UNIVERSITY OF KWAZULU-NATAL

Factors affecting the implementation of technology transfer at the University of KwaZulu-Natal

by

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Declaration

I, Tracey Leigh Samuel declare that:

(i) This research reported in this dissertation, except where otherwise indicated, is my original work.

(ii) This dissertation has not been submitted for any degree or examination at any other university.

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  Romans 8:28-"And we know that in all things God works for the good of those who love him, who have been called according to his purpose".

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Abstract

The Intellectual Property Rights from Publicly Financed Research and Development Act No. 51 of 2008 (IPR-PFRD Act) was promulgated on 2 August 2010 in South Africa which makes it mandatory for publicly funded institutions, such as the University of KwaZulu-Natal (UKZN), to carry out technology transfer activities and correctly manage its intellectual property (IP). UKZN is rated as one of the top three higher education institutions in South Africa in terms of research output and has a relatively large and diverse patent portfolio. Despite the significant investments made in promoting technology transfer activities at UKZN, the technology transfer office (TTO) has failed to successfully commercialise an invention since its establishment. The aim of this study was to identify the factors that affect the implementation of technology transfer at UKZN. Due to the small number of inventors on the TTO database, a qualitative study was conducted. The participants in this study comprised of eight inventors who had filed patent applications with UKZN's TTO. The respondents were familiar with the TT process at UKZN and were able to provide rich detailed information. Face-to-face interviews were conducted to collect data from the respondents. An interview schedule was used to guide the discussions and where necessary, probe and follow-up questions were asked. The results of the study have shown that the majority of inventors were dissatisfied with the service provided by the TTO, more especially in respect of limited funding provided by the TTO and the lack of business and commercialisation expertise of the TTO staff. It was recommended that in order to become more effective the TTO must employ suitably qualified staff with expertise in commercialisation, networking and business skills; furthermore, larger sums of seed funding is needed to finance new projects. A major limitation of the study is that in order to protect the identities of respondents, the researcher had to withhold specific project details.

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List of acronyms and abbreviations

AUTM	Association for University Technology Managers
CTV	Columbia Technology Ventures
DUT	Durban University of Technology
DVC	Deputy Vice Chancellor
HEI	higher education institution
IP	intellectual property
IPR-PFRD Act	Intellectual Property Rights from Publicly Financed Research and Development Act No. 51 of 2008
NIPMO	National Intellectual Property Management Office
NMMU	Nelson Mandela Metropolitan University
NYOIL	New York University Office of Industrial Liaison
R&D	research and development
SARIMA	South African Research and Innovation Management Association
SU	University of Stellenbosch
TIA	Technology Innovation Agency
TT	technology transfer
TTO	technology transfer office
UCT	University of Cape Town
UKZN	University of KwaZulu-Natal
UP	University of Pretoria
WIPO	World Intellectual Property Organisation
WITS	University of the Witwatersrand

CHAPTER 1
OVERVIEW OF THE STUDY

1.1. INTRODUCTION

Technology transfer (TT) is a complex subject and is multi-faceted. The importance of technology transfer has been considered more than three decades ago. According to the Southern African Research and Innovation Management Association (SARIMA, 2014), the technology transfer office (TTO) in an institution is responsible for the identification, protection, and commercialisation of intellectual property (IP) that is owned and developed by the institution. The promulgation of the Intellectual Property Rights from Publicly Financed Research and Development Act No. 51 of 2008 (IPR-PFRD, 2008) is indicative of the importance that the South African government is placing on TT activities and the correct management of IP that emanates from publicly-financed research and development. It is clear from the literature that even though TTOs vary from one institution to another, the end result is to ensure that the innovations that result from a university impacts on both economic and societal growth. What is not clear, however, is the effectiveness of TTO's in converting inventions into commercially viable products.

This chapter provides an overview of the study and discusses the motivation for the study. The problem statement is also presented in this chapter together with the aim and research objectives of the study. This chapter also briefly discusses the research methodology chosen for the study, the population, sample size, data collection methods that were used and the main limitations of the study.

1.2. MOTIVATION FOR THE STUDY

The importance of TT is entrenched in the IPR-PFRD Act, which makes it compulsory for all publicly funded institutions to comply with the IPR-PFRD Act and to correctly implement TT. UKZN is a publicly funded higher education institution (HEI) in South Africa and falls under the ambit of the IPR-PFRD Act. However, there are barriers which are preventing UKZN's TTO from successfully implementing TT and realising the commercialisation benefits that can accrue from

TT activities that are correctly implemented. This study will contribute to a greater understanding of the factors that affect the implementation of technology transfer at UKZN, thereby identifying the barriers that need to be eliminated from the TT process and the methods that need to be implemented to ensure that UKZN's TTO can successfully engage in technology transfer activities and successfully commercialise both existing and future inventions. This study will also ensure that the UKZN TTO will fulfil the purpose set out by the government in the IPR-PFRD Act.

The results of this study will benefit the following stakeholders:

- TTOs in higher education institutions in South Africa can use the results of this study to improve their technology transfer offices.
- Publicly funded institutions in South Africa, such as the Medical Research Council or Council for Scientific and Industrial Research, with existing TTOs or who wish to implement TTOs, can use the results of this study to improve their technology transfer offices or they can implement TTOs.
- Private companies, public institutions, employees and other universities that deal with TTOs will have an improved understanding of the role of the TTO.
- The National Intellectual Property Management Office (NIPMO) and other Government agencies will have a deeper understanding from the universities' perspective when implementing TT and complying with the IPR-PFRD Act.

1.3. FOCUS OF THE STUDY

Technology transfer activities are prevalent around the world at different institutions and entities. However, this study was focused on TTOs in HEIs in South Africa, more specifically this study was focused on the technology transfer office of the University of KwaZulu-Natal, which is an HEI based in KwaZulu-Natal, South Africa. The TTO at UKZN falls under the research portfolio of the Deputy Vice Chancellor of Research, in a unit called UKZN InQubate. The sample that was used for the study consisted of inventors who were involved in technology transfer activities with the UKZN TTO. The data provided by these inventors was analysed in order to determine the effectiveness of the UKZN TTO.

1.4. PROBLEM STATEMENT

UKZN is rated as one of the top three HEIs in South Africa in terms of research output and has a diverse IP portfolio which consists of a large number of patent applications (UKZN, 2013). However, despite the large investment made in promoting TT activities at UKZN and the establishment of a TTO, there is no evidence available to clarify why there has been no successful commercialisation of inventions at UKZN. This raises the question "what are the barriers faced by UKZN's TTO in generating commercialisation income?"

1.5. AIM AND OBJECTIVES

The aim of this study was to identify the factors that affect the implementation of technology transfer at UKZN.

The objectives for this research study are set out hereunder:

- To identify the experiences that inventors have faced whilst working with the TTO;
- To establish whether the TTO is providing sufficient resources to facilitate the TTO process;
- To ascertain whether UKZN's IP Policy is enabling TT;
- To establish the competence of UKZN's TTO staff in facilitating the TT process;
- To identify the challenges that inventors experience during their participation in technology transfer activities at UKZN;
- To identify methods to improve the service delivery of the TTO.

1.6. POPULATION AND SAMPLE

The population for this study comprised of inventors who had filed patent applications with UKZN's TTO. For the purposes of this study, non-probability sampling was used as the study focused on an in-depth analysis of TT at UKZN. Judgement sampling was selected since the chosen respondents were "advantageously placed or in the best position to provide the information required"

(Sekaran & Bougie, 2010:252). Since the selected participants were familiar with the TT process at UKZN, they were able to provide rich information. The sample chosen by the researcher consisted of eight respondents who were inventors at UKZN.

1.7. METHODOLOGY

Hennink, Hutter and Bailey (2011) suggested that a qualitative method allows researchers to understand the study participants' beliefs and opinions from their perspective. The main purpose of qualitative research is to ensure that detailed, rich information is obtained from the research participants' subjective perspectives.

In order to provide a clear picture of how TT is implemented at UKZN, significant detail was placed on understanding not only the critical information but also what appeared to be trivial details.

In order to gain a comprehensive idea of the TT experiences of inventors at UKZN, semi-structured, in-depth interviews were used as the researcher could then refrain from using the structured question and answer approach. This approach allowed the researcher the opportunity to probe during the interview, when further information needed to be elicited from the respondents.

1.8. DATA COLLECTION METHODS

An interview schedule was used as a guide for the interviews that were conducted, and was structured in a manner that aligned with the research objectives for this study. The use of the interview schedule was considered to be desirable for the study as it clearly set out the topics that needed to be covered during the interview and provided a clear direction of how the interview should be carried out.

Bailey (1994:188-189) described an interview schedule as "a schedule whereby an interviewer asks questions to a respondent from a list of topics and sub-topics within an area of inquiry". The interviews were conducted in an environment selected by the respondents to ensure that they were comfortable. The resulting data was analysed and the researcher used the emerging themes and sub-themes to present the results of the study. The researcher also used direct quotations from the respondents to support the findings, to illustrate similarities and differences

and to indicate strength of opinion in the various responses received from the respondents.

The researcher also represented some of the results in a quantitative manner with the use of tables and figures.

1.9. LIMITATIONS OF THE STUDY

The following constraints were identified:

- The study conducted was a qualitative study which meant that the results of the research were not generalisable. However, the main purpose of the study was not to obtain information that was generalisable, but rather to obtain expert opinions from inventors.
- Due to this being a qualitative study, the conclusion that could be reached by every researcher is not always the same. The interpretation of results could have been influenced by the researcher's personal biases. The researcher constantly compared the results of each interview to identify emerging themes and unanticipated themes within the study.
- During the interviews, personal information about an invention revealed the identity of the respondents. The researcher had to thereafter describe the disclosed confidential information in a generalistic manner to ensure confidentiality.

These limitations are discussed further in Chapter 5.

1.10. OUTLINE OF THE STUDY

This study consists of five chapters, which clearly represent a logical flow of the research processes that were conducted. Table 1.1 sets out the contents of these five chapters, which have been arranged in a sequential pattern

Table 1.1: Chapter Structure

CHAPTER	CONTENT
Chapter 1	This chapter provides an overview of the study and discusses the motivation for the study. It also presents the problem statement and the focus area of the research topic undertaken as well as the aim and research objectives of the study. Furthermore, the chapter also briefly discusses the research methodology chosen for the study, the population, sample size, data collection methods that were used and the main limitations of the study.
Chapter 2	This chapter discusses the literature surrounding the topic of technology transfer and sets out the theoretical framework behind the research questions. It also provides an in-depth analysis of the applicable literature and legislation, and a critical and comparative analysis of technology transfer as it is used in different models and in different environments.
Chapter 3	Chapter 3 discusses the prevalent questions on the research methodologies, indicating the importance of conducting research, the different forms of research methodologies that have been used and the choice of research method used for this study and its appropriateness to the research topic.
Chapter 4	This chapter analyses, interprets and presents the primary data that was collected from the research participants (inventors) at the UKZN. The chapter begins by outlining the demographic profile of the research participants and thereafter focuses on the findings related to each objective of the study.
Chapter 5	This chapter concludes the study and sets out the recommendations based on the findings identified in Chapter 4, and lists the limitations that were identified. Finally, the chapter provides recommendations for further research.

1.11. SUMMARY

The implementation of the IPR Act has made it compulsory for all publicly funded institutions in South Africa to engage in TT activities and have an office which conducts these activities. However, there is a critical need for the UKZN TTO to improve its service delivery and successfully commercialise the inventions in its IP portfolio, to ensure that it is compliant with the purposes of the IPR Act.

Chapter 2 is a detailed literature review which discusses the concept of technology transfer and provides an overview of the role that technology transfer plays in the international arena and more specifically universities in South Africa.

CHAPTER 2
AN OVERVIEW OF TECHNOLOGY TRANSFER

2.1. INTRODUCTION

A literature review is a process which involves the identification of unpublished and published work derived from secondary sources on the chosen topic, the evaluation of this work in respect of the problem and the documentation thereof (Sekaran & Bougie, 2013:50).

This chapter discusses the literature surrounding the topic of technology transfer and provides a theoretical framework behind the research questions; conducts an in-depth analysis of the applicable literature, and provide a critical and comparative analysis of technology transfer as it is used in different models and in different environments; provides an overview of the role that technology transfer plays in the international arena and more specifically South Africa; and discusses the relevant legislation and key policy instruments that drive technology transfer activities in South Africa and across the various universities.

2.2. WHAT IS TECHNOLOGY TRANSFER?

There are various definitions of technology transfer; however, there are core elements which define the true purpose of the technology transfer process. The core elements being ‘technology’ and ‘transfer’.

2.2.1. Technology

According to Eveland (1986), technology can be described as information that is made for the purpose of accomplishing a task. Oxford University Press (2013) uses a narrower description of technology and describes it as scientific knowledge that is used in practical ways in industry. A broader description of technology was proposed by Gee (1993) and Carayannis, Rogers, Kurihara and Allbritton (1998) and they referred to it as a “set of knowledge contained in technical ideas, information, personal technical skills and expertise, equipment, prototypes, designs or computer codes. It is the useful application of knowledge and expertise into an operation”. A common interpretation of technology is an object that fulfils a certain purpose.

2.2.2. Transfer

Transfer is the movement of something or somebody from one place to another (Oxford Advanced Learners Dictionary, 2013; Macmillan Dictionary, 2014). Rogers, Takegami and Yin (2001), on the other hand, described transfer as the movement of technology from one individual or organisation to another, using a communication channel. Mansfield, Romeo, Schwartz, Teece, Wagner and Breach (1982:1) did not refer to technology as a 'movement' as the previous authors did; instead, they defined technology as "society's pool of knowledge concerning the industrial, agricultural and medical arts".

2.2.3. Technology transfer

The concept of technology transfer and its importance has been considered more than three decades ago. Mansfield (1975) realised the importance of technology transfer 30 years ago and pointed out that "one of the fundamental processes that influences the economic performance of nations and firms is technology transfer". According to Ramanathan (2010), technology transfer is defined as "a mutually agreed upon, intentional, goal oriented and proactive process by which technology flows from an entity that owns the technology to an entity seeking the technology". Bennett (2002) similarly defined technology transfer as "a transaction in which technological know-how is transferred normally between businesses or agencies representing businesses". Teng (2010:297) provided a description of technology transfer that is limited to IP and described technology transfer as a process in which "inventions or IP from research is either licensed or conveyed through use rights for commercialisation".

The Association for University Technology Managers (AUTM, 2014) similarly defined technology transfer as a process in which scientific findings are transferred from one organisation to another to ensure further development and commercialisation thereof.

AUTM (2014) provides a holistic view of the process of technology transfer which is explained as follows:

- Identification of new technologies

- Protection of these identified technologies
- Patent and copyright protection of the new technologies
- The formation of development and commercialisation strategies in the form of marketing and licences to private companies or the creation of new companies based on the new technology.

According to Rogers *et al*. (2001:254), the technology transfer process involves the "movement of a technological innovation from a Research and Development organisation to a receptor organisation" and includes the stages from research and development to commercialisation and thereafter. This definition introduces the concept of innovation which is described by South African Research and Innovation Management Association (SARIMA, 2014) as "the development of new customer value through solutions that meet new needs, unarticulated needs, or address old customer and market needs in new ways".

Recent research by Brodhag (2013:1) states that "technology transfer and innovation are considered as major drivers of sustainable development as they place knowledge and its dissemination in society at the heart of the development process". It is evident from the above definitions that the technology transfer process is crucial for innovation to happen. Technology transfer and innovation go hand in hand in ensuring that society is able to tap into its intellectual capital in the best way possible (SARIMA, 2014). Technology transfer operates on various scales and involves technical contact within the organisation, between organisations and industries (Charles & Howells, 1992:4). According to Maskus and Reichman (2005:10), "international technology transfer is a comprehensive term covering mechanisms for shifting information across borders and its effective diffusion into recipient economies".

SARIMA (2014) defines technology transfer as "the process in which skills, knowledge, technologies, IP, methods of manufacturing are transferred among governments or universities and other institutions to ensure the accessibility of scientific and technological developments to a wider volume of users". Thereafter, the users can further develop and exploit the technology for commercial benefit and can achieve new products, processes, applications, etc.

There are several fundamental characteristics concerning technology transfer that can be derived from the above-mentioned definitions:

- Firstly, there is a movement of technology from one body to another;
- Secondly, the technology can be classified as an innovation or IP;
- Thirdly, the IP is created for the purpose of commercialisation by the end user;
- In addition, in most cases the creator of the IP or innovation emanates from the government/university/publicly funded institutions.

For the purpose of this study the definition of technology transfer as proposed by SARIMA (2014) has been used, due to the study focusing on the context of a university.

2.2.4. Importance of intellectual property to technology transfer

The common theme among the definitions of technology transfer, explicit and implicit, is that intellectual property is pivotal to the process of technology transfer. The Intellectual Property Rights from Publicly Financed Research and Development Act No. 51 of 2008 in South Africa ("IPR-PFRD Act") defines intellectual property as "any creation of the mind that is capable of being protected by law from use by any other person, whether in terms of South African law or foreign law, and includes any rights in such creation, but excludes copyrighted works such as thesis, dissertation, article, handbook or any other work which, in the ordinary course of business, is associated with conventional academic work". In her research, Hoye (2006:6) stated that IP protection "addresses the inherent conflict between academics expectations of open publishing of academic work and their industrial partners' need to preserve competitive advantage, which in many countries is accomplished by preserving trade secrets". The most common form of IP protection in the technology transfer process appears to be patents (Hoye, 2006). The World Intellectual Property Organisation (WIPO) delivers global services for the protection of IP. WIPO (2014) defines the different forms of IP as follows:

a. Patent

This is an exclusive right that is granted to the inventor for an invention. An invention refers to a new process or product which is able to offer a new or improved method of performing a task.

b. *Industrial designs*

WIPO (2014) describes an industrial design as "the ornamental or aesthetic aspect of an article which may consist of two-dimensional features (such as patterns or colour) or three-dimensional features (such as shape)".

c. *Copyright*

Those rights that creators/authors have over works that are literary or artistic. Works that are covered by copyright range from books, films, painting and sculptures to databases, advertisements and maps.

d. *Trade mark*

A sign that is capable of creating a distinction between the good or services of one entity from that of another.

e. *Geographical indications*

According to WIPO (2014), geographical origin refers to "a sign used on goods which have a specific geographical origin and possess qualities which are attributable to the place of origin".

The definition of implementation is "the process of putting a decision or plan into effect or to execute a plan" (Oxford Advanced Learners Dictionary, 2013). For the purpose of this study the implementation of technology transfer refers to the execution of technology transfer.

2.3. ORIGINS OF TECHNOLOGY TRANSFER

The process of technology transfer has played a critical role in society since ancient times, and is not a modern day phenomenon. According to Sagasti (1979:15 as cited in Brodhag, 2013:2), "the transfer of technologies has been on the international agenda for a long time, ever since the lacking scientific and technological capacities of developing countries were considered an illustration of an inequitable world order". The introduction of the Bayh-Dole Act was a highlight

in remedying this gap. The success of technology transfer activities worldwide is the direct result of the introduction of the Bayh-Dole Act.

The Bayh-Dole Act (Public Law 96-517, Patent and Trademark Act Amendments of 1980) enacted on 12 December 1980 in the United States, serves as a key piece of legislation enabling technology transfer. Jamison (1999) described this Act as the 'Magna Carta' for university technology transfer. Not only does the Act create a uniform policy on technology transfer, it also enables universities to retain title ('own') IP that was created using federal ('government') funding. Due to the Act, universities consider technology transfer to be a commercial activity (Shane, 2004).

Not only was the Bayh-Dole Act influential in encouraging universities to engage in technology transfer activities, it was also instrumental in facilitating the commercialisation of university discovered technologies that were federally funded (AUTM, 2013). Furthermore, this Act has encouraged universities worldwide to create technology transfer offices (TTOs) and has inspired the enactment of the IPR-PFRD Act, 2008, in South Africa.

