UNIVERSITY OF KWAZULU-NATAL

"COMPARATIVE ANALYSIS OF INNOVATION SUPPORT MODELS AT HIGHER EDUCATION INSTITUTIONS IN SOUTH AFRICA"

By

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DECLARATION

I, **Silvester Olupot** declare that:

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ABSTRACT

Research universities broadly have integrated scientific research as a core component of their teaching mission and are frequently the source of technological innovation. The University of KwaZulu-Natal (UKZN) likewise, seeks to give effect to its vision of being the premier university of African scholarship in its research endeavors and is currently ranked as one of the "Big Five" research institutions in South Africa.

However, despite UKZN's high research publication output, there is negligible patenting at UKZN. This study therefore investigated why there is that anomaly and carried out a Comparative Analysis of Innovation Support Models at Higher Education Institutions (HEIs) in South Africa. Based on the research findings, this study provides some useful insights on how Innovation Support Models in South Africa in general and UKZN in particular, can best be structured to achieve success. The study highlights the extent to which patenting affects publication (for example whether patenting hinders publication) with particular emphasis on the "Big Five" research universities in South Africa. Some of the factors that affect innovation at the HEIs, which this study reviewed, include the institutional arrangements for the management of Intellectual Property and technology transfer capacity.

The study reviews literature on the roles that universities play in the national innovation systems, the complex institutional landscapes that influence the creation, development and dissemination of innovations at global and national levels. The literature shows that countries worldwide, including South Africa, are striving to stimulate innovation as a fundamental source of competitiveness and are building on locally generated Intellectual Property (IP) from Research Institutions.

To arrive at the findings, this study adopted a case study approach by examining innovation at UKZN in some detail. Purposive sampling was used to select the "Big Five" research institutions and an additional three HEIs were selected through judgment sampling. Out of a sample size of eight HEIs, a response rate of 75% was achieved. The case study and the interview analysis showed that HEIs use more than one indicator to

measure their performance. These indicators include: the number of disclosures, number of patents, number of breakthroughs to the industry, number of projects managed within the innovation portfolio, the level of efficiency of innovation systems and tools, successful commercialisation of projects and the income generated.

While there are several good innovation performance indicators, this study recommends the patent system, which is accepted internationally as a good yardstick and is used in South Africa by the Department of Science and Technology to monitor technological performance. Patents are valuable because they provide a researcher with a coherent set of data across countries and specific technological fields for long time series. Proper use of the patent system could result in additional publications to the researchers and could facilitate the transfer of new technology to the industry. Despite delays in obtaining patents, the patent system has the benefit of securing the researchers with a priority date for their work.

This study further shows that there is a low rate of patenting by South African HEIs at both local and international level. The existence of IP management policies at HEIs and patenting appears to be correlated given the fact that HEIs with IP policies and established structures performed well in the area of patenting. Improvement of infrastructure and availability of highly skilled and creative researchers coupled with proper management of IP is necessary for successful commercialisation. A useful tool for enhancing commercialisation would be a mechanism for increasing the number of disclosures of inventions made by researchers to technology transfer offices.

This study therefore recognizes that achieving research and innovation excellence in South African HEIs, especially in UKZN, requires breaking down existing barriers within and outside the institutions while building a collaborative and entrepreneurial culture.

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LIST OF ABBREVIATIONS

ARC	Agricultural Research Council
AUTM	Association of University Technology Managers
BIBA	Bachelor of Innovation in Business Administration
BOD	Board of Directors
BE@UP	Business Enterprises at University of Pretoria
CEO	Chief Executive Officer
CIPRO	Companies and Intellectual Property Registration Office
CSIR	Council for Scientific and Industrial Research
DoE	Department of Education
DST	Department of Science and Technology
DUT	Durban University of Technology
DVC	Deputy Vice Chancellor
DVC:RKPP	DVC: Research, Knowledge Production and Partnerships
ESI	Essential Science Indicators
EU	European Union
IF	Innovation Fund
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
HESA	Higher Education South Africa
HEIs	Higher Education Institutions
IAP	Institutional Audit Portfolio
IPMO	Intellectual Property Management Office
IPR	Intellectual Property Rights
IS&T	Information Systems and Technology
JPO	Japan Patent Office
MNC	Multinational Corporations
MOA	Memorandum of Agreement
MRC	Medical Research Council
NDA	Non-Disclosure Agreement

NACI	National Advisory Council of Innovation
NMMU	Nelson Mandela Metropolitan University
NRF	National Research Foundation
UNISA	University of South Africa
NSI	National Systems of Innovation
NIPMO	National Intellectual Property Management Office
WSMU	Walter Sisulu Metropolitan University
NWU	North West University
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
PCIP	Proposed Commercial Initiatives Policy
PoC	Proof of Concept
PoV	Proof of Value
R&D	Research and Development
RCIPS	Research Contracts and Intellectual Property Services
RSA	Republic of South Africa
RU	Rhodes University
SARIMA	Southern African Research and Innovation Management Association
SASRI	South African Sugarcane Research Institute
SMRI	Sugar Milling Research Institute
TB	Tuberculosis
TT	Technology Transfer
TTO	Technology Transfer Office(r)
TUT	Tshwane University of Technology
UCCS	University of Colorado at Colorado Springs
UCT	University of Cape Town
UGH	Unistel Group Holding
US / Unistel or SU	University of Stellenbocsh or Stellenbocsh University
UF	University of Fort Hare
UL	University of Limpopo
US	United States
USA	United States of America

