraph represents the informed consent letter, to be signed by both the researcher and the interviewee during each interview.

I am doing research on the impact of Intellectual Property Rights Act from publicly funded research and development on the technology transfer process at publicly funded universities and universities of technology. To that end, you have been asked in an earlier email to review an on-line brochure on the recently enacted South African Intellectual Property Rights Act. Your responses with regards to the impact that this Act has on your TT process(s) will greatly assist us in understanding the Act's overall impact on TT process in general. Our interview is expected to last about an hour. Your participation is voluntary and you can withdraw at any time without penalty. Please note that all data will be kept confidential. If you have any concerns, please contact me or my supervisor using the details provided below.

Researcher name: Norman Erasmus

Email: norman@pecgroup.co.za

Phone: 082 379 3111

Supervisor name: Leon Staphorst

Email: leon.staphorst@gmail.com

Phone: 082 857 1135

Signature of participant: _____

Date: _____

Signature of researcher: _____

Date: _____

B.3 Preliminary Interview Guide Part B

B.3.1 Research Question 1

Which impact elements listed in Table 1 of the new IPR Act has/will influence/d the technology transfer process in terms of **IP creation** at your institution. The interviewee was asked to rank the order of importance or strength, in his/her estimation, of the impact elements of the IPR Act from 1 (Highest) to 11 (Lowest) **(Part A)** then, asked to elaborate on the top 3 chosen impact elements in order to determine driving factors why these impact elements are important **(Part B)**.

B.3.2 Research Question 2

Which impact elements listed in Table 1 of the new IPR Act has/will influence/d the technology transfer process in terms of **IP disclosure** at your institution. The interviewee was asked to rank the order of importance or strength, in his/her estimation, of the impact elements of the IPR Act from 1 (Highest) to 11 (Lowest) **(Part A)** then, asked to elaborate on the top 3 chosen impact elements in order to determine driving factors why these impact elements are important **(Part B)**.

B.3.3 Research Question 3

Which impact elements listed in Table 1 of the new IPR Act has/will influence/d the technology transfer process in terms of **IP protection** at your institution. The interviewee was asked to rank the order of importance or strength, in his/her estimation, of the impact elements of the IPR Act from 1 (Highest) to 11 (Lowest)

(Part A) then, asked to elaborate on the top 3 chosen impact elements in order to determine driving factors why these impact elements are important **(Part B)**.

B.3.4 Research Question 4

Which impact elements listed in Table 1 of the new IPR Act has/will influence/d the technology transfer process in terms of **IP commercialisation** at your institution. The interviewee was asked to rank the order of importance or strength, in his/her estimation, of the impact elements of the IPR Act from 1 (Highest) to 11 (Lowest) **(Part A)** then, asked to elaborate on the top 3 chosen impact elements in order to determine driving factors why these impact elements are important **(Part B)**.

Table 11: Ranking of extracted impact domains from Staphorst 2010

1. Choice of IPRs ownership
2. State walk-in rights on IP not declared
3. Benefit-sharing policies
4. Offshore IP registration process
5. Requirement for non-exclusivity in IP transactions
6. Preference in commercialisation rights to SMEs and BBBEE firms
7. IP detection process by TTO
8. NIPMO reporting process
9. NIPMO reaction time
10. IP disclosure process
11. Structural and resource requirements to manage and commercialise IP

Possible measurements/observations/outcomes:

- Identify the type and significance of technology transfer impact generated by the impact domains identified by Staphorst (2010).
- Identify domains with no substantial influence (Staphorst, 2010).
- Determine how these impact domains identified by Staphorst (2010) impact on the technology transfer process.

B.4 Survey (Questionnaire) Part A

B.4.1 Part A.1

Please indicate the level of impact of the elements of the IPR ACT on the stages of IP development using the dropdown selection boxes in the green area.

If necessary, refer to the brochure for additional information.

elements of the IPR ACT	brochure section	*IMPACT*	IMPACT on Intellectual Property Stage of Development			
			Creation	Disclosure	Protection	Commercialisation
1. Choice by TTO for IP ownership i.e. whether to obtain statutory protection or refer to NIPMO	4		nil	nil		
2. State walk-in rights on IP not declared to NIPMO	14					
3. Benefit sharing policies (inventor takes 20%)	10					
4. Offshore IP registration process	12					
5. Requirement for non-exclusivity in IP transactions	11					
6. Preference in commercialisation rights to SMEs and BBBEE firms	11					
7. IP detection process by TTO	5					
8. NIPMO reporting process	6					
9. NIPMO reaction time	9					
10. IP disclosure process	5, 7					
11. Structural and resource requirements to manage and commercialise IP	15					

**adapted from Staphorst (2010)*

scale
nil
low
medium
high

B.4.2 Part A.2

PLEASE RANK THE ORDER OF IMPORTANCE OR STRENGTH, IN YOUR ESTIMATION, OF THE ELEMENTS OF THE IPR ACT FROM 1 (HIGHEST) TO 11 (LOWEST)	
	RANK
Choice by TTO for IP ownership i.e. whether to obtain statutory protection or refer to NIPMO	
State walk-in rights on IP not declared to NIPMO	
Benefit sharing policies (inventor takes 20%)	
Offshore IP registration process	
Requirement for non-exclusivity in IP transactions	
Preference in commercialisation rights to SMEs and BBBEE firms	
IP detection process by TTO	
NIPMO reporting process	
NIPMO reaction time	
IP disclosure process	
Structural and resource requirements to manage and commercialise IP	