Since the implementation of the Bayh-Dohl Act, the size and magnitude of the operations of TTOs in the US have increased steadily over the past two decades, as indicated by the increase in employees. Figure 2.1 is a representation of the growth in university TTOs as reported by the Association of University Technology Managers (AUTM) which is an organisation that promotes technology transfer between universities, colleges, private enterprises and government (AUTM, 2013).

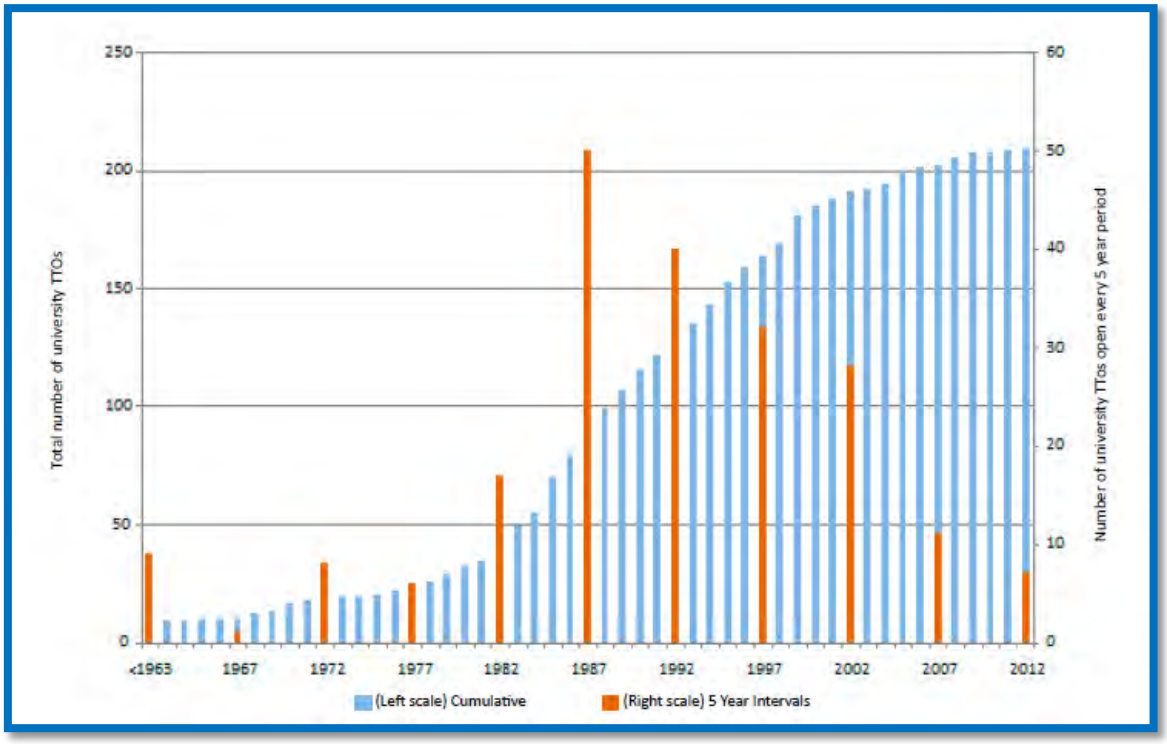

Figure 2.1: Growth of university TTOs

Source: AUTM). 2013. *AUTM Licensing Activity Survey.* [Online]. Available WWW: http://www.autm.net/FY2012_Licensing_Activity_Survey/11449.htm (Accessed 5 January 2014).

According to Rogers *et al*. (2000), the rapid increase in TTO licensing was encouraged by the following factors:

- The enactment of the Bayh-Dole Act;
- The increasing importance of research in the life sciences;
- The attraction that the next technology could be the 'big winner" which could earn millions.

2.4. TECHNOLOGY TRANSFER IN UNIVERSITIES

Technology transfer is prevalent throughout the world in various institutions and can be applied at various levels. Technology transfer can also be applied at universities and this is discussed in detail hereunder.

2.4.1. Role of the university in technology transfer

Witkamp, Raven and Royakkers (2011) described how innovation was previously restricted to "science, technology and process innovations", but in recent years

“there has been an improvement towards a broader understanding of innovation, which includes innovation within the social and public arenas.” The Industrial Partnership Office (2005) proposed that “the role of university or national laboratory IP will become increasingly important, as the economy has evolved from a manufacturing-based economy to a knowledge-based economy”.

The traditional core role of a university was to educate students and conduct basic research (Breznitz, O’Shea & Allen, 2008). According to Carayannis *et al*. (1998), “irrespective of the universities primary mission being to engage in research and disseminate knowledge to students and academics, indirectly universities have contributed to technology transfer activities by providing the industry with highly educated and qualified personnel”. It is evident from the views proposed by the afore-mentioned authors that technology transfer is relevant to universities.

Powers (2004) described the rapid escalation in technology activities by universities over the recent years as being indicative of the entrepreneurial nature of universities. According to Guerrero and Urbano (2010:44) “an entrepreneurial society refers to places where knowledge-based entrepreneurship has emerged as a driving force for economic growth, employment creation and competitiveness”. As a result, universities are increasingly being viewed by policymakers in various countries as engines of growth (Teng, 2010).

A factor that must be considered is that technology transfer activities can take place without adversely affecting the core values of a university such as publications and research results (AUTM, 2014). This view is echoed by Teng (2010) who further noted that the co-operation that exists between industry and universities must be intensified and university inventions must be more geared into innovations, to ensure that knowledge flows into business and society from these universities.

Universities that are entrepreneurial are involved with networks, partnerships and other relationships with both public and private organisations, and serve as an umbrella for activities that encourage collaboration and co-operation (Inzelt, 2004). The most common goals of a university TTO (Swamidass & Vulasa, 2009:349 as cited by Mowery *et al*., 2004) are “enhancement of licencing revenues; the

maintenance or expansion of industrial research support; regional economic development; faculty retention and technology commercialisation".

Universities are viewed as important originators of new ideas and advocates of innovation; therefore there is an increase in TTOs and an increased importance on transferring this technology for commercialisation to the private sector (Collier & Gray, 2010). Similarly, Teng (2010:296) described technology transfer activities of a university enterprise as increasingly important as a "source of both economic development and revenue for the university". A research university's core role is to conduct research and train students on how to conduct research. Research universities do not only play an important role in the technology transfer process, but are also considered to be more effective than research and development technologies in transferring technologies (Rogers *et al*., 2000). Wolson (2007b) stated that "the TTO could play a crucial role in bridging the 'innovation chasm' and overcoming some of the barriers that are preventing the flow of promising early stage research and development from research laboratories to industry".

Hockaday (2009), the Managing Director at Isis Innovation Ltd in the University of Oxford, stated that it is imperative to invest resources for technology transfer to take place effectively. These resources are:

1. *People*-dedicated staff that are able to develop skills and experience in conducting technology transfer activities.
2. *Patent Budget* - a dedicated budget that is sufficient to cater for the protection of inventions, prior to them being marketed.
3. *Proof of Concept* - funding should be allocated to the TTO which will be allocated to building prototypes of the inventions, conduct market research activities, etc. These activities allow the university to present their inventions in a manner which makes them appealing to industry.

In the technology transfer process, universities collaborate with industry for many reasons. The primary reason for universities to collaborate with industry is to raise additional resources which are required to fund research and other university activities (Cohen *et al*., 1998 as cited in Muscio, 2010). There are reciprocal benefits for both parties, as collaboration with industry has positive impacts on the

university's academic research and this inevitably improves the effectiveness of the academics without adversely affecting their academic careers (Guldbrandsen & Smeby, 2005 as cited in Muscio, 2010).

Academic and research institutions implement technology transfer for a number of reasons, such as recognition for the IP generated by the institution; to ensure compliance with government regulations; to attract and retain a talented faculty; local economic development; to attract corporate research support; and to license revenue to support further research activities and education (AUTM, 2014). One of the reasons that industry seeks research and technical collaborations with HEIs is to tap into scarce scientific experience and save costs (Charles & Howells, 1992:18-19).

2.4.2. University technology transfer models

According to the Southern African Research and Innovation Management Association (SARIMA, 2014), the TTO in an institution is responsible for the identification, protection, and commercialisation of IP that is owned and developed by the institution. One of the key challenges that universities face is deciding on which model to implement in their TTO for transferring their IP to the commercial world (Pries & Guild, 2011). According to Wolson (2007b), "institutions would be well-served by critically assessing their needs and exploring a range of technology transfer models, in order to identify the structure most appropriate for them".

There are several technology transfer models that have developed over time. Two models of university technology transfer are discussed next.

2.4.2.1. Traditional Model of University Technology Transfer

A schematic of what is referred to as the traditional model of university technology transfer is presented in Figure 2.2.

Figure 2.2: Traditional Model of University Technology Transfer

Source: Adapted from Bradley, S.R., Hayter, C.S., & Link, A.N. 2013. *Models and Methods of University Technology Transfer*. The University of North Carolina, Greensboro.

This linear model of technology transfer is discussed by closely analysing each step of the model as follows:

Step 1: The process of technology transfer is initiated by the discovery made by the university scientist (Siegal, Waldman, Atwater & Link, 2004). The scientist refers to the researcher at the university. This researcher could take the form of an academic or a student. TTOs at this stage must assist in raising awareness amongst researchers on the opportunities available to them in exploiting their research (Wolson, 2007a). Similarly, Siegal *et al*. (2004) pointed out that TTO staff must spend time and effort to inspire academics to disclose their inventions. The catalyst which starts the technology transfer process could come from research funding emanating from the government or industry (Bozeman, 2000).

Step 2: The scientist discloses his invention to the TTO. The various TTOs have different methods in which they request disclosures to be made. A disclosure can take many forms. It can be verbal, electronic or hand-written.

Step 3: The TTO conducts an evaluation of the invention and decides on whether they should proceed with protecting the IP or not (Bradley *et al*., 2013). This affords the TTO personnel the opportunity to assess the commercial value of these inventions (Macho-Stadler & Pérez-Castrillo, 2010). Siegal *et al*. (2004) confirmed the views of Macho-Stadler and Pérez-Castrillo (2010) by stating that this is the stage in which the commercial benefit of the invention is considered, along with the prospective interest from the private or public sector.

Step 4: If a decision is taken by the TTO to invest in the invention, then a patent application is filed at this stage. The costs of patent protection are quite high and therefore TTOs cannot file patents for every patent that is disclosed to them. According to Siegal and Phan (2005), "TTOs are reluctant to file for a patent if there is limited interest expressed by the industry for the technology, due to the high costs associated with patenting".

Step 5: The patent is awarded at this stage, and thereafter the TTO starts to market the technology to external organisations and entrepreneurs. The role of a TTO is not only to protect the IP portfolio of the University, but also to act as a facilitator between the university and industry allowing for effective technology commercialisation (Swamidass & Vulasa, 2009). Recent research by Bradley *et al.* (2013) stated that "the goal of this marketing effort is to match the technology with an organization or entrepreneur that/who can best utilize the technology and provide opportunity for revenues to the university".

Step 6: Upon the identification of a suitable partner (in Step 5) the University's TTO works with the partner to negotiate a licence agreement. The IP is officially licensed when an agreement is reached by both parties. According to Colyvas *et al.* (2002 as cited in Bradley *et al*., 2013), the marketing activities of the TTOs are increasingly important for those inventions in which the existing links between industry and the university is weak. Employing technology transfer personnel that are skilled in this area is crucial.

Step 7: The usual way of commercialising technology is through licensing, whilst the ground-breaking way involves the formation of spin-off companies (Macho-Stadler & Pérez-Castrillo, 2010). According to Owen-Smith and Powell (2001),

"licensing, strategic alliances and the formation of spin-off companies through University technology transfer offices, have become a driving force in the development of high technology industries". The AUTM (2014) defined spin-offs as "those firms formed to license technology from a university". The spin-offs are formed with the assistance of the staff from the TTO.

Step 8: This is the final stage in which the licensee adapts and uses the technology. During this process the initial technology may undergo further development. The university and/or the inventing scientist may still be required to continue their involvement in the project and assist the licensee in developing the technology further or maintain the licence agreement (Thursby & Kemp, 2002).

Step 9: According to Lowe (2002), "spinoffs and start-ups provide academic entrepreneurs with an alternative pathway for disseminating and commercialising research, often when they are unable to license their technology to large companies or an external entrepreneur". This is often the case when the technology is in an embryonic state or when the technology is considered as high-risk by investors.

2.4.2.2. Steven Kline's Chain Link Model

The Chain Link Model is one of many non-linear technology transfer models. Figure 2.3 suggests that university research is a node in the network which has several important links.

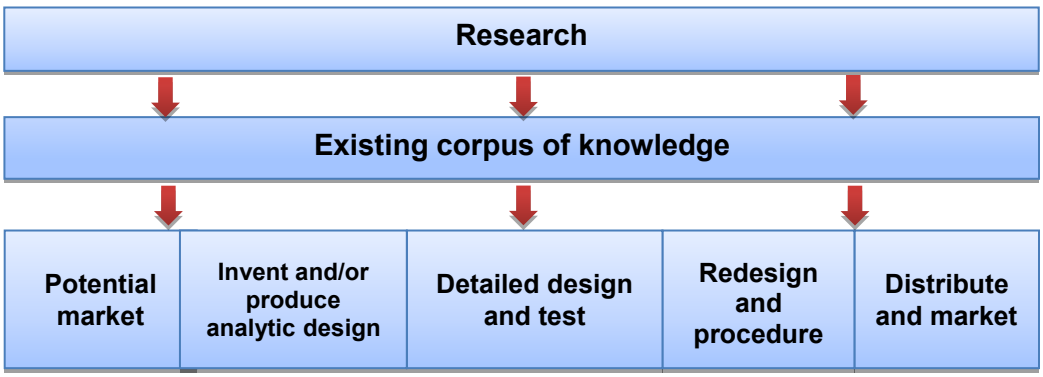

Figure 2.3: Chain Link Model

Source: Adapted from. Langford, H.L. 2009. *Measuring the Impact of University Research on Innovation.* [Online]. Available WWW: http://www.thecis.ca/index.php?catID=30&itemID=75 (Accessed 14 January 2014).

The chain-linked method is a complex system which emphasises the socio-technical nature of industry and technology and consists of five paths. This model is an alternative framework to the traditional model (as represented in Figure 2.2) and contains multiple feedback loops in which the university contribution can intervene at any stage in the process (Kline & Rosenberg, 1986:289).

Some authors have pointed out the inaccuracies of the traditional model of technology transfer and prefer the chain-linked method of technology transfer. Rogers *et al*. (2001:254) argued that “the linear model of the technology transfer process does not fully take into account external environmental factors, such as market demand or regulatory changes that can influence the technological innovation process”. Similarly, Bradley *et al*. (2013) stated that the traditional model fails to capture technology transfer as it is currently practised and “it is not particularly useful for understanding the routes to commercialisation available to universities”.

2.4.3. University technology transfer - international perspective

A licensing survey conducted by AUTM listed the top 10 earners of licensing income in the years ranging from 2003-2012. The results of this survey are represented in Table 2.1.

Table 2.1: Top earners of licensing gross income 2003-2012

University	Rank 2012	Number of times in the top 20 in the last decade
New York University	1	10
Columbia University	2	6
Massachusetts Institute of Technology	3	10
Princeton University	4	2
Northwestern University	5	7
University of California System	6	10
University of Washington	7	10
Stanford University	8	9
Mount Sinai School of Medicine	9	7

Source: Adapted from AUTM). 2013. *AUTM Licensing Activity Survey.* [Online]. Available WWW: http://www.autm.net/FY2012_Licensing_Activity_Survey/11449.htm (Accessed 5 January 2014).

A brief analysis of the top two technology transfer offices is as follows:

New York University Office of Industrial Liaison/Technology Transfer (NYUOIL)

The mission of NYUOIL is "to promote the commercial development of NYU technologies from its Medical Center and Washington Square campuses into products to benefit the public, while providing resources to the University to support its research, education, and patient care missions" (NYUOIL, 2014). According to NYUOIL (2014) their office "proactively facilitates research collaborations between the researchers at NYU and industry on projects that are of mutual interest".

Not only has NYUOIL licensed almost 60% of their patents for development and commercialisation, they are also ranked first in the US for income received from technology licensing. According to NYUOIL (2014), "NYU created 87% more new start-up companies per research dollars expended than the national average". Revenues that are generated through technology commercialisation are shared with the inventors and governed by the NYU Patent Policy.

Columbia Technology Ventures

Columbia Technology Ventures (CTV) is the technology transfer office of the University of Columbia. According to CTV (2014), their core objective is "to facilitate the transfer of inventions from academic research to outside organizations for the benefit of society on a local, national and global basis". CTV has managed to sign 70 license deals and form 15 new start-ups. Their current portfolio contains 1200 patents which are available for licensing. According to CTV (2014) their aim is "to ensure that Columbia technology is licensed to capable business partners whose objectives for commercialization of the technology are aligned with their mission".

The traditional model of technology transfer (represented above in Figure 2.2) is used in CTV as reflected below in Figure 2.4.

Figure 2.4: Technology transfer process at CTV

Source: Columbia Technology Ventures (CTV). 2014. *Technology Transfer at Columbia*. [Online]. Available WWW: http://techventures.columbia.edu/about (Accessed 5 January 2014).

2.4.4. Impact and benefits of TTOs in universities

According to Hoye (2006), there are benefits of technology transfer in universities that impact both internal and external stakeholders, as follows:

- Some of the new technologies that have been introduced by TTOs have had the ability to improve the quality of life of people, based on the new technology that is made into good, services or industrial practices. This refers to high and low profile technology that has been able to assist people and entities in daily activities. Some examples would be technology relating to medicine, manufacturing, information technology and the environment. Technology transfer is not a matter that deals only with commercialisation of intellectual property. According to Valdivia (2013), "technology transfer is the

complex works that takes place at the interface of research and productive organizations and permeates the entire ecosystem because all major players intervene: universities, laboratories, big and small companies, etc."

- Successful licensing and spin-off revenue generation can have a major impact on the economy and have the ability to create jobs which in turn has a significantly positive effect on the economy. According to Hoye (2006:15), "the possibility that university research can stimulate economic growth in their surrounding regions is of great interest for government, as it implies that the economic benefits of university research can be captured within the country". Monjon and Walebroeck (2003 as cited in Hoye, 2006) confirmed this view by stating that knowledge spillovers from universities generally increase the innovativeness of firms in the area surrounding the university. According to Fostdic (2014), "one of the benefits of technology transfer is the globalization of industries, as technology transfer is able to bring the world together as one large market place".

- Receiving returns from technology transfer activities is an incentive to conduct technology transfer at universities, especially since most government universities depend on external funding for their operations. Raine and Beukman (2002 as cited in Hoye, 2006) attribute the growing interest in technology transfer to the declining public funds that are available. These revenues are generally split between the inventors and the university, therefore most parties involved in the process are winners if the technology is successfully commercialised.

Other authors have proposed several benefits that arise when spinoffs are created by universities, such as:

- Long-term payoff, creation of jobs and the generation of significant returns if the firm goes public (Siegal & Phan, 2005).

- The university can provide skilled labour, expertise and facilities that are specialised. (Bercovitz, Feldman, Feller & Burtman, 2001).

- Spinoffs can be developed within the university's research park (Siegal & Phan, 2005) which can benefit from the support structures like incubators or

science/research parks which are located close to or within the university (Heinzl, Kor, Orange, and Kaufmann, 2008 as cited in Bradley *et al*., 2013).

- There are intrinsic benefits, such as prestige, self-realisation, independence and career advancement (Cassar, 2007).

2.4.5. Challenges facing technology transfer offices

Despite the immense benefit that technology transfer activities provide to an institution, there are also constraints which have the possibility of inhibiting the technology transfer process. Various authors have written on the challenges facing technology transfer offices. A few of these challenges are listed below:

2.4.5.1. Insufficient funding to accommodate for high costs of patenting/commercialisation

Access to funding in the early stages of the formation of the TTO is extremely important. Swamidass and Vulasa (2009) argued that when there is a shortage of budget and staff, patents are filed at the expense of commercialisation. This view is supported by Wolson (2007b) who stated that TTOs often struggle to secure a suitable budget for patenting costs, as TTOs can be viewed as competing with those researchers who prefer that the funding be allocated directly to support their research.