UK	United Kingdom
UKZN	University of KwaZulu –Natal
UKZN IAP	University of KwaZulu –Natal Institutional Audit Portfolio
UKZN PCIP	UKZN Proposed Commercial Initiatives Policy
UPPR	University of Pretoria Research Report
USPTO	United States Patent and Trade Office
VUT	Vaal University of Technology
WITS	University of Witwatersrand
WRC	Water Research Council

1 CHAPTER ONE: INTRODUCTION

1.1 Introduction

A research university plays an important role as a source of fundamental knowledge and, occasionally, industrially relevant technology in modern knowledge-based economies (Mowery, 2004). Universities are good at producing, assimilating and disseminating new knowledge. However, from research to innovation there is a gap which only a few universities bridge. Industry, on the other hand, is good at developing know-how on making products and selling them. There is a need to bring knowledge and know-how closer to each other to foster innovation (Kamoun, 2008). According to Wolson (2008), there is need to influence research in universities to ensure quality inventions which are usable, relevant and with market potential as shown in Figure 1.1.

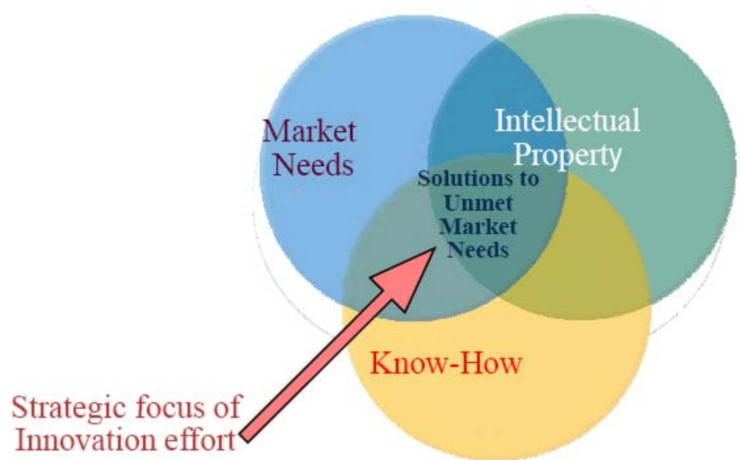


Figure 1.1: Strategic Focus of Innovation Effort

Source : Wolson, R. (2008) ; IP Management & Technology Transfer at CSIR: SARIMA Workshop: Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

In recognition of the above fact, governments throughout the industrialised world have launched numerous initiatives since the 1970s to link universities to industrial innovation more closely. Many of these initiatives seek to spur local economic development based on university research. Examples include creating “science parks” located near research university campuses, supporting “business incubators” and public “seed capital” funds and the organization of other forms of “bridging institutions” that are believed to link universities to industrial innovation. Other efforts are modeled on the United States law, the Bayh-Dole Act of 1980, which is widely credited with improving university-industry collaboration and technology transfer in the United States (US) national innovation system (Mowery, 2004).

This study analyses the innovation support models at South African Higher Education Institutions (HEIs). The study provides some useful insights on the extent to which patenting affects publication, with particular emphasis on the “Big Five” research universities in South Africa. The study reviews the institutional arrangements for the management of intellectual property and technology transfer at the institutions and various policy initiatives by the Department of Science and Technology (DST) of South Africa (Sibanda, 2008).

1.2 Background to the Research

In December 2002, a merger of a number of HEIs was initiated resulting in 23 HEIs from an original number of 36 HEIs. In the same year, the South African Research and Development Strategy (“R&D Strategy”) identified disparate practices in respect of ownership, management and commercialisation of intellectual property emanating from publicly financed research institutions (DST, 2002). Furthermore, the R&D Strategy proposed a need for harmonisation of intellectual property practices and establishment of dedicated funds to finance the securing of intellectual property from publicly financed research (Sibanda, 2008).

Since then, some of the institutions have proceeded to develop and implement intellectual property policies aimed at ensuring certainty in respect of ownership and commercialisation and technology transfer of intellectual property developed at the institutions. The institutions include the “Big Five” research institutions, namely: University of Pretoria (UP), University of KwaZulu-Natal (UKZN), University of Stellenbosch (US), University of Cape Town (UCT) and University of Witwatersrand (WITS). According to a 2006 report by the Organisation for Economic Co-operation and

Development (OECD, 2006), research in the South African higher education sector is concentrated with only five universities doing the lion's share and producing in many cases globally excellent research. Research by Sibanda (2008) revealed that all the big five, apart from UKZN, had Intellectual Property (IP) policies and technology transfer capacities established. Below is a summary of analysis of provisional and complete patent applications filed by these institutions at the South African Companies and Intellectual Property Registration Office (CIPRO), and patents granted to the institutions for the period 2001 to 2007.

Name of HEI	Research Publication Output Ranking	Number of Provisional applications	Number of Complete applications	Number of Granted patents
UP	1st	41	22	28
UKZN	2nd	2	0	0
US	3rd	85	23	19
UCT	4th	49	23	14
WITS	5th	69	11	3

Table 1. 1 : Patent Applications Filed and Granted to the "Big Five" at CIPRO (2001- 2007).

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

Table 1.1 shows an anomaly in respect of the UKZN, where patenting activity is negligible as compared to its peers. Other factors held constant, UKZN should have had between 20 and 27 patents granted within the same period in order to achieve the second position in patenting. Sibanda (2008) attributed the anomaly at UKZN to a lack of policy in respect to IP management, as the individual researchers retained ownership of IP generated from their research.