Appendix C – Information Overview Brochure: IPR Act (Act No. 51 0f 2008)

Source: Leon Staphorst (2010)

Goals of the IPR Act:

· *To provide for more effective utilisation of IP emanating from publicly financed R&D.*

· *To establish NIPMO and the Intellectual Property Fund.*

· *To provide for the establishment of TTOs at institutions.*

Domains covered by the Act (excluding purely administrative sections related to, for example, the definition of terms, creation of regulations and Act title):

Section 4: Choice of IPRs ownership

Here the IPR Act reiterates that IP generated by publicly financed R&D institutions are owned by these institutions. However, if institutions plan not to obtain statutory protection for their generated IP, this choice needs to be declared to NIPMO and ownership thereof will then pass to NIPMO. If private sector entities funded the research in part, these entities should be given the option to take ownership of the IP within the stipulations of Section 10 of the IPR Act.

Section 5: Management obligations and disclosure duties

This section details the requirements for publicly financed institutions to put in place systems/processes to detect new IP, declare IP to NIPMO and report to NIPMO on all matters pertaining to the IPR Act (such as reasons why certain IP was not commercially pursued).

Section 6: Establishment of TTOs at institutions

Here the requirement to establish TTOs at publicly financed R&D institutions is detailed. It elaborates on the goal of these offices in detecting IP and reporting to NIPMO.

Section 7: Functions of TTOs

The functions of TTOs are described here, including the creation of processes and establishing of resources to detect and declare IP. It also elaborates on its functions to manage IP related transactions, the obligation to pursue statutory protection of IP in order to realise its commercial potential, and its responsibility to liaise with NIPMO.

Section 8: Establishment of NIPMO

This section states that, as part of the IPR Act, NIPMO is henceforth established and that the functions thereof be defined by the South African Minister of Science and Technology.

Section 9: Functions of NIPMO

Here the IPR Act describes the primary function of NIPMO, which entails the promotion of the goals of the IPR Act. Furthermore, it describes NIPMO's obligation to ensure that it has the capacity to deal with all IP referred to it according to Section 4 of the IPR Act.

Section 10: Rights of IP creators in institutions to benefit-sharing

The obligatory granting of a portion of the revenue that accrues from IP to the creators of the IP is covered by this section of the IPR Act. It also defines specific benefit-sharing proportioning formulae that need to be adhered to.

Section 11: Conditions for IP transactions

This section of the IPR Act defines certain guidelines that need to be adhered to by institutions holding IP when executing commercial transactions related to this IP. For example, in transactions where IP is licensed to entities in order to pursue commercialisation, preference needs to be given to non-exclusivity deals with South African SMEs, as well as BBBEE accredited firms. If IP holders are not able to license the IP within this framework, evidence to this effect needs to be submitted to NIPMO for approval. All IP transactions are subject to the condition that unsuccessful commercialisation will entitle the State to exercise the rights specified in Section 14 of the IPR Act.

Section 12: Restrictions on offshore IP transactions

Here the requirements related to IP transactions with non-South African firms are detailed. For example, IP holders that intend to pursue offshore transactions need to declare these transactions to NIPMO. Furthermore, IP holders wishing to undertake an IP transaction offshore in the form of an assignment or exclusive licence must satisfy NIPMO that there is insufficient capacity in South Africa to develop or commercialise the IP locally, as well as the benefit to South Africa that such an offshore transaction will have.

Section 13: Intellectual Property Fund

This section of the IPR Act establishes an Intellectual Property Fund, to be managed by NIPMO. An institution may recover some of the costs incurred in obtaining statutory protection for IP from this fund.

Section 14: Acquisition of intellectual property rights by State

According to the Act, NIPMO must conduct reviews of non-commercialised IP in consultation with the IP holders. If these reviews reveal that the IP can be commercialised, NIPMO may require that the IP be licensed to any person on reasonable terms. Lastly, if an IP holder fails to disclose this IP to NIPMO, NIPMO may demand the assignment of rights to the State.

Section 15: Co-operation between private entities or organisations and institutions

This section of the Act dictates that a private entity may become an exclusive licensee of IP emanating from publicly financed R&D, if such a private entity has the resources to manage and commercialise the IP in a manner that benefits South Africa. Furthermore, such a private entity may become co-owner of the IP if it has contributed background IP, there was joint IP creatorship, arrangements for benefit-sharing have been established, and an agreement is concluded for the commercialisation of the IP. Any R&D undertaken at a public institution and funded by a private entity on a full cost basis (defined as all applicable direct and indirect costs), shall not be subjected to the provisions of this Act.

Section 16: Confidentiality by NIPMO and TTOs

Employees of NIPMO and TTOs may not disclose any information related to matters covered by this Act, which have come to their attention. It also discusses exclusions to this stipulation, such as a court order.