The Patent Rebate which is allocated by the National Intellectual Property Management Office (NIPMO) to universities and public research organisations allows TTOs to claim back 50% of their patent-related expenditure (NIPMO, 2014). However, this rebate will not assist TTOs with a non-existent or relatively small patent budget (Wolson, 2007b). This view is supported by Swamidass and Vulasa (2009) who argued that budget cuts and relatively small budgets build barriers which prevent the smooth transition of university inventions to the commercial markets, and this defeats the purpose of technology transfer.

There are many arguments surrounding the issue of whether it is a legitimate goal for university TTOs to become self-supporting by increasing the income from university inventions. According to Trune and Goslin (1998 as cited in Swamidass & Vulasa, 2009) some university TTOs accept the fact that they operate on a

break-even basis, or lose money. The pitfall of not having a TTO that is self-supporting is that university budget cuts and belt-tightening will directly impact on the activities of the TTO (Swamidass & Vulasa, 2009).

The average time that the technology transfer process takes to deliver benefits is 7 to 12 years (Morberg & Moon, 2000). This is an indication of the large amount of time and monies that are required for this process. During this period the budget allocated to the TTO may be depleted, resulting in under-funding of the office, which is a concern especially when the TTO is not self-supporting (Morberg & Moon, 2000). Universities often get a mistaken sense of accomplishment when they count the number of patents filed in the year by the TTOs. Instead, their focus should be on the commercialisation income that they have received from the patents (Swamidass & Vulasa, 2009). Universities generally add resources to activities that are considered to be value-adding to the mission of the university, if the TTO does not perform this may result in the TTO being chronically under-funded (Swamidass & Vulasa, 2009).

2.4.5.2. Few invention disclosures

According to Owen-Smith and Powell (2001), “in University environments a crucial step for technology transfer is to convince faculty to disclose their potentially valuable innovation to TTOs”. Many reasons why researchers fail to disclose their research to universities it to avoid the regulations surrounding the technology transfer process and to avoid the university owning the research.

2.4.5.3. Unclear expectations and objectives for TTOs

The stakeholders of the university often misunderstand the rationale for engaging in technology transfer. Hence, the university must have a clear idea of the direction it would like to take and obtain buy-in from the researchers. Many academics/researchers oppose the idea of a technology transfer office and are of the opinion that universities should not participate in commercialisation activities and that they should be entitled to ownership of their IP and not the university (Wolson, 2007b). Wolson (2007b) further discusses that university executives have unrealistic views on the financial returns that they will receive from the technology transfer process, and when these expectations fail to materialise they

quickly withdraw their support of the TTO or redirect the focus of the TTO. According to Warren, Hanke and Trotzer (2008), “the mission of a TTO should also be defined or at least supported at the top levels of the institution’s administration to ensure the alignment of TTOs activities with the broader goals of the institution”.

2.4.5.4. Limited capacity and skills deficiency

According to Siegal *et al*. (2004:134), “evidence suggests that TTOs are often either too narrowly focused on a small set of technical areas, or too focused on the legal aspects of licensing, inevitably giving the marketing aspect short thrift.” Marketing expertise amongst TTO personnel is poor, as TTOs often lack personnel that specialise in marketing (Siegal *et al*., 2004). A technology transfer office must be staffed appropriately, both quantitatively and qualitatively. It is crucial to hire personnel that possess the skill necessary to protect and commercialise IP. Professional staff should have degrees in science and/or business together with experience in business and law. Metz *et al*. (2000) adopted a broader approach than Siegal *et al*. (2004) by identifying a broader skills deficit. According to Metz, Davidson, Martens, Rooijen and McGregory (2000), there is a shortfall of skills and capabilities in areas such as “technology selection, financing, marketing, maintenance, service, information dissemination, utility regulation, policy development, technology transfer, market intermediation, tax policies, microeconomic policies and property rights”.

Many TTOs lack the competencies and resources which are required to search the laboratories and research groups for technologies that are commercially viable (Owen-Smith & Powell, 2001). It is clear that institutional success at patenting depends on the institution, the quality of the TTO as well as the department’s views of the benefits of patenting. There are a limited number of experienced technology transfer practitioners to act as mentors and share work experiences (Wolson, 2007b). These factors inevitably affect the efficiency and effectiveness of the technology transfer process as confirmed by Mutschler and Graff (2007:747) who stated that “lack of basic information regarding IP and technology transfer issues can result in problems that are costly in terms of time, opportunity and money”. Errors in the mishandling of the discovery may result in a complete loss of

the protection of the discovery, limited protection of the IP or reduction or loss in the opportunity to market the invention (Mutschler & Graff, 2007:748).

2.4.5.5. Difficulties with IP management

One of the main challenges that face a technology transfer office is the decision on which IP to protect and to what extent (Dodds & Somersalo, 2007). According to Teng (2010), there is a serious mismatch between publicly funded research and development and the market needs. It is vital for technology transfer offices to invest in those inventions that are significantly innovative and which may have commercial value (Dodds & Somersalo, 2007).

2.4.5.6. Limited licensing opportunities

Institutions and researchers that receive public funding are constantly under pressure from government to partner with industry and to actively commercialise their research output (Bubela & Caulfield, 2010). According to Swamidass and Vulasa (2009:343) “high-tech inventions are often difficult to market when there are no ready markets for them, especially if the inventor had no pre-invention contacts with a potential licensee”. It is clear that TTOs must possess the necessary skills and resources to facilitate the technology transfer approach. Technology transfer will not flourish in an environment where the university lacks skill in fostering and managing relationships with industry.

2.4.5.7. Inadequate/Lack of an IP Policy

Each institution has its own manner of governing the technology transfer process. These policies govern the research of the university and define the rights and responsibilities of each stakeholder in the technology transfer process in respect of IP protection and the commercialisation process (Hoye, 2006). According to Hockaday (2009), there are a number of areas in which a clear policy is required within the university setting out rules and regulations regulating the technology transfer processing in an unambiguous manner. Confusion exists when the policy does not exist or the policy fails to contain clear terms on the technology transfer process and how it will be governed at the university.

2.5. TECHNOLOGY TRANSFER IN SOUTH AFRICA

Technology transfer is a global phenomenon and is also implemented in South Africa. Various forms of legislation are in place to regulate technology transfer activities in South Africa and this section discusses the implementation of TT in South Africa.

2.5.1. The need for technology transfer and innovation in South Africa

The World Economic Forum (WEF) publishes a comprehensive series of reports which closely analyses the broad range of global issues it seeks to address with stakeholders. The Global Competitiveness Report 2013-2014 which emanates from the forum, reports that highly innovative countries with strong institutions continue to top international competitiveness rankings. According to the WEF (2014) in the Global Entrepreneurship Monitor South African Report, “South Africa still has a low level of business innovation which is impeding its growth and wealth creation, which is an indication that South Africa is not maximizing the gains which will be possible through the exploitation of research and development and innovation, especially in comparison to other successful competitors in the world’s economy” (Herrington, Kew & Kew, 2010).

According to the International Education Association of South Africa (2014), universities are facing immense pressure from government to generate third stream income (through donations, investments and entrepreneurial activities) as a way of bolstering the universities’ autonomy. According to Festel (2013:454), “technology transfer is becoming more and more important to close the gap between academic research and the commercialisation of the results to realise industrial applications”.

2.5.2. Key policy instruments and governance

Many policies and strategies recognise the need for technology transfer in South Africa and the need to protect the IP that is generated at publicly funded institutions. These policies and strategies are highlighted below.

2.5.2.1. South African Research and Development Strategy, 2002 ("R&D strategy")

The concept of a National System of Innovation (NSI) was established in the 1996 White Paper on Science (Department of Arts, Culture, Science and Technology, 1996). According to the South African Government (2002) and the Department of Science and Technology (2002), the South African Research and Development Strategy (R&D strategy) was released in 2002, in an effort to sustain the vision of the White Paper for an effective and well-managed NSI. According to this strategy "inadequate IP legislation and infrastructure" is one of several factors that needed to be addressed in South Africa. The R&D strategy also introduces the concept of the 'innovation chasm" to describe the gap that exists between knowledge generators (such as universities and research institutions) and the market; and also highlights that "inventions and innovations from publicly financed research are not effectively protected and managed in South Africa".

2.5.2.2. Ten Year Innovation Plan

According to the R&D strategy, SA has yet to effectively mobilise innovation in a manner that stimulates and supports economic growth. The R&D strategy identified that there is a serious anomaly between the medium to high technology products and services and local research. Inevitably, this anomaly has led to extensive importation of technology and intellectual property by South Africans, which has resulted in an unfavourable balance of payments. According to the South African Government (2014), the Ten-Year Innovation Plan proposes a bold new stance for South Africa to transform towards a knowledge-based economy in support of government's broad developmental agenda.

2.5.2.3. Technology Innovation Agency Act (Act no. 26 of 2008)

The Technology Innovation Agency Act (Act no. 26 of 2008) established the Technology Innovation Agency (TIA) whose mandate is to stimulate and intensify technological innovation in South Africa. TIA's role is to improve economic growth in South Africa and improve the quality of life of South Africans through the development and exploitation of technological innovations.

2.5.2.4. IPR-PFRD Act, 2008

Against this background, the South African government promulgated the IPR-PFRD Act, 2008 on 22 December 2008 (SARIMA, 2014). The IPR-PFRD Act came into effect on 2 August 2010 and is indicative of the importance that the South African government is placing on technology transfer activities and the correct management of IP that emanates from publicly financed research and development. The IPR-PFRD Act serves to ensure that the public is able to derive greater benefits from the increasingly significant research and development investments made by government. The IPR-PFRD Act is not unique to South Africa as its main objectives are based on the United States Patent and Trademark Laws Amendments of 1980, Bayh-Dole Act (NIPMO, 2014).

According to NIPMO (2014), “the IPR-PFRD Act is intended to provide for more effective utilisation of IP emanating from publicly financed research and development; to establish the National IP Management Office and the IP Fund; to provide for the establishment of offices of technology transfer at institutions; and to provide for matters connected therewith".

The Act seeks to ensure that “human ingenuity and creativity must be acknowledged and rewarded, the people of South Africa, particularly small enterprises and BBBEE entities, must have preferential access to opportunities arising from the production of knowledge from publicly financed R&D and the resultant IP” (NIPMO, 2014). The Act also makes provision for the establishment of Regional Offices of Technology Transfer to assist the individual regional institutions in conducting technology transfer activities.

SARIMA is a key stakeholder organisation that was established in 2002 to “provide a platform for those from government, academia, and industry with an interest in research and innovation management to foster networking and the promotion of common interests” (Wolson, 2007a:1652). SARIMA provides a number of seminars on these subjects which most TTOs subscribe to.

2.5.3. Overview of the TTOs in South Africa

Prior to the implementation of the IPR-PFRD Act, 2008, there were limited TTOs in South African universities. The only university with an established TTO at that

stage was the University of Stellenbosch whilst the University of Cape Town, Nelson Mandela Metropolitan University and the University of Johannesburg had a TTO that had limited capacity. However, since the implementation of the IPR-PFRD Act, 2008, most of the universities have established TTOs, as reflected in Table 2.2 below.

Table 2.2: Overview of TTOs in South African universities

Region	Institution	Full TTO	Part of regional office only
Western Cape	University of Stellenbosch (SUN)	Yes	
	University of Cape Town (UCT)	Yes	
	University of Western Cape (WC)	Yes	
	Cape Peninsula University of Technology (CPUT)	Yes	
Eastern Cape	Nelson Mandela Metropolitan University (NMMU)	Yes	
	Rhodes University (RU)		Yes
	University of Fort Hare (UFH)		Yes
	Walter Sisulu University (WSU)		Yes
Free State	University of Free State (UFS) Vaal University of Technology (VUT) Central University of Technology (CUT)	Yes	
Gauteng	University of the Witwatersrand (Wits) University of Pretoria (UP) University of Johannesburg (UJ) Tshwane University of Technology (UT) University of South Africa (UNISA)	Yes Yes Yes	
North West	North West University (NWU)	Yes	
	University of Limpopo (UL) University of Venda (UNIVEN)	 N/A	 N/A
KwaZulu-Natal	University of KwaZulu-Natal (UKZN) University of Zululand (UniZulu) Durban University of Technology (DUT) Mangosuthu University of Technology (MUT)	Yes Yes	 Yes Yes

Many TTOs in SA have received revenue from commercialisation activities that were undertaken prior to the implementation of the IPR-PFRD Act. These commercialisation revenues are depicted in Figure 2.5 below.

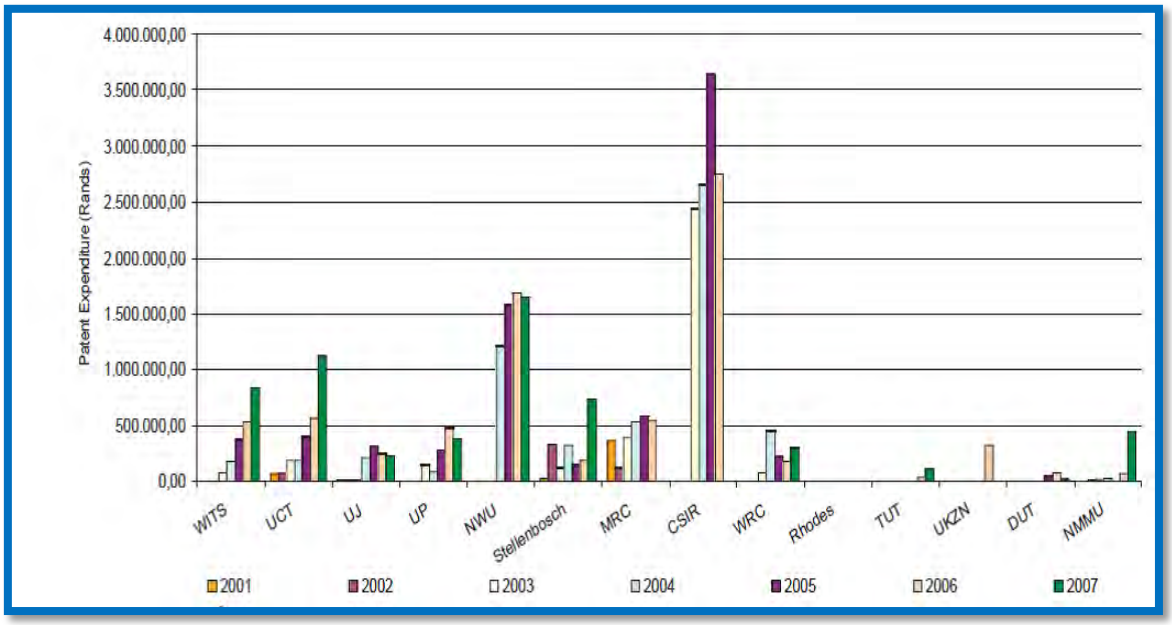

Figure 2.5: Commercialisation revenue generated by institutions in South Africa

Source: Sibanda, M. 2008. *Intellectual Property Commercialisation and Institutional Arrangements at South African Publicly Financed Institutions.* Innovation Fund, National Research Foundation, Pretoria.

Figure 2.5 clearly indicates TTOs that have been successful in commercialisation activities, however, the majority of the TTOs have had limited success in the commercialisation of their patent portfolio.

Figure 2.6 reflects the patent expenditure of universities in South Africa prior to the implementation of the IPR-PFRD Act.

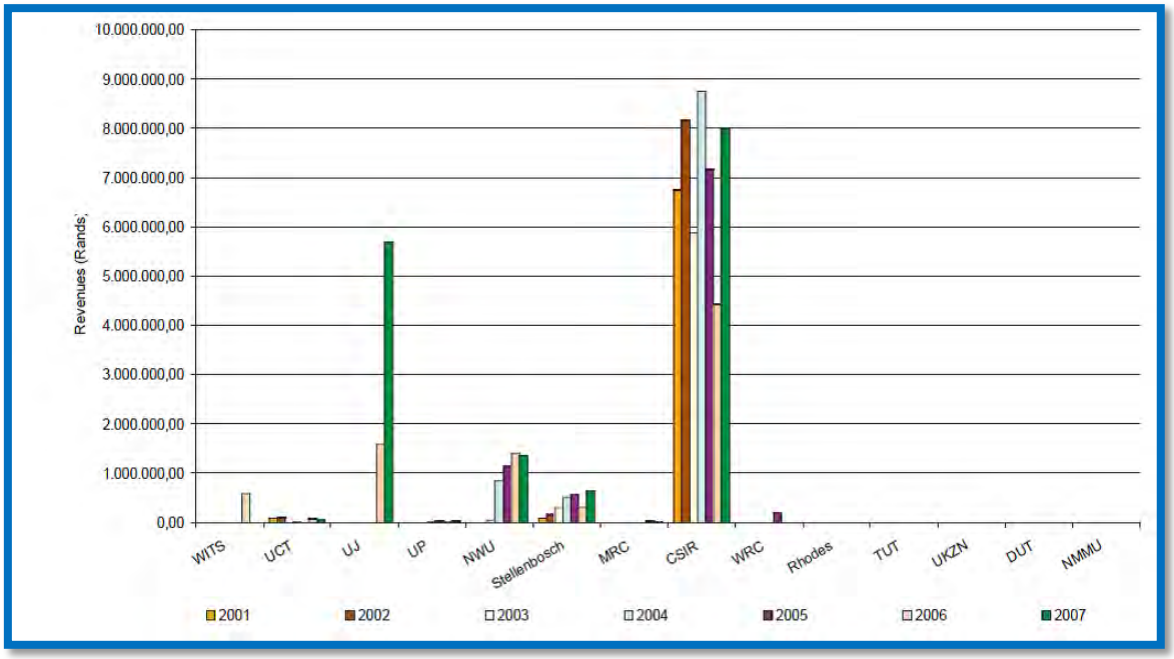

Figure 2.6: Patent expenditure by universities in South Africa

Source: Sibanda, M. 2008. *Intellectual Property Commercialisation and Institutional Arrangements at South African Publicly Financed Institutions.* Innovation Fund, National Research Foundation. Pretoria.

Figure 2.6 clearly indicates that although some institutions spent a significant amount of money investing in their IP portfolio, they did not receive correlating benefits from the commercialisation activities that they conducted.

In 2013, a similar situation existed in some institutions in which considerable amounts of monies were spent on filing patents, but there was limited or no income received from the commercialisation of these patents. This situation exists in the UKZN TTO which was formed in 2008, wherein substantial monies have been invested in patent protection. However, the TTO has not been successful in commercialising these patents and experiencing the benefits of commercialisation as proposed by the IPR-PFRD Act.

Section 2 (1) of the IPR-PFRD Act sets out the object of the Act as follows:

> *"to make provision that IP emanating from publicly financed research and development is identified, protected, utilised and commercialised for the benefit of the people of the Republic, whether it be for a social, economic, military or any other benefit".*

However, the majority of South African universities have not yet been able to licence their IP, let alone receive income from commercialisation. Wolson (2007a:1697) stated the following in respect of SA institutions: “substantial investments in technology transfer are needed to generate downstream benefits; there is typically a significant time lag before net benefits are realized, and the distribution of returns are very skewed”.

Some TTOs in South African universities have dedicated TTOs within their organisations which sometimes carry out other functions such as contract management and sponsored research (Wolson, 2007a). Examples of these universities are the Durban University of Technology (DUT), University of KwaZulu-Natal (UKZN) and Nelson Mandela Metropolitan University (NMMU). Other universities, like the University of Stellenbosch (SU), have set up a university-owned company. At SU it is called ‘INNOVUS’ and carries out the technology transfer activities of the university (Wolson, 2007a:1651).