Cloete, Nel and Theron (2006), as cited by Sibanda (2008) are of the view that one of the reasons for low patenting activity by South African scientists is that “Research has not been carried out with commercialisation in mind and has, therefore lacked market focus.”

Nonetheless, UKZN has identified itself as a research institution, and has become aware of the potential risks to its status as one of the “Big Five” research institutions in the country, and is thus responding quickly to such concerns (UKZN IAP, 2008).

UKZN Innovation Pty Ltd. (UKZN Innovation) has since 2006, been established as a facility to help researchers develop the commercialisation of research and develop in the area of patents, which is currently weak in the UKZN research profile. A Commercial Initiatives Policy has since 2008 been approved by the UKZN Senate and is intended to provide a framework for the successful translation of research projects into viable commercial projects, thereby stimulating the creation of third stream income (UKZN IAP, 2008).

1.3 Purpose

The purpose of this study is to make comparative analysis of innovation support models established at HEIs in South Africa and make recommendations on how innovation support at UKZN can best be modeled for its success.

1.4 The Value of the Study

The value of research is the key issue for management if it faces the question whether or not to carry out research. Kasper Helsdingen and Wovter (1999) gave two approaches that can be used to assess the value of the research as:

- Analyzing the benefits the firm / institution gets from the research carried out.
- Identifying the downside risk the firm / institution incurs if it does not carry out the research.

According to Kasper *et., al. (*1999), research is the systematic gathering, recording and analysing of data to provide information useful for decision making. The two basic purposes of research are:

- To reduce uncertainty when plans are being made.
- To gather information about the present … environment and future trends.

This study is aimed at giving guidance to policy makers at UKZN and other HEIs in South Africa, thus reducing uncertainty when making technology transfer plans and decisions. The information gathered in this study provides some useful insights on how research from HEIs can successfully be commercialised.

1.5 Problem Statement

According to Sekaran (2003), the problem statement is a clear, precise and succinct statement of a question or an issue that is to be investigated with the goal of finding an answer or a solution. Sekaran (2003) stated that it is useful to define a problem in a situation where a gap exists between the actual and a desired ideal state. It is important to know what exactly an issue is for which one seeks answers. Without addressing the central issue, the desired results will not be achieved because the right problem would not have been addressed.

One of the main areas in which the University of KwaZulu-Natal seeks to give effect to its vision of being the premier university of African scholarship is in its research endeavors. In terms of total publication count in 2005 (and 2006 as per Figure 1.2), UKZN was second only to the University of Pretoria and currently ranks as one of the "Big Five" research institutions in the country (UKZN IAP, 2008).

Research universities broadly have integrated scientific research as a core component of their teaching and mission. They are frequently the source of technological innovation which is usually measured by use of patents data (Garduno, 2004). Patents data are the only manifestation of innovation activity covering virtually every field of innovation worldwide and over long periods of time. Patents counts are found to be highly correlated with contemporaneous Research and Development (Trajtenberg, 1990). However, despite UKZN's high research publication output as shown in Figure 1.2, there seems to be no patenting activity at UKZN as shown in Table 1.1.

This study seeks to investigate why there is an anomaly by critically analyzing innovation support models at HEIs in South Africa, and make recommendations for possible success of technology transfer of UKZN's research output. Thus the research topic: "Comparative Analysis of Innovation Support Models at Higher Education Institutions (HEIs) in South Africa."

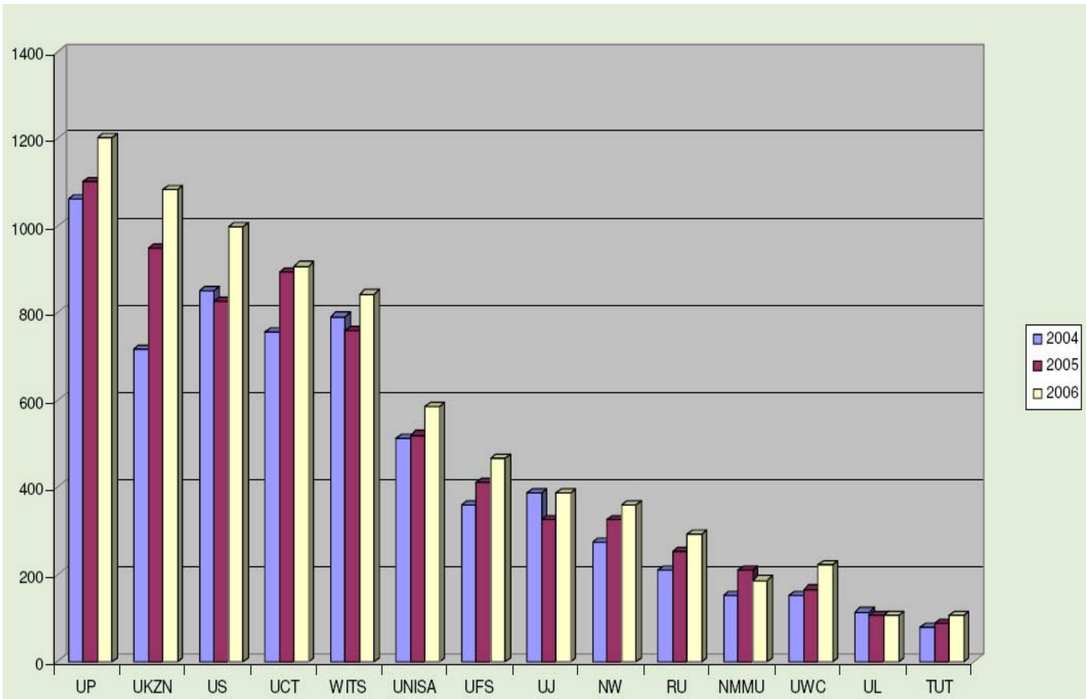


Figure 1.2 : The Publication Output of 14 Selected HEIs in South Africa

Source: Eloff, T. (2008); Research and Innovation as a Differentiating Factor in Higher Education. HESA Presentation by HESA Chair to the SARIMA conference, Stellenbosch, 4 June 2008.