NIPMO (2014) stated that “NIPMO has not only a regulatory (compliance monitoring, review and enforcement) function, but also an administrative and supporting function in respect of the Act, on behalf of government”. NIPMO provides an interface between the public and private sector on issues relating to research and development, intellectual property and commercialisation. NIPMO ensures that TTOs are compliant with the provisions of the IPR-PFRD Act, 2008, and TTOs are expected to report on their technology transfer activities at regular intervals.

UKZN, UCT and SU feature amongst the top five universities in 2012 according to the Department of Higher Education in respect of research output (UKZN, 2013). The technology transfer activities of UCT are discussed in detail next.

Technology transfer at UCT:

UCT’s technology transfer office is called Research Contracts and Intellectual Property Services (RCIPS) and its IP portfolio comprises of 149 patent applications (which are at various stages of application), 95 different inventions and 152 granted patents that are still active (UCT, 2014). The Annual Times Higher Education BRICS and Emerging Markets Rankings ranks universities in

emerging markets according to 13 performance indicators which include teaching, research volumes and research influence. Five South African universities (UP, UCT, SU, UKZN, WITS) featured in the list of top 100 universities in the BRICS and emerging markets. This is an indication of the quality of research that is being conducted at universities in SA which indicates the potential for IP that could emanate from this research.

Table 2.3 represents the licensing income that has been earned by RCIPS through its licensing of technology, and the manner in which UCT distributes this income.

Table 2.3: Distribution of RCIPS licensing income

YEAR	LICENSING INCOME	INVENTORY	RESEARCH GROUPS	DEPART-MENT	CENTRAL FUND	PATENT EXPENSES	ALLOCATION PENDING
2001	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0
2004	13,905	6,952	6,953	0	0	0	0
2005	1,728	864	864	0	0	0	0
2006	70,058	35,029	35,029	0	0	0	0
2007	49,815	24,907	16,537	8,370	0	0	0
2008	170,346	11,625	41,000	7,720	0	110,000	0
2009	77,311	43,565	0	11,383	0	22,362	0
2010	3,531,989	879,966	435,291	7,733	885,960	531,037	792,000
2011	558,545	10,302	4,755	5,546	0	179,053	358,887
2012	986,010	219,366	315,972	7,733	54, 845	377,675	30,417
TOTAL	5,459,706	1,232,580	856,402	48,487	940,805	1,220,127	1,161,304

Source: University of Cape Town (UCT). 2014. Innovation at UCT. [Online]. Available WWW: http://www.rcips.uct.ac.za/usr/rcips/ip/innovation2013.PDF (Accessed 5 January 2014).

RCIPS share many similarities with the UKZN TTO which is described below (UCT, 2014):

- The IP team at RCIPS provides support for IP protection, UCTs research endeavours and commercialisation.
- RCIPS is responsible for the maintenance and implementation of the IP policy at UCT.

- IP education is one of the important goals of RCIPS especially with the research community.
- A close relationship is maintained with IP attorneys who are specialists in their fields and attorneys are hired on the basis of their area of expertise.
- A database called Leonardo is used at UCT to track the development of the patent in the patenting process. This database is able to provide both statistical and information reporting.
- An annual budget is allocated to RCIPS which is used towards patent protection.
- RCIPS also facilitates the commercialisation of technology and determines the appropriate innovation route.

Other TTOs that have not been successful in technology transfer activities have to report to NIPMO on the reasons for this, and NIPMO is able to provide monetary and non-monetary assistance to these TTOs (NIPMO, 2014). The IPR-PFRD Act sets out that financial support would be provided to the TTOs for the establishment of the TTOs. However, many years after the promulgation of the Act, university TTOs that are not newly established have been requested to fund their own TTOs and to provide NIPMO with details on how they intend to do so. The aim is to ensure that TTOs are commercialising their IP and using the commercialisation income to fund their offices. The Act will effectively force an increase in South Africa's GDP which is considered as relatively low as compared to other countries.

2.6. SUMMARY

In this chapter it was established that technology transfer is a complex subject and is multi-faceted. Furthermore, the literature has provided an overview of how technology transfer originated, the applicability of technology transfer to universities, the different models of university technology transfer and more particularly the introduction of technology transfer to South Africa and its applicability to universities in South Africa. The literature emphasises the importance of innovation and entrepreneurship to a technology transfer office and also on the role and importance of a technology transfer office in both the

economy and at the university. It is clear from the literature that even though technology transfer offices vary from one institution to another, the end result is to ensure that the innovations that result from the university impact on both economic and societal growth. What is not clear, however, is how effective the TTO is to convert inventions into commercially viable products. UKZN has a dedicated TTO, however, 2006 was the last recorded income generated from commercialisation and this raises the question “what are the barriers faced by UKZN’s TTO in generating income from the successful commercialisation of its inventions?”

The next chapter will focus on the methodology that was used to answer the research question.

CHAPTER 3
RESEARCH METHODOLOGY

3.1. INTRODUCTION

In the previous chapter it was established that technology transfer is a complex subject and is multi-faceted. Furthermore, the literature has provided an overview of how technology transfer originated, the applicability of technology transfer to universities, the different models of university technology transfer, and more particularly the introduction of technology transfer to South Africa and its applicability to universities in South Africa. This chapter discusses the methodology used to investigate and gather information in order to answer the research objectives and the research question, “What factors affect the successful implementation of technology transfer at UKZN”?

Chapter 3 also discusses the prevalent questions on the research methodologies, including: the importance of conducting research, the different forms of research methodologies that have been used, the choice of research method used for this study and its appropriateness to the research topic.

3.2. AIM AND OBJECTIVES

The aim of a study sets out the desired outcome, aspirations and expectations of the study. It contains a broad statement that not only summarises the desired outcome of the study but also “paints a picture” of the research project. Objectives on the other hand, emphasise the manner in which aims are to be achieved.

3.2.1. Aim

To identify the challenges faced by UKZN’s TTO in generating income from the successful commercialisation of its inventions.

3.2.2. Objectives

The objectives for this research study are set out hereunder:

- To identify the experiences that inventors have faced whilst working with the TTO.

- To establish whether the TTO is providing sufficient resources to facilitate the TTO process.
- To ascertain whether UKZN's IP Policy is enabling TT.
- To establish the competence of UKZN's TTO staff in facilitating the TT process.
- To identify the challenges that inventors experience during their participation in technology transfer activities at UKZN.
- To identify methods to improve the service delivery of the TTO.

3.3. DEFINITION OF RESEARCH METHODOLOGY

Sekaran and Bougie (2013:2) defined research as "the process of finding solutions to a problem after a thorough study and analysis of the situational factors". Research is conducted to ensure that information is gathered so that an informed decision can be made.

Research methodology refers to a framework that relates to a set of definitive assumptions that are used to conduct research studies (O'Leary, 2004). There is a clear distinction between both concepts as research is aimed towards finding solutions to research problems whilst research methodology focuses on the use of correct procedures to ascertain these solutions.

3.4. RESEARCH DESIGN

Research design refers to the overall strategy that is chosen to integrate the different components of the study, in a manner that is coherent and logical. A research design constitutes the blueprint of the study and according to Kothari (2008), the research design is the heart of a study and is a road map of the investigation undertaken during the study. This chapter seeks to describe and analyse the different elements of the research design implemented in this study.

3.4.1. Methodological justification

After choosing the research topic, evaluating the research problems and setting out the aims and objectives of the study, the next step was to ascertain the research methodology framework that would be used for this study. The type of

data required largely determines the collection method to be employed. Primary data refers to data being obtained for the first time by the researcher, whilst secondary data has already been collected elsewhere and has passed through the statistical processes (Kothari, 2008). For the purposes of this study primary data was collected.

Sekaran and Bougie (2013) classified the basic types of research as descriptive or analytical, applied or fundamental, conceptual or empirical and quantitative or qualitative. The characteristics of these different types of research as well as the differences between them are outlined in Table 3.1 below.

Table 3.1: Different types of research methods

TYPES OF RESEARCH	DESCRIPTION
Descriptive	Is a scientific method involving observing and describing the behaviour of a subject as it exists at present, without influencing it in any way. The researcher does not control the variables and is only able to report on what is happening or has already happened (Kothari, 2008).
Analytical	Whilst descriptive research attempts to describe, determine and identify the subject, analytical research attempts seeks to establish why it is that way or how it came to be.
Applied	Applied (action) research is aimed at finding solutions for immediate problems rather than just gaining knowledge (Sekaran & Bougie, 2013).
Fundamental	Sekaran and Bougie (2013) described fundamental research as "basic research that serves to produce a body of knowledge in order to comprehend the level of certainty the problem could be solved".
Conceptual	Conceptual research focuses on the concept or theory that is able to explain or describe the phenomenon that is being studied.
Empirical	Empirical research differs from conceptual research, as it relies on experience or observation on its own, without due regard for theories (Kothari, 2008).
Quantitative	Quantitative research is grounded on the measurement of quantity or amount. According to Kothari (2008), this "process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationship".

TYPES OF RESEARCH	DESCRIPTION
	An advantage of qualitative research is that the researcher is more objective with the findings and it can also be used to test hypotheses, due to its ability to measure data using statistics (Jones, 2012). However, the disadvantage is that a large sample of the population must be studied to obtain more accurate results (Jones, 2012).
Qualitative	Qualitative research on the other hand relates to phenomena involving or relating to quality or kind (Kothari, 2008). A main feature of qualitative research is that it is able to focus on events that occur naturally in natural settings and the richness of the data collected allows for thick descriptions (Miles & Huberman, 1994). A qualitative research design is described by Yin (2009) as "the logic that links data to be collected (and the conclusions to be drawn) to the initial questions of the study". The advantage of qualitative research is that the researcher is able to gain data that is rich and comprehensive (Jones, 2012). The disadvantage is that the researcher may skew the results during their interpretation or introduce bias (Jones, 2012). Jones (2012) also highlights that this method is time consuming.

This research study comprised of a blend of different types of research methods such as descriptive, applied, empirical and qualitative research. The reasons for the selection of these criteria are listed below:

- Descriptive research: the study was intended to investigate a situation that already exists at UKZN in respect of TT, as TT is not a new phenomenon. The information that was collected at UKZN was collected without changing the UKZN environment as the research summarised how TT is implemented at UKZN.
- Applied research: the aim of the study, discussed above, was to determine how to successfully implement technology transfer at the University of KwaZulu-Natal which is a matter of application.
- Empirical research: the research relied on the experience and observations of inventors at UKZN, without due regard for theories.

- Qualitative research: was deemed to be most suitable for this study as it addressed the “why” and how” questions that needed to be answered in this study. This is in line with the focus of the study, which entailed understanding the context of TT in a real life context, in UKZN. By undertaking an in-depth investigation into the implementation of TT at UKZN, it was anticipated that this concept will be uncovered and clearly understood. In order to provide a clear picture of how TT is implemented at UKZN, significant detail was focused on to understand not only the critical information but also what appeared to be trivial details.

According to Henning, Van Rensburg and Smit (2004), the researcher is able to draw a meaning from the raw data by seeing the bigger picture and thereafter converting the raw data into what they describe as thick descriptions, which give an account of a phenomenon that is coherent.

Hennink *et al.* (2011) suggested that a qualitative method allows for the “understanding of behavior, beliefs, opinions and emotions from the perspectives of study participants”. The main objective of the study was to ensure that detail rich information was obtained from the research participants’ subjective perspectives, which made the qualitative research design the most appropriate for this study.

3.4.2. Methods of collecting qualitative data

Shao (1999) identified three different types of qualitative research techniques as focus groups, projective techniques and interviews. These techniques are described in Table 3.2.

For the purposes of this study, the researcher used interviews as a means to collect the required data from the research participants as it allowed the researcher to question, consult and evaluate the participants. It also provided the researcher with the opportunity to probe the participants for further elaboration when it was required. However, there are different types of interview formats that can be used in a study, namely: unstructured, structured and semi-structured interviews.

Table 3.2: Qualitative research techniques

Technique	Description
Focus groups	A discussion on a particular topic which is led by a moderator and which consists of eight to ten members (Sekaran & Bougie, 2013)
Projective techniques	Encourages the research participants to reveal their unconscious feelings and attitudes by providing them with verbal or visual stimuli.
Interviews	A formal meeting in which the interviewer elicits information from the research participant by questioning, consulting or evaluating the research participant. In the interview session the interviewer asks the participant many questions and may probe the participant for further elaboration after the question is answered (Zikmund, 2003). The use of interviews allows the researcher the opportunity to discuss the intentions behind the questions with the interviewee, and the meanings of some of the items can be amplified (Jankowicz, 2000).

In order to gain a comprehensive picture of the TT experiences of inventors at UKZN, semi-structured in-depth interviews were used as the researcher could then refrain from using the structured question and answer approach. This approach allows the researcher to probe during the interview when further information needs to be ascertained from the research participant.

Kothari (2008) described primary data as data that is being collected by the researcher for the first time, whilst secondary data refers to data that was collected and analysed previously by another person. For the purposes of this study, primary data was collected by using face-to-face (in-depth) interviews to collect qualitative data. The researcher found this to be the most suitable for exploring phenomena in a real life context such as UKZN as it allowed the researcher to uncover the underlying motivations behind the participants' responses to certain questions by probing further.

3.4.3. Research instrument

Bailey (1994:188-189) described an interview schedule (Appendix 1) as "a schedule whereby an interviewer asks questions to a respondent from a list of topics and sub-topics within an area of inquiry". This schedule serves as a guide

for the interviewer during the interviewing process (Bailey, 1994). The use of the interview schedule was considered to be desirable for the current study as it clearly set out the topics that needed to be covered during the interview and provided a clear direction of how the interview should be carried out. Most of the questions asked were open-ended which allowed the participants the freedom to answer the question in a way that suited their interpretation of events. The researcher focused on designing the questions in a manner that was clear and unambiguous.

The interview schedule was issued to the research participants one week prior to the interview by e-mail. This allowed the participant the opportunity to have an idea of the type of questions that would be asked and to assist them to follow the questions on the guide as the interview progressed. This was a way of increasing the transparency and validity of the study.

For the purposes of this study, the interview schedule was structured in a manner that aligned with the research objectives for this study. These questions were designed using the funnelling approach in which general broad questions were first asked and thereafter more specific narrow questions were asked on the topic.

The introductory section of the schedule provided the participant with an explanation of the purpose of the study, an indication of the time frame for the interview and confirmed that ethical clearance was obtained to carry out the study. Thereafter, key open-ended questions were asked at the beginning to get a broad impression of the background of the participant and the UKZN TT process. More detailed questions were asked as the interview progressed.

The questions posed to the participants included the following broad themes: challenges, mandate and business model, resources, governance, incentives, competence of management and TTO staff and areas of development.

3.4.4. Pilot testing

A draft interview guide was sent to two inventors at UKZN for their guidance. The purpose of conducting a pilot study was to establish the appropriateness of the questions in the interview schedule and to determine the accuracy and clarity of

the schedule. The pilot study provided valuable input which enabled the researcher to consider the input and make the necessary amendments that were deemed as appropriate. For example, one of the inventors suggested that a question be included regarding the business model of the TTO. This was a valid and valuable comment and a question was added to the interview schedule. The pilot study was vital and ensured that amendments were made to the interview schedule prior to the commencement of the actual data collection process.

3.4.5. The process of interviewing

As mentioned earlier, the method of face-to-face, in-depth interviews was selected to obtain information from the research participants. The setting of the interviews, description on how the interviews were conducted, as well as the duration of the interview will be discussed in detail next.

3.4.5.1. Setting of the interviews

Due to a qualitative research methodology being chosen, the interviews were conducted at venues that were selected by the research participants and free from disturbance. This ensured that the participants were comfortable during the interview as it was in a setting that was familiar to them. In choosing these settings the researcher followed the requirements proposed by Greeff (2002) by considering the elements of privacy, comfort and possible threats in the environment selected for the study. Interviews were conducted over a period of two weeks in the month of June 2014. The interviews were conducted at times that were suitable for the research participants, to avoid interrupting the participants' academic schedules.

3.4.5.2. Procedures followed during the interviews

The researcher conducted the interviews personally due to the fact that the sample size consisted of ten research participants. This ensured that the respondents' behaviour and non-verbal communication could be observed (Neuman, 1997). Neuman (1997) cautioned that conducting interviews can also be time consuming. Professionalism was maintained at all times during the interviews and the participants were not rushed to answer the questions. At the beginning of the interview the participants were informed of the nature and purpose of the

study. The confidentiality of the identities of the participants was maintained and the participants were re-assured that the research will remain confidential and that the research will be used for scientific purposes only. This affirms the views of Greeff (2002) who stated that when a researcher introduces the study to the participant, the researcher should also confirm that the information will be treated confidentially. According to Polit and Hungler (1993), the researcher's promise of confidentiality to the research participant is a guarantee that the information that is disclosed by the participant to the researcher will not be reported publicly or made available to anyone other than those parties involved in the research. Informed consent letters (Appendix 2) which were signed by the researcher were handed to the respondents confirming in writing that confidentiality and anonymity of records will be maintained by the Graduate School of Business at UKZN and the researcher.

The interviews were recorded using a tape recorder. According to Greeff (2002) the use of a tape recorder aids the researcher in focusing on the process of interviewing, observing the participants reactions as well as their non-verbal communication. The use of the tape recorder assisted in transcribing the interviews thereafter.

The interview schedule was used as a guide during the interview. The interview was initiated by establishing background details of the participants and thereafter focused questions that were related to the study were asked. Probing was used primarily as a means to clarify the responses provided by the participants and to gather more information on the topic. Greef (2002) described probing as asking follow-up questions which expand and clarify the responses received from the participant. Probing also assists when the answer to the question does not provide sufficient information.

3.4.5.3. Duration of the interviews

The researcher spent on average an hour with each participant. This provided the researcher with sufficient time to discuss the purpose of the interview with the participants as well as to ask each question and probe further. The time allocated was sufficient to complete the interview and ensured that a follow-up interview was not required.

3.4.6. SAMPLING STRATEGY

3.4.6.1. Setting of the study

The study was conducted within the University of KwaZulu-Natal, a higher education institution which was formed on 1 January 2004 after the merger of the University of Natal and the University of Durban-Westville. The technology transfer office at UKZN falls under the research portfolio of the Deputy Vice Chancellor of Research, in a unit called UKZN InQubate. The Intellectual Property and Commercialisation (IPC) subunit of UKZN InQubate is responsible for the protection and commercialisation of intellectual property emanating from research at the University of KwaZulu-Natal. The population for this study comprised all inventors who registered patent projects with InQubate.

3.4.6.2. Composition of the sample

Sampling refers to the process in which items are selected from the population and the attributes of the sampled subjects are generalised to the population (Sekaran & Bougie, 2010).

Sampling can be divided into random (probability) sampling and non-random (non-probability) sampling. Random sampling refers to a sample in which each element of the population has an equal chance of being selected, whilst non-random sampling refers to a method in which the researcher cannot guarantee that each element of the population will be represented in the sample.

For the purposes of this study, non-probability sampling was used as the study focused on an in-depth analysis of TT at UKZN. According to Sekaran and Bougie (2010), the results of a non-probability sampling method cannot be confidently generalised to the population. However, it is important to take note of the fact that generalisation of findings from a sample to the population is not the objective of the qualitative method of research. Instead, the qualitative method seeks to obtain rich information and allow a deeper understanding of phenomena, which is the objective of this study.

The sample method chosen for this study was judgement sampling, since the chosen respondents “were advantageously placed or in the best position to

provide the information required" (Sekaran & Bougie, 2010:252). Since the selected participants were familiar with the TT process at UKZN, they were able to provide rich information. Table 3.3 sets out the criteria used to identify the respondents to be selected for this study.

Table 3.3: Criteria for selection of sample for the study

	CRITERIA	DESCRIPTION
1	Staff member or student of UKZN	To ensure that the research participants are currently staff members or students of UKZN.
2	Inventor of a patent	The selection of research participants that are inventors ensures that the participants have knowledge of the technology transfer process.
3	Patent filed at UKZN's TTO	To ensure that the inventor has had first-hand experience in interacting with the UKZN TTO in respect of IP protection and commercialisation.