1.6 Research Questions

The research was carried out to be able to address the following major questions from empirical studies:

- To what extent does innovation integrate into the academic research? A case of the top five research institutions in South Africa.
- What is the measure of successful innovation at HEIs in general?

The underlying sub-questions adopted from the study of Sibanda (2008) and addressed by this research include the following:

i. What is the extent of innovation by the institutions both at the local and international offices?
ii. What are the factors perceived by the institutions as affecting innovation?
iii. To what extent are the institutions commercialising their research?
iv. What is the mode of commercialisation of innovation by the institutions?
v. Are the institutions' commercialisation activities based solely on patents or other forms of intellectual property?
vi. Is patenting hindering scientific development by reducing publication rate?
vii. To what extent is the existence of technology transfer offices and IP policies influencing patenting and commercialisation of research results at HEIs?

1.7 Limitations of the Study

Research carried out at any time cannot adequately address all matters of the study. Among different limitations to the study, the following were identified, which should be considered as one looks at the information presented in this research report:

- Some prospective respondents did not avail themselves for the interview. Other respondents interviewed had limited time and the interviews had to be compressed to suit the respondents' available time.
- A further limitation relates to the respondents' reluctance to avail all the necessary information due to Non Disclosure Agreements (NDAs) regarding some of their projects.

1.8 Structure of the Study

The research report consists of six specified chapters. This was done in such a way as to give a clear view of understanding of the research topic, related theoretical material, research methodology, and a case study of UKZN, analysis of the collected data, conclusions and recommendations.

1.8.1 Chapter One: Introduction

This is an introductory chapter that presents the problem at hand and how it was handled. It stipulates the role played by a research university as a source of fundamental knowledge, background to the research, purpose and the value of the study. Problem statement, research questions and the limitations of the study are discussed in this chapter.

1.8.2 Chapter Two: Literature Review

This chapter reviews a broad theoretical framework in relation to Innovation practices globally and nationally. The literature entails a review of South Africa's national and institutional framework as it looks for ways to promote and strengthen technology transfer at HEIs.

1.8.3 Chapter Three: Research Methodology

The chapter describes sampling, data collection and data analysis techniques. Ethical considerations and resource constraints have been dealt in this chapter. It has also been noted that the research design incorporated a case study approach which is discussed in detail in the following chapter.

1.8.4 Chapter Four: Case Study of UKZN

This chapter focuses on UKZN as a case study. This chapter entails in-depth contextual analysis of factors which are operating in the institution in regard to research output and innovation. Analysis of an innovation support model as per relevant sources and interviews is discussed in this chapter.

1.8.5 Chapter Five: Research Results and Discussion

Comparative analysis of innovation support models in other institutions and discussion of results from interviews, and secondary data is done in this chapter.

1.8.6 Chapter Six: Conclusion and Recommendations

This chapter draws conclusions from the research findings. Based on the findings, the study gives recommendations for improvement of innovation support models in South African HEIs in general and UKZN in particular.

1.9 Summary

In summary, Chapter One of this research gives a brief introduction and background of the study. The anomaly identified in respect to high publication output and negligible patenting activity at UKZN has led to comparative analysis of innovation models at HEIs in South Africa. This study addresses the extent to which innovation integrates into academic research and possible yardsticks for measuring innovation at HEIs in general. Despite the limitations, this study provides some useful insights on technology transfer in South African HEIs. The structure of the entire research report has been summarized in this Chapter.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Saunders, Lewis and Thornhill (2003) indicate that literature review is a preliminary research that helps to generate and refine research ideas and it forms part of a research project. Saunders *et., al(* 2003) say that knowledge does not exist in a vacuum, and work only has value in relation to other people's work and findings.

This chapter reviews the roles of universities in national innovation systems, the complex institutional landscapes that influence the creation, development and dissemination of innovations. Global diffusion of universities research- deliverables in the form of patented discoveries has received too little attention in the literature on innovation. Data allowing for systematic cross national comparisons of the structure of the higher educational systems are surprisingly scarce (Mowery and Sampat, 2005). This paper therefore reviews several case studies, conferences and discussion papers in this field of innovation. In this era of globalisation, policy makers have been prompted to "borrow" policy instruments (such as the "Bay-Dole Act" and the "Triple Helix Framework) from other economies and apply these instruments in very different institutional contexts. South Africa is not exceptional in this area of innovation which is defined in several ways in section 2.2 below.

2.2 Definitions

Innovation has become a buzzword, uttered alongside such catch - phrases as competitive advantage, sustainable development, the connected knowledge economy, globalization, convergence, digitization, moving at the speed of thought (Cheshire, 2006). Cheshire expressed innovation (I) as a function of creativity (C) and knowledge (K) utilized effectively (n) both at personal and organizational levels. Innovation process is thus represented by use of a pseudo equation:

$\mathbf{I = \alpha F(C,K,c,k)^n}$.

Where the variables are:

I= Innovation,

α = willingness to embrace innovation,

F= Function of

cC = creativity on a personal (c) level or organisational (C) level,

kK= existing knowledge at personal (k) level or at organisational (K) level,

n = effectiveness / maturity of the innovation process put in place.

London Innovation describes Innovation as the successful exploitation of new ideas in any setting which is a vital ingredient for competitiveness, productivity and social gain within businesses and organizations. It can be anything from changing a daily business procedure and designing a new product for sale to discovering a new drug that reduces heart disease.

Innovation is not what innovators do....it is what customers and clients adopt. Invention (discovery of new ideas) followed by innovation (implementation of new techniques) drives economic growth (Kamoun, 2008).

Innovation is the process of transforming an idea, generally generated through R&D, into a new or improved service, product, process or approach that relates to the real needs of society and involves scientific, technological, organisational or commercial activities. The key to this definition is the fact that the innovation process is only complete once a defined product, process or system with some tangible benefit has been implemented (NACI, 2006).

South African Technology Innovation Agency Act No. 26, 2008 defines technological innovation as the application in practice of creative new ideas, which includes inventions, discoveries and the processes by which new products and services enter the market and the creation of new businesses.

The study of innovation systems sets out to establish how resources are organized for the discovery, creation, development and economically productive application of new technologies (Garduno, 2004).

Against the backdrop of the above definitions, this study defines innovation as the successful exploitation of new ideas through technology transfer and commercialisation programmes

2.3 Innovation Development Tools

Practitioners and policy makers often confuse economic development tools with strategies. However, technology transfer and commercialisation programmes are regarded as tools; strategy is determining how these tools are best used, independently and in conjunction with other tools in promoting development (Reamer, Icerman and Youtie; 2003).

2.3.1 Technology Transfer

Technology Transfer is when a firm obtains technology from an external source, for example, a university, a government laboratory, another corporation, or an individual, Reamer *et., al.* (2003). According to Moore (2009), Technology Transfer covers broadly the transfer of ideas and IP to the market (similar to commercialisation). Reamer *et., al.* (2003) argue that all innovation builds on existing knowledge. Technology development depends on scientists and engineers knowing about and having access to other researchers' good ideas and discoveries. The greater the extent to which technical staff have knowledge of and access to other researchers' work, the more likely they will develop new technologies that can be the basis for successful products. Technology transfer is essential to technology development

2.3.2 Commercialisation

This is a process of transforming new technologies into commercially successful products. Commercialisation is to cause something having only a potential income-producing value to be sold, manufactured, displayed, or utilized so as to yield income or raise capital. Commercialisation encompasses a diverse array of important technical, business, and financial processes that together aim to transform a new technology into a profitable product or service. These processes include such efforts as market assessment, product design, manufacturing engineering, management of intellectual property rights, marketing strategy development, raising capital, and worker training (Reamer *et., al.* 2003).

Commercialisation is a costly, lengthy process with a highly uncertain outcome. The costs of commercialisation can run from between 10 and 100 times the costs of development and demonstration of a new technology. Moreover, success is rare; less than five percent of new technologies are successfully commercialised. Even when successful, technology commercialisation does not happen quickly. On average, the commercialisation of university research takes over six years. Commercialisation of radically new technologies can take well over a decade. For instance, radio technology was first demonstrated in 1895, but did not come into general commercial use until 1925; computer games were first created in the 1960s but did not become commercially popular until the 1980s, Reamer *et., al.* (2003)

2.4 Intellectual Property

In order to promote the investment of money, time, and talent in the process of technology transfer and commercialization, unique technical knowledge developed through that process is eligible for designation as intellectual property (IP), with legal protections that prevent the ability of others to appropriate that technology without permission, Reamer *et., al.* (2003). In the context of the Intellectual Property Rights from Publicly Financed Research & Development Bill 2008, (IPR Bill, 2008) Intellectual property means “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 a thesis, dissertation, article, handbook, or any other work which, in the ordinary course of business, is associated with conventional academic work”.

2.4.1 Intellectual Property Protection Measures

According to Hefter and Litowitz in Reamer *et., al.(*2003), there are three major types of IP protection:

- **Trade secret: “**Is the information that is secret or not generally known in the relevant industry and that gives its owner an advantage over competitors”. Trade secret protection exists as long as the information has value, is kept secret or confidential by its owner, and is not lawfully and independently obtained by others.

Examples of trade secrets include product formulas (example is Coca-Cola), patterns, methods, techniques, manufacturing processes, and compilations of information that provide a business with a competitive advantage.

- **Copyright**: "Is an exclusive right to reproduce an original work of authorship fixed in any tangible medium of expression, to prepare derivative works based upon the original work, and to perform or display the work in the case of musical, dramatic, choreographic, and sculptural works. In the realm of advanced technology, the intellectual property underlying computer software is commonly protected by copyright".

- **Patent: "**Is a contract between society and the inventor of a technology that is new or novel and not obvious." Under the terms of this social contract, the inventor is given the exclusive right to prevent others from making, using, and selling a patented invention for a fixed period of time, in return for the inventor's disclosing the details of the invention to the public. Thus, patent systems encourage the disclosure of information to the public by rewarding an inventor for his or her endeavors. Patents are granted by national offices, for example the U.S. Patent and Trademark Office (USPTO) and CIPRO in South Africa.