The use of the criteria outlined in Table 3.3 ensured that the research participant was not only aware of the process of technology transfer but was actively involved in the technology transfer process with the UKZN TTO. The interactions and experiences of the respondent provided first-hand knowledge and accurate results that were able to enhance the validity of the information that was collected. Therefore, inventors who met the criteria were the unit of analysis for this study.

3.4.6.3. Sample frame

According to Sekaran and Bougie (2010), a "sample frame is a (physical) representation of all the elements in the population from which the sample is drawn". The UKZN TTO keeps a portfolio of the inventors of patent applications in a document entitled 'IP Tracking Sheet'. The use of this sample frame to select research participants ensured that each research participant met the criteria outlined in Table 3.3.

3.4.6.4. Sample size

There is no set sample size for qualitative research; however, a sample generally consists of six to eight people especially when large amounts of data are collected (Bineham, 2006). There is often a misconception that "generalisability is the

ultimate goal of all research" (Marshall, 1996). However, an appropriate sample size is one in that is able to adequately answer the research questions and could be in single numbers. The sample chosen for this study comprised of eight research participants. Sekaran and Bougie (2013) stated that "theoretical saturation is reached when no new information emerges on the subject in repeated cases". Data saturation was noticed after the sixth interview had been conducted by the researcher as no new information was being provided by the respondents.

3.5. RELIABILITY AND VALIDITY OF THE INTERVIEW DATA

Validity and reliability are two concepts that build into the design of research (Henning *et al*., 2004). The meaning of validity and reliability differs in qualitative research as opposed to quantitative research (Sekaran & Bougie, 2010).

3.5.1. Reliability

Reliability of research refers to the consistency of the data and in qualitative research it refers to the extent to which the instrument measures what it is intended to measure. However, in qualitative research this does not mean that the interpretation and conclusion should be the same, as the conclusion reached by every researcher is not always the same (White, 2002).

Hussey and Hussey (1997) advised that the use of qualitative research results in replication can be impossible and the verification of interpretive research is problematic.

Despite these arguments, the researcher was able to successfully manage the potential weakness in the study by vigorously collecting data and using various methods of interviewing, using a tape recorder, making detailed observations and note taking. This approach was confirmed by Creswell (1994) who stated that reliability of qualitative research can be enhanced by using a top quality tape recorder, transcribing the tape recordings accurately and taking detailed field notes. In a further attempt to increase the reliability of data, the data for each interview was transcribed soon after the completion of the interview, to ensure that the perspective of one research participant did not prejudice the views of another participant and introduce bias to the research being conducted.

3.5.2. Validation

Validation depends on good craftsmanship which entails the continuous questioning, checking and theoretical interpretation of the findings (Henning *et al*., 2004). Craftsmanship in relation to validity refers to the perceived credibility of the researcher and his research, its integrity and credibility based on how the research findings have been checked and examined. Communicative validity refers to whether the research participants agree with the findings whilst pragmatic validity refers to issues of truth and power (Kvale, 1996). Face validity was used in this particular study as the study required detailed accounts of the experiences of the research participants with the UKZN TTO.

Validity in the study was distinctively high due to the extensive period spent on the field interviewing the research participants, ensuring detailed descriptions of information and the critical validation of the research participants' accounts. Upon completion of this study, the findings will be published as it is anticipated that communication of the findings to the public domain will further validate this study. This view was proposed by Henning *et al*. (2004) who argued that validity is able to emanate from the ability to get your ideas accepted and to publish them for even broader communication. To further strengthen the validity of the study, the respondents were selected on the basis of their expertise in the area of TT and are considered to be experts in the field.

3.6. ETHICAL CONSIDERATIONS

Research ethics refers to the manner in which researchers treat the participants in their study and how the researcher handles data after it has been collected (VanderStoep & Johnston, 2009). Leedy and Ormrod (2010) described ethics as falling into one of four categories, namely "protection from harm, informed consent, right to privacy, and honesty with professional colleagues".

Hennink *et al.* (2011) confirmed the ethical factors proposed by Leedy and Ormrod (2010) and in addition the factors of beneficence and justice are also considered. Beneficence ensures that the research is shown to benefit wider society whilst the ethical factor of justice ensures that research procedures are administered in a fair and non-exploitative manner. These factors were taken into account during the

course of the study. The researcher ensured sensitivity and empathy when the participants had to discuss personal experiences and challenges. Furthermore, the researcher did not divulge the confidential information that was received from research participants, or issues that were covered. A gatekeepers letter (Appendix 3) was also obtained from the Registrar of UKZN which indicated that the researcher obtained consent to conduct the study at UKZN and to use inventors from UKZN as research participants.

3.7. TECHNIQUES FOR ANALYSING AND INTERPRETING DATA FROM QUALITATIVE STUDIES

Interpretation is required for qualitative data, as the information received does not speak for itself (Denzin & Lincoln, 1994). Qualitative interpretations are constructed by the researcher, and are not inherent in the interview texts. Therefore, the role of the researcher as an “interpreter” is quite significant and should be performed in a manner that allows the reader to understand the phenomenon that is under investigation. This view is confirmed by Schram (2003) who stated that qualitative fieldworkers not only gather or generate ‘facts’ from respondents on what happened, instead they also engage in an active process of interpretation. According to Patton (2002) and Neuman (1997), “the goal of qualitative data analysis is to uncover emerging themes, patterns, concepts, insights, and understandings”. In addition to this, Neuman (1997) also mentioned that in this process the researcher may “develop new concepts, formulate conceptual decisions and examine relationships between concepts”. The researcher in this study noted the importance of her role as an interpreter and ensured active participation in the interviews in order to interpret the responses of the respondents in a manner that represented the correct facts and a manner that was free from bias.

Researchers have the ability to code qualitative data into conceptual categories by using qualitative techniques.

For the purposes of this study content analysis was chosen as the qualitative technique for the analysis of the research data. Content analysis is typically conducted on forms of human communication (Leedy & Ormrod, 2010).

According to Henning *et al.* (2004), content analysis is the preferred choice of researchers due to easy accessibility and the fact that it works on one level of meaning. However, it may unfortunately lead to "naïve or superficial findings as it captures what is presumed to be the real world through the eyes of the research participants" (Henning *et al*., 2004).

The researcher commenced with a set of data, derived from a transcribed interview (Henning *et al*., 2004). Thereafter, the data was transcribed into a written version. According to Henning *et al*. (2004), this is a highly interpretative process of inductive making of meaning, and is preceded by a process that is more technical and involves the conversion of spoken works into a written language.

Creswell (2009) described a data analysis spiral that can be applied in the analysis of qualitative research. The spiral is closely linked to the steps taken during content analysis. Figure 3.1 is a graphical representation of the spiral which illustrates the manner in which qualitative data can be analysed and interpreted.

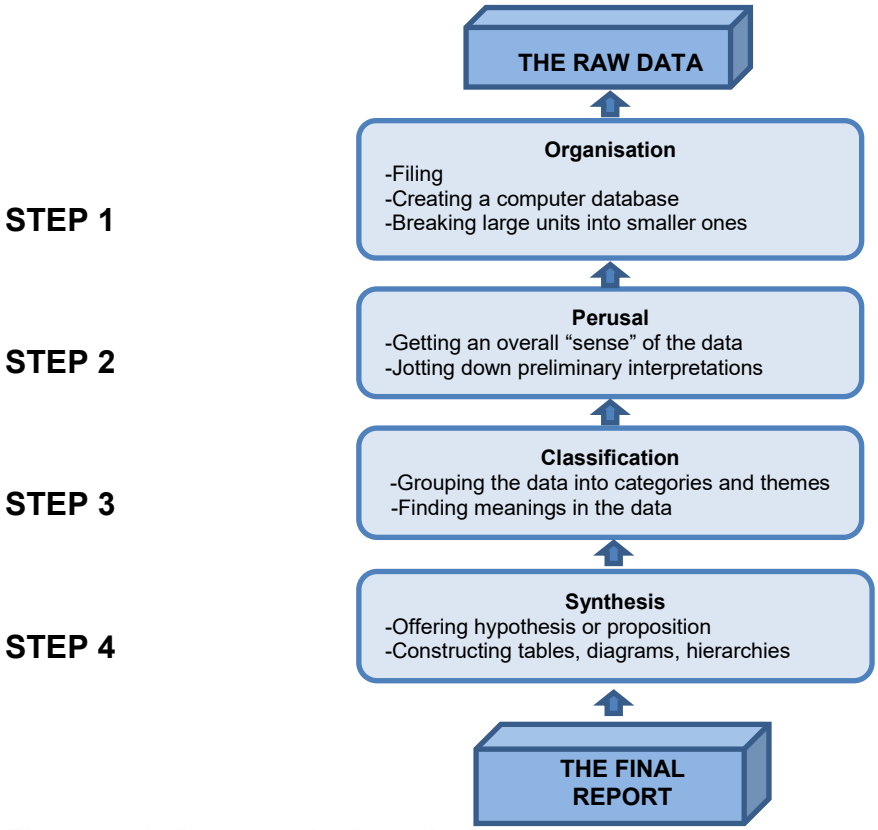

Figure 3.1: Data analysis spiral

Source: Adapted from Creswell, J.W. 2009. *Research Design: Qualitative, Quantitative, and Mixed Methods Approach.* 3rd ed. Sage Publications, Thousand Oaks.

Henning *et al*. (2004) suggested that wide margins should be catered for as they allow for writing down of codes and notes. The analyst then reads through the entire document and gets an overview of the content. Thereafter, the themes will be observed, however the coding process does not begin (Henning *et al*., 2004). The researcher did follow this advice and ensured that there was a wide margin on the note book in which notes were written down during the interview, so that certain aspects and themes could be highlighted in the margin. Codes are selected according to what the data means to the researcher, therefore an overview of as much of the contextual data is important prior to attributing formal meanings to a single unit (Henning *et al*., 2004). This process is illustrated in Figure 3.2 below

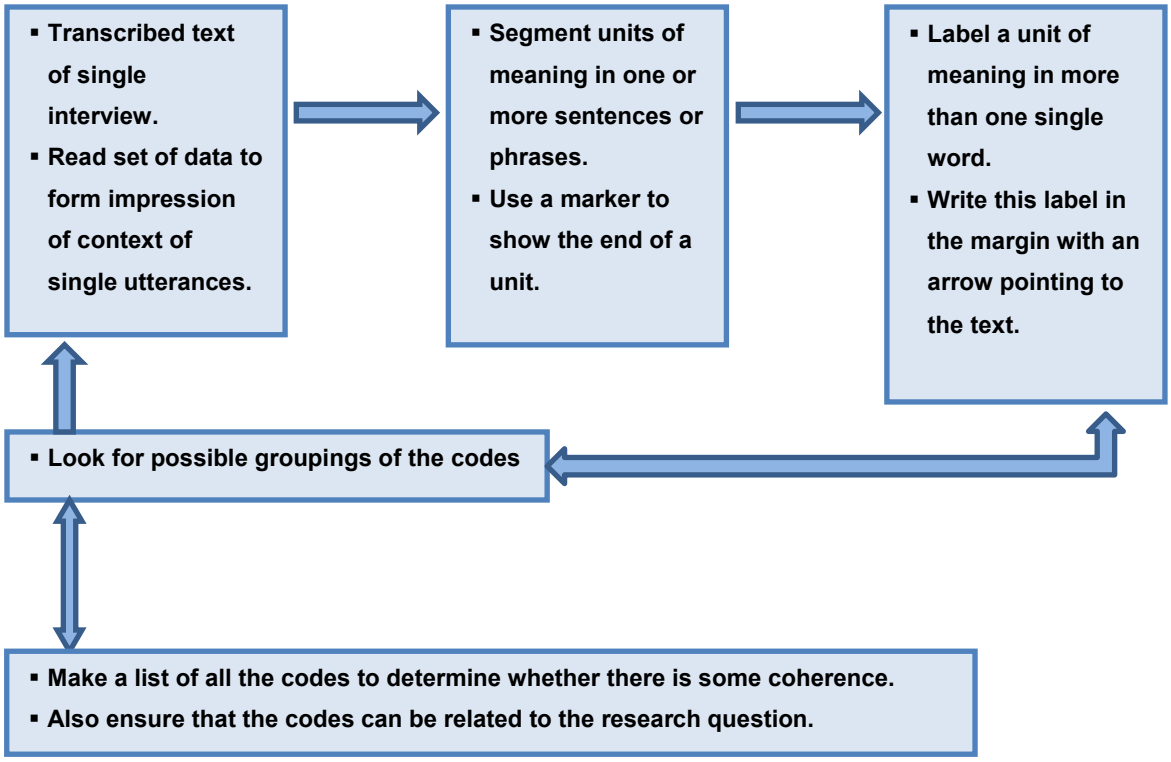

Figure 3.2: Coding from texts

Source: Adapted from Henning, E., Van Rensburg, W., & Smit, B. 2004. *Finding Your Way in Qualitative Research*. Van Schaik Publishers, Pretoria.

Figure 3.2 illustrates how transcripts of scripts can be reread to identify units of meaning, however, it is important not to remain fixed on one section of the text that the researcher is coding, as the meaning may only become clear later in the interview notes (Henning *et al*., 2004). The researcher ensured that the interview

transcripts were viewed holistically and read the notes repeatedly to ensure that the correct meaning was taken into account, and to avoid bias. The researcher also listened to the tape recorded interview more than once to ensure that information was correctly translated into handwritten notes.

Construction and selection of codes:

Open coding refers to codes that are generated as the researcher works through the data. A researcher is more competent in labelling the units of meaning when he/she is familiar with the contents of the data. As soon as the transcription is ready and codes have been assigned to the various segments or units of meaning, the relevant codes can then be categorised (Henning *et al*., 2004). The researcher was able to code the data as soon as the contents of the data were reread and understood. The researcher thereafter categorised the various codes. Categories are able to indicate the themes that will be emerge from the data which will be used in the discussion of the study.

Once the entire transcript data is categorised into minor and major categories/themes, a review must be conducted to ensure that the information is categorised as it should be. All the categories must be reviewed to ascertain whether some categories can be merged or if some need to them be sub-categorised. Henning *et al.* (2004) stated that as soon as the researcher is satisfied that the themes represent a "reasonably sized research chunk" of reality, then each theme can be used in the study as a basis for an argument upon which a discussion can take place. 'Findings' result from themes which have been discussed and argued to make a point, the point in question comes from the research questions (Henning *et al*., 2004). Once the researcher had allocated codes and categories, she was thereafter able to merge some of the categories and also sub-categorise. The researcher was also able to synchronise the themes with the research objectives that needed to be met.

3.8. SUMMARY

Chapter 3 has articulated the research methodology and research paradigm that was applicable to this study. The qualitative method was selected as it was found to be the most suitable method for this study. The size of the sample was

appropriate for the study as research participants were able to provide their first hand experiences with the UKZN TTO, proving deeper understanding and insight of the manner in which TT is implemented at UKZN. The data collection methods as well as the selected research instrument allowed for the collection of credible data for this study. The various procedures for data processing and analysis ensured the presentation of the results in an objective manner. The selected techniques and methods outlined in this chapter were deemed to be appropriate for gathering data for the study. Chapter 4 will detail the presentation and discussion of the research results obtained from the interviews that were conducted.

CHAPTER 4
ANALYSIS AND DISCUSSION OF RESULTS

4.1. INTRODUCTION

The aim of the study was to identify the challenges faced by UKZN's TTO in generating income from the successful commercialisation of its inventions. This chapter analyses, interprets and presents the primary data that was collected from the research participants (inventors) at the UKZN. The chapter begins by outlining the demographic profile of the research participants and thereafter focuses on the findings related to each objective of the study. Concepts and discussions as presented in Chapter 2 in the literature review have been used to validate the research findings of this study, where applicable.

4.2. DESCRIPTION OF THE RESPONDENTS

The purpose of this section is to discuss the quality and the credibility of the sample that was chosen by the researcher.

4.2.1. Sample size

The sample size chosen for this study consisted of eight research participants. The expertise of the research participants is represented in sub-section 4.2.2.4 and is indicative of the quality of research participants chosen. There is no set sample size for qualitative research. However, generally the sample consists of six to eight people especially when large amounts of data are collected (Bineham, 2006). There is often a misconception that "generalizability is the ultimate goal of all research" (Marshall, 1996). An appropriate sample size is one that is able to adequately answer the research questions and could be in single numbers. The sample size chosen for this study consisted of eight research participants and theoretical saturation was observed after six interviews had been conducted. Sekaran and Bougie (2013) stated that "theoretical saturation is reached when no new information emerges on the subject in repeated cases". It is impossible to determine when theoretical saturation will be reached, however, in this study it was evident to the researcher especially when no new information was received after conducting six interviews.

4.2.2. Summary of demographics

4.2.2.1. Gender

The survey sample composed of one female and seven males as represented in Figure 4.1 below.

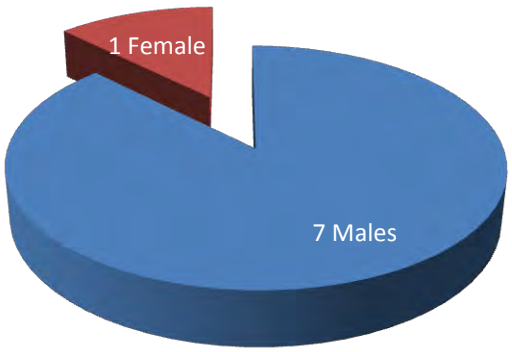

Figure 4.1: Gender distribution of research participants

The high skew towards males indicates the dominance of male inventors over female inventors at UKZN in the IP portfolio, which consists of approximately 42 inventors.

4.2.2.2. Race

Overall, the ethnic composition of the sample was one White, one Indian and one Black. This is representative of the IP portfolio of UKZN-InQubate which is dominated by the White race, as depicted in Figure 4.2 below.

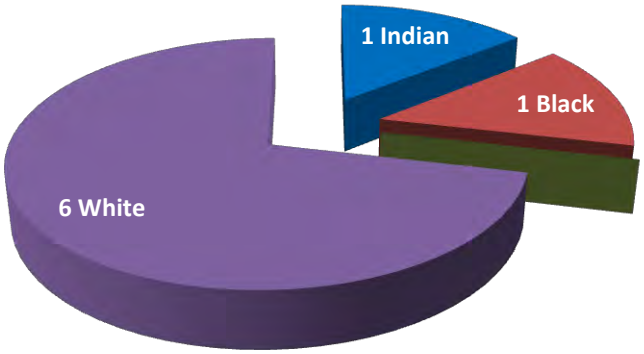

Figure 4.2: Race of research participants

4.2.2.3. Age

Figure 4.3 represents the age groups of the research participants. One inventor fell in the age group of 30-39 years whilst there were two inventors in the category 40-49 years, three inventors in the category 50-59 years and two inventors in the category 60-69 years. This is indicative of the maturity level of the inventors.

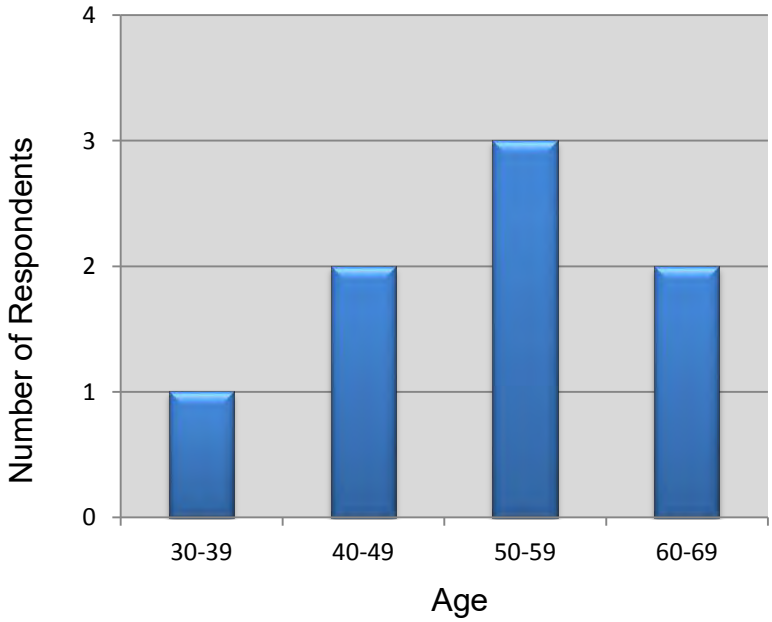

Figure 4.3: Age of research participants

4.2.2.4. Employment level

Figure 4.4 represents the employment rank of each of the research participants at UKZN. The diagram indicates that the majority were professors, followed by senior lecturers and then senior professor. This indicates that the chosen research participants are senior skilled employees at UKZN and have the ability to participate in the study from a qualification and experience perspective.