2.4.2 The Relevance of Patenting

Among the three types of IP protection measures, patents are accepted internationally as a reflection of a country's inventive and technological achievements. Patents are used for monitoring and assessing national systems of innovation. In South Africa, patents are one of the technological indicators monitored by the Department of Science and Technology (Pouris, 2005).

Pavitt, (1988) Grupp, (1990) and Griliches 1990 as cited by Montobbio, (2007) argue that patent data are an extremely useful and rich source of information. According to Montobbio (2007), many papers have assessed the use of patents as economic indicators for at least two decades. Patents can be used to analyze the technological activities of inventors, firms, regions and countries. They are valuable because they provide the researcher with a coherent set of data across countries and specific technological fields for long time series. Moreover, patents show a high level of correlation with R&D at the firm level and this suggests using patents as an ‘input’ indicator that is measuring the technological effort of companies and non-firm organisations to create new products and process (Montobbio, 2007).

However, Shankerman and Pakes (1986) in Montobbio (2007) cautioned that most of the patents have very low economic and technological value while a few of them are extremely valuable. Patent citations are therefore used, to measure the economic and technological value of a patent. Citations are particularly reliable because they have a legal value. Trajtenberg (1990), Albert, Avery, Narin and McAllister, (1991) as cited by Montobbio (2007) are among the first scholars that empirically demonstrated that highly cited patents have higher economic and technological importance.

Harhoff, Narin Scherer and Vopel (1997), show that the private value of a patent and its subsequent patent citations are correlated. Also Hall, Jaffe and Trajtenberg (2005) bring solid evidence about the relationship between market value and patent citations. If a patent is highly cited it also generates many technological spillovers. Therefore citations have also been used to track knowledge flows and spillovers. Again there is a lot of evidence on spillovers within region, international spillovers and spillovers between universities and firms; Jaffe, Trajtenberg and Henderson (1993). Jaffe and Trajtenberg, 1996; Jaffe and Trajtenberg (1999) Maurseth and Verspagen (2002) Malerba and Montobbio (2003) and Montobbio (2007).

Some scholars argue that increased university patenting and licensing could potentially weaken academic researchers’ commitments to “open science” leading to publication delays, secrecy and withholding of data and materials. (Dasgupta, Partha and David, (1994), Liebeskind (2001). According to Henderson, Jaffe and Trajtenberg (1998), commercialisation motive which is one of the main reasons for patenting, could shift the orientation of university research away from “basic” and towards “applied” research. However, Mowery and Sampat argue that there is little evidence of substantial shifts since the establishment of Bayh- Dole in the context of academic research in the US.

2.5 Innovation as a Global Phenomenon

According to Comins (2005), countries and regions are striving to stimulate innovation as a fundamental source of competitiveness, building on locally generated intellectual property linked to their research base. Europe's Lisbon Strategy has an innovation target of outstripping the United States as the most competitive and dynamic economy in the world by 2009. In addition, a National Innovation Initiative in the United States is driving a rapid increase in innovation performance, while similar stimulation activities throughout the developing countries such as South Korea, India, China, Brazil, Malaysia, Singapore and Australia are all addressing priorities in this area.

2.5.1 Global Trends in Innovation

Dryden (2007) argued that the current phase of globalisation is characterised by several new trends which include:

- The spread of global value chains: production is increasingly fragmented across countries leading to more specialisation, even in traditional industries.
- Intra-firm trade by multinational enterprises accounts for a large part of global trade flows.
- Trade in services is growing rapidly, enabled by information and communications technologies.
- The integration of large emerging economies, notably China and India, including more innovative areas of economic activity as shown in Figure 2.1

Figure 2.1 shows that China is already among the largest investors in R&D globally and it targets R&D intensity of 2.5% by 2020. In 2005, non-OECD countries accounted for over 21% of global R&D, up from 17% four years earlier.