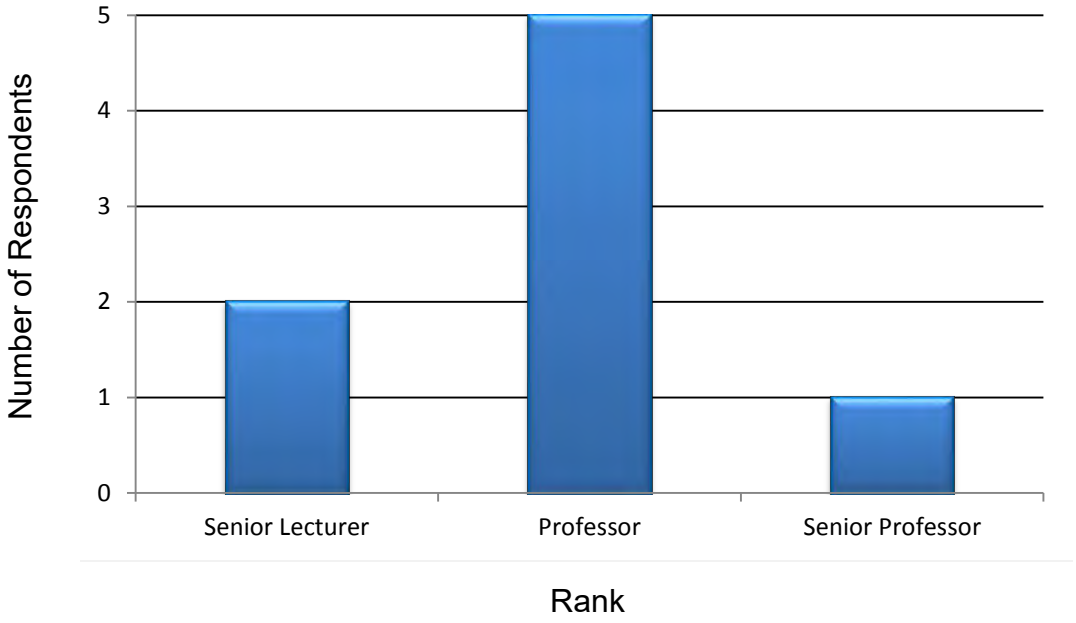

Figure 4.4: Rank of research participants

4.3. INTERVIEW SCHEDULE AND INTERVIEW

The interview schedule (Appendix 1) was distributed to the participants one week prior to the interviews. This schedule served as a guide as the interviews progressed. The interviews were conducted in a setting which was chosen by the research participant to ensure that the participant was comfortable during the interview. The majority of the questions asked were open-ended which allowed the participant the freedom to answer in a manner that suited their interpretation of events. This allowed the researcher the opportunity to probe further and uncover "the behavior, beliefs, opinions and emotions from the perspectives of the research participants" (Hennink *et al*., 2011).

4.4. OBJECTIVES OF THE STUDY

Questions were designed with the intention to reach a finding for each objective that was identified. Each objective and its corresponding questions were explained independently of each other. Graphical analysis was used to represent some of the findings in circumstances where it was found to be appropriate.

4.4.1.1. Objective one: To identify the experiences that inventors faced whilst working with the TTO

The first objective of the study was to identify the experiences that inventors faced whilst working with the TTO. This provides the key to understanding the relationship that the inventors have with the TTO.

It was necessary to firstly understand how the inventors became involved in TT activities at UKZN. To ascertain this background information, the question asked was: *"Describe the position that you are employed in and how you became involved in TT?"*

The data collected from the eight respondents showed that all the respondents were advised to contact the TTO by different sources when they realised that their research contained intellectual property that needed to be protected. Respondent 1 indicated that he had invented a few inventions and requested the TTO to assist him in commercialising his inventions. Respondent 5 on the other hand indicated that academic staff are encouraged to generate journal papers at UKZN and there was also a drive to encourage staff to produce patents and this is when he contacted the TTO.

To explore the first objective further, a secondary question was asked: *"Describe the experiences that you had with the UKZN TTO".*

The responses to this question varied drastically due to four out of the eight respondents indicating that they had positive experiences with the TTO, whilst the remaining four respondents indicated that they had negative experiences. The data was analysed and grouped into the following themes:

a. *Location of TTO staff*

Respondent 1 stated that the TTO staff had not visited the campus that he is based in. He further stated that the TTO is located on the Howard College Campus which does not help inventors based at another campus. He advised that there needs to be an increased presence of UKZN TTO staff at all campuses.

b. *TTO staff*

Respondent 2 indicated that he had a good experience with the UKZN TTO and he found the office staff to be very pro-active and commended UKZN on creating awareness and creating the framework which facilitates TT activities. Respondent 1 on the other hand stated that none of the TTO staff had contacted him since UKZN-InQubate had been formed.

c. *Efficiency of the patenting process*

Respondents 5, 7 and 8 indicated that they were happy with the efficiency of the patenting process at the TTO. Respondent 8 further stated that the patent attorney that was responsible for the filing of the patent application was very skilled and very helpful. Respondent 7 also stated he was happy about the way in which the patenting aspect of his invention had been conducted as it was a smooth process and he received the necessary support from the TTO staff.

d. *Duration of the TT process*

According to respondents 3 and 5 it takes too long for anything to be done by the UKZN TTO. Respondent 3 highlighted that there had been severe delays in registering a company for one of his projects and there had also been extreme delays in processing documents that are required for the patenting aspect. Respondent 5 stated that he was aware that patents take a while to be processed, however, when it comes to spin offs, decisions need to be made quickly and he had experiences where decisions could not be taken as there was no one available to make executive decisions. He further stated that spin-off companies operated as a business and therefore cannot wait long periods for a decision to be made.

e. UKZN TTO model

Respondent 4 highlighted his preference for the previous model of TT that was used, in which a separate company called UKZN Innovation commercialised the inventions emanating from the TTO. He advised that that was a better model compared to the current model in which TT and commercialisation is performed in one unit. He stated that since the company had been dissolved not much has happened at the TTO in respect of commercialisation.

The last question that was asked to explore the first objective was: *"Have you encouraged your colleagues to contact the TTO when they had a potential invention to protect?"* The researcher designed this question to establish whether the respondents truly believed in the TTO, enough to recommend others to use their services. Table 4.1 illustrates how likely the inventors are to recommend the services of the UKZN TTO to others.

Table 4.1: Recommending the UKZN TTO to colleagues

Respondent	Have you encouraged colleagues to contact the TTO?	
	Yes	No
1		♦
2	♦	
3	♦	
4	♦	
5		♦
6		♦
7	♦	
8	♦	

It is evident from Table 4.1 that five out of eight respondents indicated that they are likely to recommend the UKZN TTO to their colleagues. Respondent 2 stated that he had advised his colleagues during board meetings to meet with the TTO to

discuss their potential inventions. He also advised that he had invited the staff from the UKZN TTO to conduct presentations on the role of the TTO which was well received by other staff members. Respondent 7 highlighted that he had been involved in marketing the TTO and he had used the college open days as an avenue to encourage colleagues and students to contact the TTO to file patents and obtain advice on IP issues. However, the remaining three respondents were not optimistic about the TTO and Respondent 1 advised that the reason that he did not promote the TTO is based on the fact that the TTO were unable to assist him in the manner that he required. Respondents 5 on the other hand stated that his colleagues worked in silos and very seldom do they get an opportunity to discuss their research and developments with each other. Respondent 6 stated that he did not have time to encourage others to use the TTO as he was busy with his work as well as concentrating on his own project. He further stated that it should be obvious to people that they should contact the UKZN TTO when they require assistance with inventions.

4.4.1.2. Discussion of objective one

The responses received in respect of Question 1 are indicative that the respondents have different feelings towards to the TTO. Whilst half of the respondents are happy with their interactions with the TTO, the other half seemed upset with the experiences that they had with the TTO.

It is clear from the results that the majority of the respondents recommended the TTO to their colleagues. This is indicative that the respondents see value in the services provided by the TTO and understand the importance of having a TTO at UKZN.

4.4.1.3. Objective two: To establish whether the TTO is providing sufficient resources to facilitate the TTO process

The second objective of the study was to establish whether the TTO is providing sufficient resources to facilitate the TTO process. This objective highlights the appropriateness of the available resources to fulfil its mandate at UKZN.

To gather this information the question asked was: *"Do you think that the TTO is equipped with resources to facilitate the TTO process and fulfil its mandate?"*

(Table 4.2).

Table 4.2: Availability of resources at the TTO

Respondent	Do you think that the TTO is equipped with resources to facilitate the TTO process and fulfil its mandate?		
	Yes	No	Unsure
1		♦	
2		♦	
3		♦	
4		♦	
5			♦
6		♦	
7			♦
8			♦

It is evident from Table 4.2 that the majority of respondents agreed that the TTO is not equipped with resources to facilitate the TTO process and fulfil its mandate.

The following themes emerged from these results:

a. *Lack of funding*

Half of the respondents highlighted that the lack of funding from the TTO is a serious problem and hinders the TT process. They stated that the TTO does not have sufficient funding to allow the inventors to participate actively in TT activities. Respondent 8 highlighted the fact that the TTO generally assists with the patenting aspect of the TT process; however, the problems arise when funding is required for the commercialisation aspect as the TTO then states that they do not have sufficient monies to assist. Respondent 6 stated that the TTO never has money but they do possess skills and knowledge which they use to assist in the TT process.

b. *Lack of commercialisation experience*

The majority of the respondents agreed that the TT staff lacked commercialisation experience and although the first aspect of the TT process went smoothly, they did not see much development in the second aspect which is the commercialisation aspect. Respondent 4 stated that it appeared as if the TTO staff just had legal expertise and "I doubt that they have any expertise in licensing and commercialisation". Respondent 8 confirmed the views of Respondent 4 and further stated that she does not think that the expertise of the TTO staff is sufficient to cater for the diverse areas of speciality that inventions emanate from. Other respondents also confirmed that there is a lack of technical expertise at the TTO and that the TTO should employ staff that are discipline specific.

c. *Lack of awareness and visibility of the TTO*

Respondents 2 and 5 highlighted that there needs to be increased visibility of TTO staff at the different campuses and that there has to be increased awareness of the process of TT and the role of the TTO.

The remaining respondents stated that they were not in a position to comment on the resources of the TTO, as they had only experienced the patenting process with the TTO and did not get to a stage where they were involved in commercialisation, hence they couldn't advise on the availability of resources for the whole process.

To explore the second objective further, a secondary question was asked: *"Do you think the TTO is providing sufficient resources to its researchers to enable them to participate more actively in TT?"* Being an open-ended exploratory question the responses received varied.

Table 4.3 illustrates the results on whether the TTO is proving sufficient resources to the researchers to enable them to participate more actively in TT.

The evidence presented in Table 4.3 shows that the majority of respondents were not provided with sufficient resources from the TTO.

Table 4.3: Provision of resources to researchers by the TTO

Respondent	Do you think the TTO is providing sufficient resources to its researchers to enable them to participate more actively in TT?	
	Yes	No
1		♦
2	♦	
3	♦	
4		♦
5		♦
6		♦
7		♦
8	♦	

A few of the major themes that emerged from analysing the responses from this question are listed below and explored in detail.

a. Funding concerns

The major concern that the respondents had was the availability of funding at the TTO for them to successfully participate in the TT process. Respondent 1 stated that he had to fund two of his patents as he did not receive funding from the TTO, and inevitably these patents lapsed and did not proceed to commercialisation. He further stated that the mandate of the TTO is not achievable as it appears as if the TTO only wishes to protect patents but does not want to invest funding in the commercialisation of the invention or become embroiled in litigation relating to patents. Respondents 4 and 6 confirmed this by stating that in the patenting process the inventors are supported by the TTO and the inventors are provided with sufficient resources. However, as soon as the project reaches the stage of commercialisation they are requested to look for alternate sources of funding from investors or potential partners, as the TTO does not have sufficient funding. Respondent 5 advised of a situation in which he requested monies from the TTO

so that he could develop a prototype of his invention and even though the monies were initially promised to him, he never received the monies. Respondent 7 stated that if there were more monies available at the TTO then students will be encouraged to conduct research activities at UKZN instead of leaving to work in industry without completing their postgraduate studies. Another respondent expressed his concerns that if his invention led to a Spin-Off Company being formed, the TTO might not be able to fund the Spin-Off Company in the conception phase and employ people and this will result in the Spin-Off Company failing before being properly established.

b. Expertise concerns

Respondents also expressed their concern in respect of the expertise of the TTO staff members. Some of the respondents felt that they did not receive any advice on how to participate in TT. They said it would be helpful if they were guided by TTO staff on how to align their project with the needs of the industry and specific advice on what they should do to ensure that they are able to successfully commercialise their inventions.

c. TTO staff engagement with inventors and industry

The respondents emphasised the need for the TTO staff to engage more actively with them. One of the respondents mentioned that they wanted the TTO staff to be able to contact them and give them advice on their patent as well as introduce them to potential investors. They further emphasised the importance of the TTO staff engaging with industry and establishing the needs of the industry so that there can be an alignment between the inventor's inventions and industry needs. Another respondent mentioned that there is a serious delay in communication from the TTO staff with the inventors and that there has to be some sense of urgency applied especially when the invention is ready for commercialisation.

The remaining respondents were of the view that they were provided with resources that were sufficient to participate in TT. It is important to note that these respondents were still in the patenting phase of TT and had not yet had any experiences with the TTO in respect of commercialisation. Respondent 3 stated that the TTO is doing as much as they can with the resources that they have and that they have the correct channels in place to facilitate TT. Respondent 8

confirmed this view and further stated that the TTO was resourceful in securing a grant to fund their project from a Government Agency and that the TTO also provided them with advice on how to carry out TT activities in respect of their project.

The last question that was asked to explore the second objective was: "*In your opinion is UKZN's benefit sharing incentives encouraging you to engage more actively in technology transfer activities*?"

The majority of the respondents were happy with the benefit sharing incentives offered by the TTO. These respondents stated that they agreed with the ratio of benefit that is afforded to the inventors when the invention is commercialised. However, they also stated that no inventor has received this incentive yet and they had not heard of any successful commercialisation by the TTO. Two respondents stated that the benefit share is in line with the IPR Act and this is the reason that they were happy with it. Respondent 8 was concerned that even though it is a good incentive it will be very difficult to obtain this incentive, especially due to the bottlenecks that are often experienced by inventors in the commercialisation process at the TTO.

Two of the respondents were of the opinion that the benefit sharing incentive is not fair as it should be dealt with on a case by case basis. In their opinion, this will ensure that the TTO actively participates in commercialisation activities.

4.4.1.4. Discussion of objective two

The analysis of data revealed that the majority of the respondents did not believe that the TTO had sufficient resources to facilitate TT. The areas in which the TTO was found to lack resources were in funding, commercialisation experience and publicity of the TTO. The importance of these resources were amplified in the literature review by Owen-Smith and Powell (2001) who stated that many TTOs lack the competencies and resources which are often required for technology transfer activities.

The analysed data revealed that the majority of respondents felt that they were not provided with sufficient resources in the TT process and the areas of concern were

the lack of funding, the expertise of the TTO staff and the limited engagement of the TTO staff with the inventors and industry. Wolson (2007a) in the literature review confirmed the struggle experienced by TTOs to secure budgets for technology transfer activities. The literature review also set out the importance of hiring personnel in the TTO that have the skills necessary to protect and commercialise IP. The third area of concern was that there is limited interaction of the TTO with industry and the inventors. This view is consistent with that mentioned by Teng (2010) in the literature review in which the importance of co-operation between the industry and the TTO was emphasised. Teng's views were supported by Cohen *et al*. (1998 as cited in Muscio, 2009). It is deducted from the literature that technology transfer may not flourish in UKZN's TTO if the TTO lacks skill in fostering and managing relationships with industry.

The findings revealed that the majority of the respondents were happy with the benefit sharing incentives offered at UKZN. The importance and benefits of incentives are emphasised in the literature by Raine and Beukman (2002 as cited in Hoye, 2006) in which they explained that when benefit sharing revenues are split the parties involved in the process are winners when the technology is commercialised. Furthermore, receiving incentives is also an incentive for the inventors to participate in technology transfer activities at UKZN.

4.4.1.5. Objective three: To ascertain whether UKZN's IP Policy is enabling TT

The third objective of the study was to ascertain whether UKZN's IP Policy is enabling TT. This would be a key aspect to understanding whether the mandate of the UKZN TTO is aligned with the Commercial Initiatives Policy and the UKZN IP Policy. The mandate and business model of the TTO along with the understanding of the TT policies are pivotal to the TT process and must be understood by researchers if they wish to successfully participate in TT at UKZN.

It was necessary to firstly understand whether the IP Policy and Commercial Initiatives Policy were easily accessible to the researchers of UKZN and whether they enabled technology transfer at UKZN. To ascertain this information the question asked was: *"Are the UKZN IP Policy and Commercial Initiative Policy enabling TT at UKZN and are these policies easily accessible to the researchers?"*

The results showed that the majority of respondents were not aware of the IP Policy and the Commercial Initiative Policy. The themes that emerged were as follows:

- Policies were difficult to understand
- Policies were too long
- Policies were not consistent with each other

Four out of the six respondents indicated that they had heard of the policies but never read them. Respondent 5 stated that he had heard of the policies but had not seen the importance of reading them as he always puts his faith in the Research Office to enlighten him on areas that are of importance to him.

However, three of the respondents indicated that they were aware of the policies and had read them. Respondents 2 and 8 indicated that the policies were easily accessible and Respondent 2 stated that the IP Policy was circulated to staff and also made available on the school's website. He further advised that staff members from his school also had intense discussions on issues surrounding the policy and also discussed the issues of the policy with the TTO.

Respondent 4 on the other hand, explained that even though he had read the policies he did not feel that the policies enable technology transfer. He further stated that "these policies must be user friendly and as simple as possible, as they are currently too long and difficult to understand".

Respondent 3 felt that the policies were inconsistent with each other and this is what caused confusion in respect of the TT activities undertaken at UKZN. He further stated that the policies must be redrafted so that they align with each other and thereafter will be in a position to enable TT at UKZN.

To explore the third objective further, a secondary question was asked: *"Do you think that the mandate and business model of the TTO are clear, achievable and consistent?"* Being an open-ended exploratory question, a large selection of responses was received (Table 4.4).

Table 4.4: The mandate and business model of the TTO

Respondent	Do you think that the mandate and business model of the TTO are clear, achievable and consistent?		
	Yes	No	Unsure
1		♦	
2		♦	
3		♦	
4			♦
5			♦
6	♦		
7			♦
8			♦

The majority of respondents could not answer the question as they were not aware of the mandate and business model of the TTO.

The one respondent who answered yes to the question believed that researchers at UKZN did not have the competence to carry out TT activities on their own and this is why the TTO is so important. Respondent 4 felt that although the mandate and business model of the TTO was clear, achievable and consistent, the TTO needed to provide more guidance to the researchers to show them how to fulfil this mandate.

Three of the respondents felt that the mandate and business model of the TTO were unclear, unachievable and inconsistent due to the following reasons:

- Some of the researchers were unaware of the mandate and business model of the TTO as it has changed on many occasions.
- The mandate and business model were unachievable as the TTO does not have the staff resources and monetary resources to facilitate TT at UKZN.
- There is no successful commercialisation of a project emanating from the

TTO so there is no proof that the mandate and business model of the TTO are working.