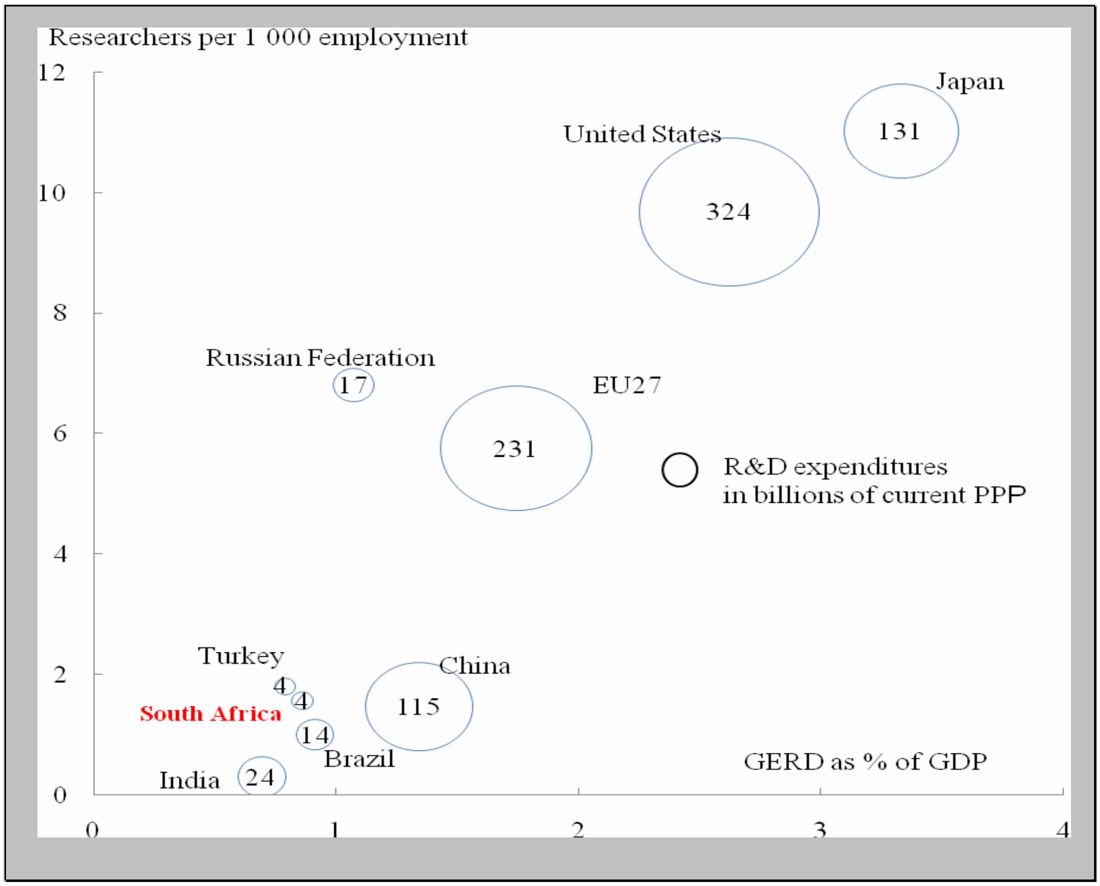


Figure 2.1: R&D Expenditure in 2005 of Various Countries

Source: Dryden, J. (2007); Innovation Trends and Policies, Istanbul Chamber of Industry- 6th Industry Congress, Istanbul, 26 – 27 Nov. 2007. www.oecd.org/sti

Note: GERD represents Gross Expenditure on Research and Development.
Circles reflect size of spending in billion USD PPP *(US $ purchasing power parity)*

2.5.2 Innovation as a Response to Globalisation

Dryden (2007) argued that there is a growing interest in innovation due to the fact that innovation is part of the response to globalisation. Innovation can help address global challenges in the environmental (climate change, energy security), health (diseases, aging society, water) and development (poverty reduction, income disparity) domains. Through innovation, countries move up the value chain, increase productivity growth and become more competitive. Likewise, the global economy also offers new opportunities for faster innovation; new technologies (information technology and the Internet) enable more rapid innovation, notably in services; globalisation broadens access to markets and enables greater efficiencies and specialisation and more resources can be devoted globally to research and innovation. Innovation therefore plays an important role in economic growth as indicated in Figure 2.2.

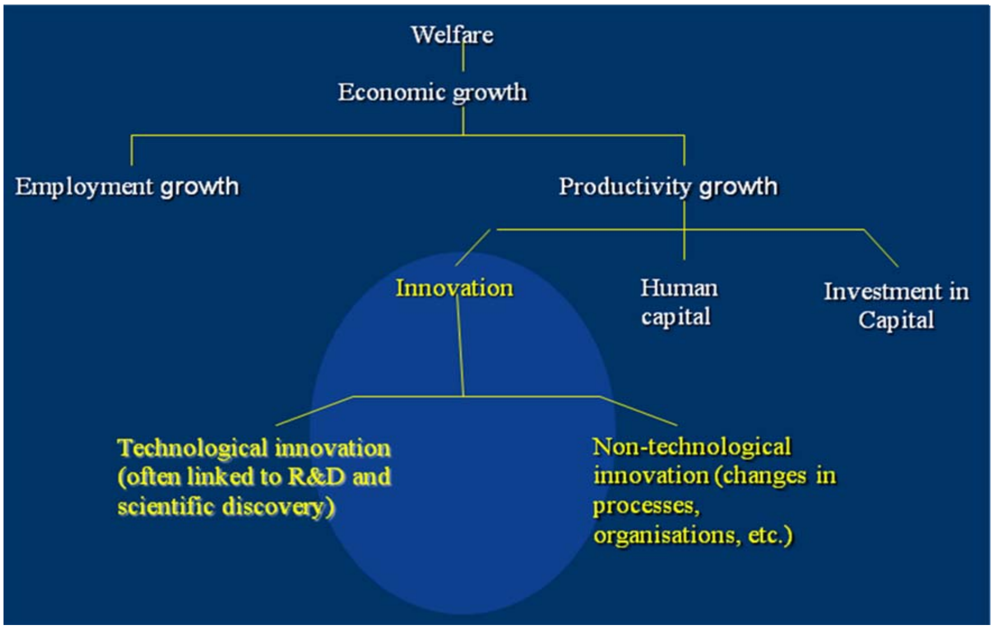


Figure 2.2: Role Played by Innovation in Economic Growth

Source: Dryden, J. (2007). Innovation Trends and Policies, Istanbul Chamber of Industry- 6th Industry Congress, Istanbul, 26 – 27 Nov. 2007. www.oecd.org/sti

Facts and evidence depicting innovation performance in OECD countries, as per Dryden (2007) are shown Figure 2.3. Dryden (2007) attributed the rising trend in innovation to several factors:

- Strong and efficient knowledge base (for example, in universities and public research institutions).
- Growing focus on excellence and relevance;
    - Ensure best research is funded – focus on excellence.
    - Growing emphasis on competitive funding.
- Growing focus on evaluation of programmes and policies; new quality assessment frameworks in several OECD countries (For example, Australia, Austria, Norway, South Africa among others).