- There is insufficient information publicising the mandate and business model of the TTO which results in people being unfamiliar with the TT process.
- There is inconsistency in the various documents outlining the TT process at UKZN.
- The mandate and business model have been changed so many times and the changes needed to be communicated correctly.

4.4.1.6. Discussion of objective three

The analysis of data revealed that the majority of the respondents were unaware of the contents of the policies, whilst the remaining respondents were not happy with the contents of the policies. The accuracy and contents of these policies are crucial to the successful implementation of TT at an institution. It is clear that these policies have not been implemented in the correct manner at UKZN. Hockaday (2009) emphasised the importance of an IP policy in the literature review and stated that a clear policy is required especially to set out the rules and regulations of the TTO and to do it in an unambiguous manner. It is clear from the results that this is not being done effectively at the UKZN TTO. Hockaday (2009) further stated that confusion will exist when the policy fails to contain clear terms on the TT process.

Furthermore, most of the respondents advised that they were not aware of the mandate and business model of the TTO, whilst three advised that they did not think that the mandate and business model were clear and consistent, and one respondent answered that the mandate and business model were clear and consistent. These results were alarming especially due to the importance of the mandate and business model of the TTO and the role it plays in the TT process at UKZN. The business model of the TTO sets out the manner in which TT will be carried out UKZN and is crucial to the effectiveness of TT implementation at UKZN. The literature review explains the importance of defining the mission of the TTO and authors Warren *et al.* (2008) highlighted the importance of the mission of the TTO and how it needs to be aligned with the broader goals of the institution.

4.4.1.7. *Objective four: To establish the competence of UKZN's TTO staff in facilitating the TT process*

The fourth objective of the study was to ascertain whether the UKZN TTO staff are competent in facilitating the TT process.

This would be key to understanding whether the TTO staff are equipped with the expertise necessary to fulfil the mandate of the UKZN TTO.

To ascertain this information the question asked was: *"Kindly provide your opinion on the competence of UKZN management and TTO staff in facilitating the TT process?"* (Table 4.5).

Table 4.5: Competence of staff and management of TTO

Respondent	Kindly provide your opinion on the competence of TTO staff in facilitating the TT process?		
	Experienced	Narrow Expertise	Inexperienced
1		♦	
2	♦		
3			♦
4		♦	
5	♦		
6	♦		
7	♦		
8		♦	

Table 4.5 indicates that the majority of the respondents found the TTO staff to be experienced in TT. Respondent 2 stated that "the TTO staff are competent and they know what they were doing in the TT process". However, he suggested that UKZN is a huge institution and there should be complementary staff available to provide focused attention to the diverse disciplines. Furthermore, Respondent 2 stated that there is also a high turnover of staff at the TTO and these staff members were competent in the TT process. Respondent 5 stated that he could not criticise the competence of the TTO staff at present but said that it would be

beneficial to employ more discipline-focused staff.

Respondent 3 was the only respondent that indicated that the TTO staff are incompetent in fulfilling their duties at the TTO. Respondent 3 stated that “the TTO staff are inexperienced as they do not have sufficient years of experience in TT, they lack actual hands on experience of taking a project to market and commercialising the invention thereafter”.

Table 4.5 also indicates that three out of eight respondents found that the TTO staff had narrow expertise in TT. The respondents provided the following reasons to justify their answer:

- The TTO staff have narrow expertise and do not have the full spectrum of commercialisation expertise that is required.
- They do not understand the value chain of innovation and what is required to go from invention to innovation.
- TTO staff are proficient in the patent protection aspect of TT, however, they are lacking in commercialisation skills which is a serious downfall in the TT process.

Only five respondents discussed the competence of management in facilitating TT at UKZN. Four of the respondents advised that management was incompetent in facilitating TT at UKZN. One of the respondents stated that “it is unfortunate that most of management do not understand TT, innovation and commercialisation to the extent that they should in order to make decisions on TT”. Another respondent stated that although management was competent in facilitating TT, they are not interested in the manner in which TT is implemented at UKZN. It is important for the UKZN TTO to have someone in management that is well acquainted with TT. Another respondent felt that they would be more confident if management had personal experience in commercialisation of inventions as this would encourage researchers to participate more actively in TT activities and seek the guidance of management.

4.4.1.8. Discussion of objective four

It is clear from the results that there needs to be a change in the TTO staff and

management which will contribute towards improving the effectiveness of the office. The results show that the majority of the respondents are not confident in the abilities of the TTO staff and management in facilitating the TT process. This supports the findings of the literature review in which Metz *et al.* (2000) and Siegal *et al* (2004) mentioned the importance of employing TT staff with the correct skill set. Wolson (2007a) also confirmed the importance of employing the correct personnel and stated that there is a shortage of experienced technology transfer practitioners.

4.4.1.9. Objective five: To identify the challenges that inventors experience during their participation in technology transfer activities at UKZN.

The fifth objective was aimed at identifying the specific challenges that inventors experience when participating in TT activities at UKZN. The aim of the question was to discover what problems inventors are experiencing during their engagement with the TTO so that these challenges can be addressed.

The first question asked to ascertain this information was: *"Describe the challenges that you have experienced or you are currently experiencing during your participation in TT activities. How were these challenges addressed?"* Being an open-ended exploratory question, a large selection of responses was received.

Three major themes emerged from analysing the responses received from this question, namely HR challenges, operational challenges and financial challenges. These themes are explored in detail below.

α. Human resource challenges

The respondents experienced challenges in respect of their involvement with TT staff and their respective management.

The following sub-themes emerged which highlighted the specific HR challenges in detail:

- High staff turnover

  Many of the respondents found the high staff turnover at the TTO to be problematic. Respondent 4 stated that "the people in the TTO change so quickly that as soon as you start explaining your situation to one of the staff

the next day that person has resigned and you have to start the whole process again and start explaining the situation from scratch". The respondents further stated that the handover process is not very good when a person resigns because often the new people do not know anything about the project and this makes it difficult to continue with the next step in the process as much time is taken by the new person to find out exactly what has transpired thus far. Another respondent stated that this results in a lack of institutional memory at the TTO. The respondents also discussed how problematic it is to work with the TTO as there has been no director in the office since last year, and a new director has not been appointed. They advised that this meant that all decisions needed to be made by senior management and this sometimes led to delays in the TT process as management were not acquainted with the details of the project. The high staff turnover also resulted in there being limited staff at the TTO to conduct TT activities which is one of the challenges faced by the respondents as they have limited access to people resources and business expertise.

- TTO staff and management inexperienced in commercialisation

  The results showed that the majority of respondents complained about lack of commercialisation experience at the TTO which has led to many of the projects failing and not being commercialised. One respondent complained that after a patent had been filed for his project, the TTO staff had difficulty putting together a business plan for his project which was required for commercialisation of the project. He further advised that "the TTO staff are inexperienced and although they have the necessary qualification on paper, they lack practical experience in putting together commercialisation models or developing proper business plans which is important for commercialisation".

  Another respondent stated that there is emphasis on getting people with patenting skills and skills in particular areas, and that there should be a focus on hiring staff with business experience and who are able to take the patent to the market and assist in commercialisation. Some of the respondents mentioned that management is not fully aware of what goes into TT and this

is why there is confusion when decisions need to be made in respect of TT. Another respondent mentioned that they required assistance from someone who is acquainted with the different fields that the inventions emanate from, as they face a challenge receiving guidance from staff at the TTO who do not have expertise in the field that the invention emanates from. The respondent further advised that they require more guidance from the TTO on specific areas to focus on in the TTO process and to advise them on amendments that need to be made to their inventions so that the patenting process and commercialisation can be successful.

b. Operational challenges

Another challenge that the respondents experienced involved the operations of the TTO management.

The following sub-themes emerged which highlighted the specific HR challenges in detail:

- Insufficient training in the TT process

  The respondents felt that there was insufficient training provided by the TTO in the TT process. One respondent stated that he was unclear about the full value chain of innovation at UKZN as this was never communicated to him and he was also unaware of what is actually involved from the invention stage to commercialisation. The respondents stated that there have been many changes that were made to the TTO model at UKZN. Initially UKZN had a company called UKZN Innovation that carried out commercialisation of inventions, now the role is fulfilled by UKZN-InQubate, a TTO that is responsible for the whole TT process.

  There have also been many changes made to management and staff at UKZN as well as changes to the TT process, and some respondents felt that they have not been requested to attend training sessions so that they can be educated on these changes. Respondent 5 stated that when he first had his invention he didn't know who to contact and contacted the Research Office who provided him with the details of the TTO.

- Lack of visibility of staff at other campuses

  A few of the respondents mentioned that there is a lack of visibility of TTO staff at their campuses. One of the respondents based at the Pietermaritzburg campus stated that he was unaware of what the TTO staff looked like and that he was never contacted by them for a meeting to discuss his project. Another respondent advised that he is not aware of the expertise of the TTO staff as this was never communicated to him so he never knew who to contact for the different TT processes. Respondent 2 stated that "there needs to be an increased communication and visibility about the TTO, its functions and its processes". Respondent 5 stated that "the office funded my patent initially but other than those monies no other monies were made available and I was forced to obtain resources on my own from external sources".

- Technology transfer process takes too long

  Many of the respondents complained about the TT process taking too long. They stated that UKZN puts a lot of pressure on the inventors and researchers to publish; however, they cannot publish the results of their invention until the patent is filed, and this process generally takes a while. This hampers the publication of results which affects the inventor's research productivity units. Another respondent advised that there is a lot of red tape involved in the TT process. Every decision has to be made by management and management is not involved in the day-to-day activities of the TTO which sometimes leads to deadlines being missed and missed opportunities for funding and collaboration with external parties.

  The respondents also mentioned there are often difficulties in entering into collaboration agreements with external stakeholders on certain projects due to the parties disagreeing on IP issues and it takes years to get over the issues and finalise an agreement. After the lengthy discussions and negotiations the parties are not as enthusiastic as they were initially.

  Respondent 2 was the only respondent that stated that he received more benefit from the TTO and had very few challenges.

c. Financial challenges

The majority of respondents complained about the difficulties they experienced when requesting monies from the TTO for their projects. These challenges are discussed below.

- Lack of funding at the TTO

  Another main challenge faced by the respondents was the unavailability of funding from the TTO. Respondent 2 stated that initially in the patent protection stage finances were provided by the TTO; however, as soon as monies were requested to assist in the commercialisation of the invention he was told that monies were unavailable. Respondent 3 stated that even though there is an unavailability of monies at times in the TTO, he also found that the TTO staff lacked the expertise to leverage funding from other sources. Respondent 6 explained his situation in which monies were obtained from a funder to carry out commercialisation in respect of his invention. He stated that these monies would often come in late which would result in the commercialisation activities being stalled to accommodate the late payments. He further stated that these inefficiencies should be dealt with by the TTO and they should accommodate these types of situations and provide interim monies, etc. Respondent 8 spoke about how he had been promised monies for commercialisation by the former CEO of UKZN Innovation and when he went to UKZN InQubate to get the monies he was told there were no records of monies being promised. Another respondent felt that due to the lack of monies at the TTO he had to stop working on some projects and just focus on the ones that he had funding for.

The majority of the respondents stated that they had addressed these challenges with the TTO staff, however, nothing materialised. One of the respondents stated that they had discussed the challenges with the Research Office; however the Research Office did not understand what he was talking about and therefore could not assist him.

The second question asked to answer the fifth objective was: *"Do you think that these challenges could have been addressed differently to arrive at a suitable resolution?"* (Table 4.6).

Table 4.6: Results on whether challenges could have been addressed differently

Respondent	Do you think that these challenges could have been addressed differently to arrive at a suitable resolution?	
	Yes	No
1	♦	
2	♦	
3	♦	
4	♦	
5		♦
6		♦
7	♦	
8		♦

The results from Table 4.6 show that the majority of the respondents felt that their challenges could have been addressed in a different manner and suggested the following alternatives:

- There has to be a crystal clear understanding (by both parties) of the chain of TT activities that need to take place from the original discovery until commercialisation and sale of the invention.
- The commercialisation skill of the TTO staff and management needs to be enhanced. The necessary training should be provided to enhance existing skills and instil new skills.
- The TTO should create relationships with incubators and other external stakeholders which will benefit the commercialisation process and create a link to industry. These stakeholders should be allowed to assist in developing business plans and/or provide funding for projects.
- Processes should be put in place to ensure that there is some sort of institutional memory at the TTO. There must be a detailed history of all activities that have taken place in respect of each project.

- There should be access to students and funding, which will improve the quality of the invention and assist in the commercialisation process.

4.4.1.10. Discussion of objective five

It is clear from the results that each of the respondents has experienced both similar and diverse challenges with the TTO. These findings are indeed concerning and have significant implications for the successful implementation of TT at UKZN. The challenges identified were grouped into different themes, namely HR challenges, operational challenges and financial challenges. The literature review set out these challenges in detail and the various authors described how these challenges negatively impact on the successful implementation of TT. Mutschler and Graff (2007) confirmed that lack of basic information in respect of IP and TT challenges can result in problems that will inevitably be costly in terms of time, money and opportunity. They further stated that if inventions are incorrectly handled then this could result in failure of the TT process. The literature reviews set out the views of Guldbrandsen and Smeby (2005) as cited in Muscio (2010) who confirmed the recommendation of the respondents that suggested that there needs to be collaboration with industry due to the various benefits associated with it.

4.4.1.11. Objective six: To identify methods to improve service delivery of the UKZN TTO

The sixth objective is aimed at identifying methods that inventors believe will improve the TTO's service delivery.

The two questions that were asked to obtain this information were:

What areas do you think need to be developed at the TTO to increase its effectiveness and your involvement as an inventor?

Is there anything else that you would like to comment on that we may have not discussed?

Being an open-ended exploratory question a large selection of responses was received.

The data was analysed and grouped into the following themes: Human resources considerations, operational considerations and financial considerations. These themes and the respective sub-themes are explored in detail next. The order of the discussion is not a representation of the importance of each consideration.

a. HR considerations

Almost all of the respondents agreed that one of the most important factors that needed to be addressed to improve the service delivery of the TTO was the human resources aspect of the TTO. The main challenge that the respondents experienced involved the expertise of the TTO staff and their respective management. Table 4.7 ranks the suggestions received from the participants in the study.

Table 4.7: HR considerations

What areas do you think need to be developed at the TTO to increase its effectiveness and your involvement as an inventor?								
HR considerations	**Respondent**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Employ staff with TT expertise	♦	♦	♦	♦	♦		♦	
Ensure that staff are present at the different campuses	♦		♦					

The sub-themes that are depicted in Table 4.7 are discussed in detail hereunder:

- Employ staff with TT expertise

  Most of the respondents concurred that there is a need to employ staff at the TTO who have the expertise to carry out all TT activities. The respondents emphasised that expertise in the commercialisation aspect of TT was lacking and that this needed to be remedied to ensure that the inventors have all the resources that they require to engage in successful TT at the TTO. Respondent 1 felt that credible people need to be employed at the TTO so that inventors will be encouraged to communicate with them and seek

assistance from the TTO. Another respondent stated that the director and staff involved in commercialisation must have a proven track record of inventions that they have commercialised. Respondent 4 felt they are not guided on how to commercialise their inventions, and this has caused him to have little faith in the TTO. The respondents agreed that there should be an increase in the staff at the TTO also so that there are sufficient resources to cater for the wide UKZN community. The respondents also believed that the staff employed should have contact with external stakeholders that can contribute to the success of the project and also have expertise in leveraging funding from other sources.

- Ensure that staff are present at the different campuses

  Respondent 1 highlighted the importance of having TTO staff visit different campuses on a regular basis so that they can be present at the different campuses at which inventions are made and interact with the inventors. This view was also proposed by Respondent 3 who stated that “to fully realise the TTO’s full potential the TTO needs to realise that they need to market their office and immerse themselves in the various Schools and Colleges so that academics know them on a first name basis”.

- Staff training

  Respondent 3 highlighted the importance of employing staff with the expertise in TT and stated that service delivery can improve by not only employing staff with the necessary expertise but also by providing existing staff with training which will allow them to acquire the necessary skills that are required. He further stated that it is important to hire external business consultants to teach the necessary business skills that are currently lacking in the TTO.

b. Operational considerations

Almost all of the respondents agreed that many of the processes and operations of the TTO had to be changed or improved in order to improve service delivery. Table 4.8 ranks the operational considerations received from the participants in the study.

Table 4.8: Operational considerations

What areas do you think need to be developed at the TTO to increase ts i effectiveness and your involvement as an inventor?								
Operational considerations	**Respondent**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Increased training and workshops	♦	♦	♦	♦	♦	♦		
Produce a showcase invention	♦	♦			♦	♦		
Regular evaluation of projects		♦						
Effective screening process					♦	♦		
Implementation of TT software for effective communication							♦	
Assist with formation of companies						♦		

The sub-themes that are depicted in Table 4.8 are discussed in detail hereunder.

- Increased training and workshops

  Many of the respondents concurred that they required more training on the TT process and suggested that more training workshops are conducted by the TTO. This will ensure that the university community is familiar with all the TTO processes and will encourage researchers to engage with the TTO. Respondents 4 and 5 mentioned that new staff and students were not aware of the TTO and its purpose and there should be training programmes aimed at educating them. Another respondent stated that the school board meetings are a good place to start with TTO presentations as this is the place that both academics and management are present.

- Produce a showcase invention

  Five out of the eight respondents emphasised the need for the TTO to produce an invention that has been fully commercialised and has been successful so that the invention can be used as a 'showcase invention' to highlight the benefits of engaging in TT activities with the UKZN TTO. The respondents highlighted that the failure of the TTO to successfully

commercialise an invention led them to have little faith in the TT system at UKZN. They felt that a showcase invention can be used as an example which they can follow when engaging in TT. Respondent 1 highlighted that the TTO needs to focus on one invention that will be easy to commercialise and use that invention as the 'showcase invention' when it makes money.

- Regular evaluation of projects

  Two of the respondents highlighted the need for the TTO staff to engage more actively with the inventors on their projects and to conduct regular evaluations on the project. This will ensure that the inventors are updated on each step in the process and can also be given instructions on what they will have to do to assist in the process. Respondent 2 stated that once a patent is registered regular meetings must be conducted with the inventors and the TTO staff so that they can get a proper sense of where the project is and where the project is likely to end.

- Effective screening process

  Respondent 6 highlighted the need for the TTO to have an improved screening process for new inventions that are taken to the TTO for patent protection and commercialisation. This will ensure that proper due diligence is conducted in the initial steps to ensure that monies are not wasted in the future. Furthermore, many patents that lapsed at the TTO lapsed due to the TTO not wanting to commercialise those patents. Therefore, the initial screening process should conduct an evaluation of the project to ensure that it has potential for commercialisation as well. Respondent 5 proposed that a selection committee should be formed to assist in this initial screening process and thoroughly scrutinise the suitability of the new invention for patent protection and commercialisation. The selection committee should consist of the DVC of Research, the Dean of Research for the particular college, two experts in the discipline from which the invention emanates and the Director of the TTO. Respondent 5 further stated that this will prevent wastage of monies on patents that can't be used and will ensure non-biasness in the selection of the project.

- Implementation of TT software for effective communication

Respondent 7 suggested that the TTO should use software which will enable more interaction and communication between the TTO and the inventors. He stated this will also ensure that staff can upload their proposed inventions onto the software and the TTO staff can receive it online and provide quick feedback on it.

- Assist with formation of companies

  Respondent 6 felt that there is a need for the TTO staff to assist with the formation of spin-off companies especially due to this being an important avenue for commercialisation.

c. Financial considerations

The results revealed that the majority of respondents agreed that the provision of funding plays a huge part in the improvement of service delivery at UKZN. Table 4.10 represents the financial considerations received from the participants in the study.

Table 4.9: Financial considerations

What areas do you think need to be developed at the TTO to increase its effectiveness and your involvement as an inventor?								
Financial considerations	**Respondent**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
UKZN to invest monies in the TTO funding	♦		♦	♦	♦	♦		

The sub-theme represented in Table 4.9 is discussed in detail next.

- **UKZN to invest monies in the TTO funding**

Five out of eight respondents agreed that there has to be an improvement in the funding provided by the TTO for projects. Respondent 3 stated that it is important for the TTO to have sufficient funding before they take on new projects, this will ensure that the TTO can afford commercialising the invention. He further stated that it is important for the TTO staff to have the skills necessary to leverage funding from other sources to alleviate the burden of UKZN. Respondent 4 stated

that UKZN should be more aware of the fact that if they want to commercialise they need to provide capital and take some risks. He further stated that most of the projects will fail at commercialisation; however, this is the nature of TT.

Respondent 5 highlighted the need for seed funding which can be used by inventors to develop prototypes and conduct research. He further stated that the Research Office of UKZN needs to put mechanisms in place to ensure that this funding is always available for the TTO to use. Respondent 6 stated that even though the TTO should provide funding for TT activities, they are not obliged to provide funding to everyone and should make business decisions when allocating monies. Respondent 1 stated that successful commercialisation will assist UKZN in generating third stream income; however, they will need capital to do so. Respondent 3 further stated that UKZN needs to create a nurturing TT environment and in time they will reap the benefits.

4.4.1.12. Discussion of objective six

The factors that have emerged from the analysis of objective six, such as HR considerations, operational considerations and financial considerations are consistent with those mentioned in the literature review. The authors Hockaday (2009) , Wolson (2007a), Siegal *et al. (*2004), Metz *et al*. (2000) and Teng (2010) emphasised the importance of employing personnel with the correct skill set so that they can carry out the TT function optimally. In the literature review authors Wolson (2007a), Siegal *et al*. (2004) and Owen-Smith and Powell (2001) confirmed the views of the respondents by highlighting the importance of raising awareness of TT and communicating on the subject of TT with others. Siegal, Waldman and Link (2003) emphasised the importance of TTO staff spending time with academics and inspiring them in the TT process.

Dodds and Somersalo (2007) and Teng (2010) confirmed the importance of conducting regular evaluations of projects as inevitably this will ensure that business decisions are made at the TTO and that monies are not wasted on filing patents that cannot be commercialised.

According to authors Owen-Smith and Powell (2001) and AUTM (2014) in the literature review, it is the duty of TTO staff to assist with the formation of spin-off

companies which is one of the methods that can be used to market inventions. There was no mention in the literature review about the use of a showcase invention as a method to inspire and encourage TT. However, this view was strongly proposed by the respondents to improve service delivery.

The authors Swamidass and Vulasa (2009) and Wolson (2007a) in the literature review confirmed the views of the respondent in respect of the importance of funding in a TTO. Swamidass and Vulasa (2009) confirmed that the shortage of finances will result in commercialisation activities being sacrificed.

The findings under this objective can contribute towards improving the service delivery at the TTO, as the inventors themselves are involved in the TT process and have first-hand experience of the challenges and opportunities that exist.

4.5. SUMMARY

The main findings of the study highlighted many challenges that are being experienced by the inventors in the TT process and have identified many gaps in the TT process. The findings have also identified areas which can be improved at the TTO to assist the TTO in effectively implementing TT at UKZN. Some of the barriers related to the lack of expertise of the TTO staff, the limited training provided by the TTO to the UKZN community, and the lack of financial assistance from the TTO for TT-related expenses. Chapter 5 discusses the results and provides recommendations which will improve the service delivery of UKZN's TTO and assist in implementing TT at UKZN.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1. INTRODUCTION

UKZN is rated as one of the top three higher education institutions in South Africa in terms of research output, and has a diverse patent portfolio which consists of a large number of patent applications. Despite the large investment made in promoting technology transfer activities at UKZN, the TTO has failed to successfully commercialise a single invention since its establishment.

The aim of the study was to identify the factors that affect the implementation of technology transfer at UKZN. The objectives that were designed for this study attempted to assist in identifying and understanding these factors in order that the researcher could identify the barriers that are faced by UKZN's TTO in generating income from the successful commercialisation of its inventions. The results of this study are intended to contribute towards eliminating these barriers and successfully implementing technology transfer at the University of KwaZulu-Natal.

This chapter sets out the recommendations based on the findings identified in Chapter 4, the limitations that were identified and also provides recommendations for further research.

5.2. KEY FINDINGS

The research questions, as outlined in Chapter 1 were designed to correspond with each objective of the study.

The results were equally divided in respect of the inventors' experiences with the TTO, with half of the inventors stating that they had had good experiences with the TTO whilst the other half stated that they had had bad experiences. The results also showed that the majority of the respondents were happy with the benefit sharing incentives that were offered by the TTO and found these incentives to be fair and in line with the provisions of the IPR Act. The majority of the researchers stated that they acknowledge that the TTO provided a valuable service to inventors, and they have recommended the TTO to their colleagues.

However, even though the respondents acknowledged the importance of the TTO, they highlighted many challenges that they encountered during their interaction with the TTO. Some of these challenges were lack of funding for commercialisation and other related TT activities, the lack of commercialisation expertise by TTO staff and management, the limited training sessions that are provided by the TTO, the limited publicity of the TTO and its mandate, limited interaction with industry, respondents being unaware of the contents of the IP policy, inconsistency in the IP policy, respondents being unaware of the business model of the TTO, and the non-existence of a showcase invention.

Whilst the respondents outlined the numerous challenges that they had experienced they also suggested methods that can be implemented in the human resources aspects of the TTO, the operations of the TTO, and the financial area of the TTO, which could all contribute towards successful implementation of TT at UKZN.

It is clearly a need for the management of UKZN to take these barriers into account when making decisions relating to the implementation of TT at UKZN. The recommendations mentioned below (in Section 5.3) clearly stipulate the steps that must be taken by management to correctly implement TT at UKZN. The improvement of the services of the TTO will ensure that the TTO is not only able to provide a high quality of service to its stakeholders, but also that it is able to fulfil its mandate in terms of the IPR Act. The information gained from these experts (the respondents) in this study fully supports and strengthens the existing body of knowledge in the field of technology transfer.

5.3. RECOMMENDATIONS BASED ON FINDINGS

The findings from this study have provided evidence that certain gaps exist in the UKZN TTO and certain barriers need to be eliminated in order to improve the service delivery of the TTO. Based on this, the following recommendations have been proposed to improve the effectiveness of the UKZN TTO and improve the implementation of TT at UKZN.

5.3.1. Employ more staff with commercialisation and business skills

It is evident from the results that one of the main challenges that the respondents experienced involved the lack of commercialisation skills among the TTO staff. These respondents felt that they were unable to experience the true benefit of participating in TT due to the inability of TTO staff to carry out commercialisation of their inventions. The respondents also highlighted the need to employ more staff at the TTO, as UKZN is a large community and there is currently only one TT manager at the TTO servicing UKZN.

UKZN must employ strict employment selection criteria to ensure that they employ staff at the TTO who have the correct business and commercialisation skills that are required for the TT field. The position of the director of the TTO has been vacant since 2013 and this has resulted in many people being reluctant in using the services of the TTO. UKZN management must urgently appoint a director of the TTO, to ensure that the team is headed by someone that is skilled in the whole process of TT. The person appointed must also have a proven track record of having previously successfully commercialised inventions and successfully managed a TT office. Currently, the TTO manager is the only member of staff at the TTO that is providing TT advice to fellow staff, which is inadequate, taking into account the number of staff members at UKZN that require assistance. It is important to hire at least one more TT professional to assist the TT manager and future TTO director in carrying out TT activities at UKZN. It must also be compulsory for the professional TTO staff to attend appropriate training sessions which are provided by NIPMO, SARIMA and other TT agencies. This will keep the staff educated on the latest trends in the TT process and assist in creating relationships with stakeholders that can provide benefit to the UKZN TTO.

It is important for the TTO to promote and establish itself as a business office and not as a legal advisory office, as the role of legal advice is provided by the Legal Services department.

5.3.2. Increased training and workshops

The majority of the respondents emphasised the need for more training in respect of the TT process. There has to be a clear understanding (by both parties) of the

chain of TT activities that needs to take place from the original discovery until commercialisation and sale of the invention.

The TTO staff must arrange more workshops and training sessions in UKZN which will target existing and potential inventors. These training sessions must cater for all the UKZN campuses. These workshops must be planned with the involvement of the DVCs of the four colleges so that these training sessions are compulsory as this will prevent staff members from complaining that they were not provided with TT training. These workshops must take place at the times in the year when the academics are not busy with lectures so that everyone is accommodated. Furthermore, these training sessions must include an in-depth analysis of the mandate and business model of the TTO and an in-depth analysis and training session on the IPR-PFRD Act, the UKZN IP Policy and the Commercial Initiatives Policy of UKZN. This will ensure that the UKZN community is educated in every aspect of the TTO process as well as the necessary policies that support TT at UKZN. There must be a question and answer session at the end of the each training session so that the TT personnel can answer questions posed by the attendees. It is imperative for the TTO to focus on one invention and make it a success so that this invention can be used as a 'showcase invention' in the TTO training sessions. This showcase invention will encourage existing and potential inventors to participate in TT activities at UKZN.

5.3.3. UKZN to invest monies in the TTO funding

Although the UKZN TTO is funded by UKZN, the TTO receives a refund from NIPMO on monies that the TTO spends on patenting inventions. However, all other TT expenses are funded by UKZN. This study has effectively revealed that although the respondents' patenting expenses are funded by the TTO, the challenge lies in obtaining seed funding from the TTO for developing invention prototypes and also obtaining monies to assist in the commercialisation process.

UKZN management must host bi-annual meetings at which the budget provided to the TTO is scrutinised to ensure that monies are being allocated to projects and are used correctly and that valuable patents are not lapsing due to lack of monies in the TTO. Furthermore, management should conduct an annual audit of the IP portfolio so that they can select patents that have value and conduct financial

projections on these valuable inventions to ascertain the costs that will be required to cater for their commercialisation. The TTO must ensure that they have sufficient monies in their budget, before they take on new projects.

It is important for UKZN management to involve the chief financial officer of UKZN in these meetings so that proper financial advice and projections can be provided. If management is of the opinion that they require further input on how to determine the budget for the TTO, then they should appoint an external financial advisory consultant to assist. UKZN's management must look at the previous budget that was provided to the TTO, the number of projects that were not financed due to the shortfall in the budget, and use these calculations to conduct projections on a suitable budget for the new year.

5.3.4. TTO must create relationships with industry

The results of the study revealed the need for the TTO to build relationships with industry, incubators and stakeholders. These relationships will benefit the TTO as it creates a link to potential partners in industry and could assist in the commercialisation process. The literature review emphasised the importance of having relationships with industry and the benefits that can accrue from such relationships.

For future consideration, the TTO must allocate a dedicated staff member who has the necessary business and communication skills to start communicating with industry and start building relationships with external stakeholders. This staff member can thereafter keep a database with the details of stakeholders so that the TTO can contact the stakeholder when an invention is imposed to the TTO which relates to the stakeholder's areas of interest. This will assist in attracting private sector interest in licensing the TTO's technologies or creating spin-off companies. The TTO staff members must investigate potential stakeholders that would like to invest funding in the TTO. Therefore, it is important that when the TTO hires staff, these staff members must have the skills necessary to leverage funding from other sources to alleviate the financial burden on UKZN.

5.3.5. Regular evaluation of projects

The respondents emphasised the need for regular evaluation of their projects and the need for increased communication between themselves and the TTO. Regular interaction is highly important in the TT process as the involvement of the inventor is a key factor to the success of the project as they are skilled in the field in which the invention emanates and know every detail of the invention.

For future consideration, it is vital for the TTO to conduct quarterly evaluations on the progress the projects. This can serve as an audit of the project and can also highlight any barriers to commercialisation or potential routes to market. Evaluations also keep both parties focused on the project and its success in the TT process. It can also serve as a form of due diligence to ensure that monies are not wasted on the project, especially when the project has come to a standstill and there have been no developments.

5.4. LIMITATIONS OF THIS STUDY

The study conducted was a qualitative study which meant that the results of the research are usually not generalisable. However, the main purpose of the study was not to obtain information that was generalisable, but rather to obtain expert opinions from inventors who participate in TT activities at UKZN, which could be reproduced to ensure that the data was reliable.

Due to this being a qualitative study, the conclusion that could be reached by every researcher is not always the same. The interpretation of results could have been influenced by the researcher's personal biases. Furthermore, verification of interpretive research is problematic. The researcher constantly compared the results of each interview to identify emerging themes and unanticipated themes within the study. The researcher also sought to treat the data as a whole rather than treat it as fragmented portions of results.

During the interviews personal information about an invention that would have identified the identity of the respondents was revealed. The researcher had to thereafter conceal this information to ensure the confidentiality of the identities of the respondents. Following this, the researcher had to describe the disclosed confidential information in a generalistic manner to ensure confidentiality.

5.5. RECOMMENDATIONS FOR FUTURE RESEARCH

The recommendations for further research are based on the findings of this study. This is the only study identified that has specifically addressed the issue of implementation of technology transfer at a South African higher education institution. Recommendations for further studies are highlighted below:

a. *Comparative Analysis of the implementation of technology transfer at higher education institutions in South Africa*

b. *The effects of the IPR Act on the implementation of technology transfer in South Africa*

c. *Benchmarking the best performing technology transfer office in South Africa with Harvard University's Technology Transfer Office*

5.6. SUMMARY

The aim of the study was to identify the factors that affect the implementation of technology transfer at UKZN. The objectives were to identify the experiences that inventors faced whilst working with the TTO; to establish whether the TTO is providing sufficient resources to facilitate the TTO process; to ascertain whether UKZN's IP Policy is enabling TT; to establish the competence of UKZN's TTO staff in facilitating the TT process; to identify the challenges that inventors experience during their participation in technology transfer activities at UKZN; and to identify methods to improve the service delivery of the TTO.

The aim and objectives of the study have been met, as the data that was analysed clearly identified the factors that have affected the implementation of TT; and the recommendations that have been made will contribute towards improving the UKZN TTO. Despite some limitations, this study has identified existing barriers at UKZN and methods that can be used to eliminate these barriers and improve the TTOs service delivery.

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APPENDIX 1:

INFORMED CONSENT LETTER 3C

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

Dear Respondent,

MBA Research Project
Researcher: Mrs. Tracey Leigh Samuel (031-2608364)
Supervisor: Prof. Anesh Singh (031- 260-7061)
Research Office: Ms P Ximba 031-2603587

I, Tracey Leigh Samuel am a MBA student, at the Graduate School of Business and Leadership, of the University of KwaZulu-Natal. You are invited to participate in a research project entitled "Factors affecting the implementation of Technology Transfer at the University of KwaZulu-Natal". The aim of this study is to establish why UKZN's Technology Transfer Office (TTO) has failed to successfully commercialise an invention from its IP portfolio.

Through your participation I hope to understand the barriers that are faced by UKZN's TTO in generating income from the successful commercialisation of its inventions. The results of this study are intended to contribute towards eliminating these barriers and successfully implementing technology transfer at the University of KwaZulu-Natal.

If you have any questions or concerns about participating in this study, you may contact me or my supervisor at the numbers listed above.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this survey/focus group. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Graduate School of Business and Leadership, UKZN.

Attached to this consent form is an interview schedule for your attention. Kindly read through the interview schedule and advise me of your availability to conduct a face to face interview or a teleconference, if you are unable to meet with me. The interview should take 30-40 minutes to complete.

I hope you will avail yourself to participate in this study.

Sincerely

Investigator's signature_____
Date_____

APPENDIX 2

GATEKEEPER'S LETTER

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

16 April 2014

Miss Tracey Samuel
School of Accounting, Economics and Finance
College of Law and Management Studies
UKZN
Email: samuelt@stu.ukzn.ac.za

Dear Miss Samuel

RE: PERMISSION TO CONDUCT RESEARCH

Gatekeeper's permission is hereby granted for you to conduct research at the University of KwaZulu-Natal towards your postgraduate studies, provided Ethical clearance has been obtained. We note the title of your research project is:

"Factors affecting the implementation of Technology Transfer at the University of KwaZulu-Natal".

It is noted that you will be constituting your sample as follows:
Interviews will be conducted with selected inventors (who are staff members from UKZN) who have filed patent applications at the technology transfer office of UKZN (UKZN InQubate).

Data collected must be treated with due confidentiality and anonymity.

Yours sincerely

MR MC BALOYI
REGISTRAR

APPENDIX 3

INTERVIEW SCHEDULE

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

MBA Research Project
Researcher: Mrs. Tracey Leigh Samuel (031-2608364)
Supervisor: Prof. Anesh Singh (031- 260-7061)
Research Office: Ms P Ximba 031-2603587

Title of Survey: Factors affecting the implementation of Technology Transfer at the University of KwaZulu-Natal.

The purpose of this study is to establish why UKZN's Technology Transfer Office (TTO) has failed to successfully commercialise an invention from its IP portfolio. Through your participation I hope to understand the barriers that are faced by UKZN's TTO in generating income from the successful commercialisation of its inventions. The results of this study are intended to contribute towards eliminating these barriers and successfully implementing technology transfer at the University of KwaZulu-Natal.

The interview should only take 30-40 minutes to complete. This research project has been approved by the Ethics Committee at the University of KwaZulu-Natal. All results will be used for academic purposes only.

Background

- Describe the position that you are employed in and how you became involved in TT.
- Describe the experiences that you have had with the UKZN TTO.
- Have you encouraged your colleagues to contact the TTO when they had a potential invention to protect? Explain

Challenges

- Describe the challenges that you have experienced or you are currently experiencing during your participation in TT activities? How were these challenges addressed?
- Do you think that these challenges could have been addressed differently to arrive at a suitable resolution? Explain

Mandate and business model

- Do you think that the mandate and business model of the TTO are clear, achievable and consistent? Explain

Resources

- Do you think that the TTO is equipped with resources to facilitate the TTO process and fulfil its mandate? Explain
- Do you think the TTO is providing sufficient resources to its researchers to enable them to participate more actively in TT? Explain

Governance

- Are the UKZN IP Policy and Commercial Initiatives Policy enabling TT at UKZN and easily accessible to the researchers? Kindly substantiate your answer.

Incentives

- In your opinion is UKZN's benefit sharing incentives encouraging you to engage more actively in technology transfer activities. Kindly provide reasons for your answer.

Management and TTO Staff

- Kindly provide your opinion on the competence of UKZN Management and TTO staff in facilitating the TT process?

Areas of development

- What areas do you think need to be developed at the TTO to increase its

effectiveness and your involvement as an inventor?

Closing

- It has been a pleasure interviewing you. Is there anything else that you would like to comment on that we may have not discussed?

End of interview

Thank you for participating!

APPENDIX 4

ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

09 June 2014

Mrs Tracey Leigh Samuel (202515426)
Graduate School of Business & Leadership
Westville Campus

Protocol reference number: HSS/0578/014M
Project title: Factors affecting the implementation of Technology Transfer at the University of KwaZulu-Natal

Dear Mrs Samuel,

Full Approval – Expedited Application

In response to your application dated 22 May 2014, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Professor Anesh M Singh
Cc Academic Leader Research: Dr E Munapo
Cc School Administrator: Ms Zarina Bullyraj

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
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Website: www.ukzn.ac.za

APPENDIX 5

ENGLISH EDITOR'S CERTIFICATE

10 October 2014

To whom it may concern

Student:	Tracey Samuel
Student number:	202515426
Degree:	Master of Business Administration
Title:	Factors affecting the implementation of Technology Transfer at the University of KwaZulu-Natal
Graduation:	2014

This is to inform you that Ronél Gallie of the University of Stellenbosch Business School did the technical editing of the abovementioned research assignment and Jeanne Enslin, freelance language editor who is on the USB list of editors, did the language editing.

We trust that the work done to the abovementioned research assignment is satisfactory.

Kind regards

Ronél Gallie
Technical editor

Jeanne Enslin
Language editor

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