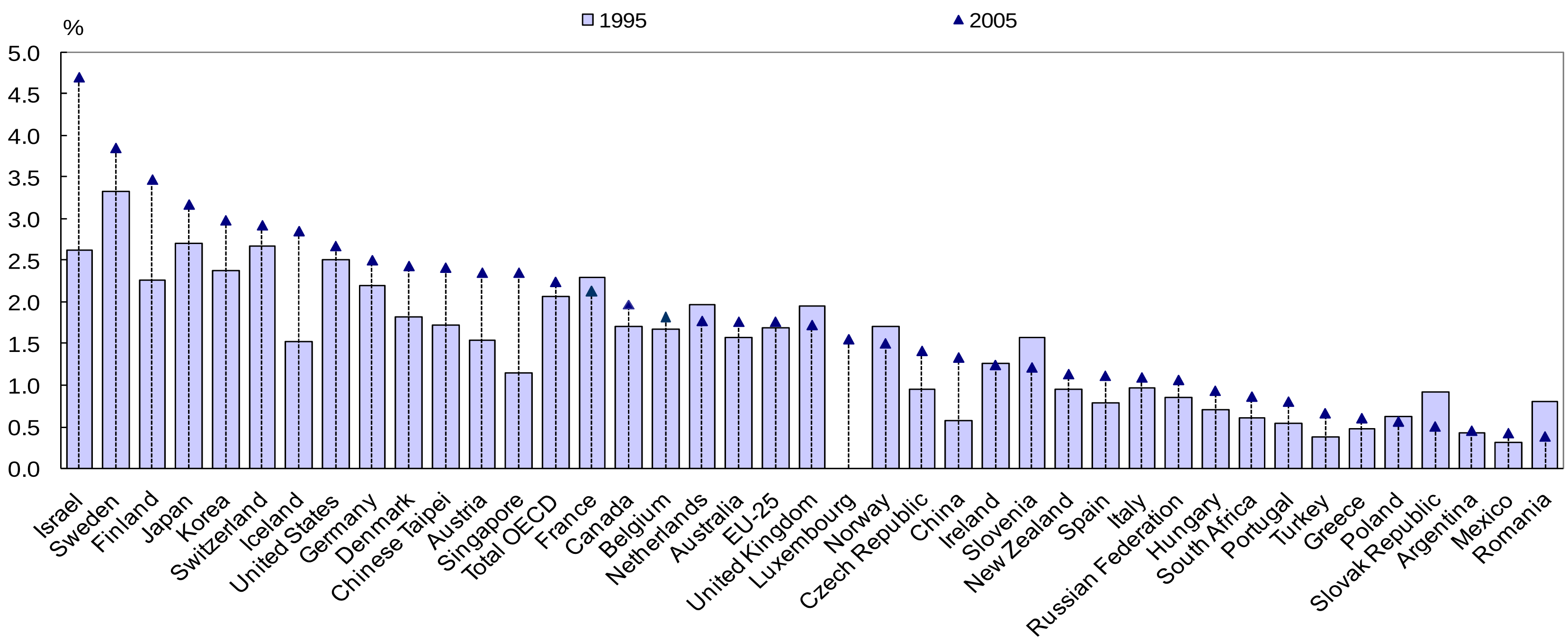


Figure 2.3: Rising Investment in Innovation in Several OECD Countries (R&D Expenditure as % Of GDP)

Source: Dryden, J. (2007) Innovation Trends and Policies, Istanbul Chamber of Industry – 6th Industry Congress, Istanbul, 26 – 27 Nov. 2007. www.oecd.org/sti.

2.6 Technology Transfer of University Research at Global Level

According to Garduno (2004) research in the area of innovation is primarily in the form of case studies, either of particular industries, or more commonly, national innovation systems. This paper therefore, reviews case studies and surveys which include the recent study by Sibanda (2008), Higher Education of South Africa (HESA) annual surveys, Garduno (2004), Reamer *et., al.* (2003), OECD, among others. Garduno (2004) gave some useful insights which have been summarized as follows:

- Case studies have shown that there are a number of different methods employed to further technological advancement and diffusion within a firm, an industry or a country. One such aspect is the role played by universities that have integrated scientific research as a core component of their teaching mission, thereby, successfully building human capital, thus, contributing to the pursuit of technological innovation.

- Using indicators like the number of licensing deals, licensing revenue generated and total number of start-ups created as measurements for success, the United States is arguably one of the most successful countries at capitalizing on the research activities of its universities. Some observers argue that the success experienced in the U.S. at bringing federally funded, university developed technological innovations to the private sector is owed in great part to the Bayh-Dole Act of 1980 that provided universities with a favorable institutional framework.

- Despite the success of Bayh-Dole in spurring the transfer of University-developed technologies to the private sector, there is a need to dispel the popular myth that universities can make “fortunes” through the licensing of their technologies. On average it costs approximately 0.5% of research expenditures to run a technology transfer office. It is clear that most universities not only make very little additional income from licensing activity but some in fact lose money compared to the licensing income they receive. (Example is given in Figure 2.4).

- Besides Bayh-Dole, other countries like Finland have gone much further in promoting industry academic collaboration. A number of countries have adopted what is known as the "Triple Helix" approach. The Triple-Helix approach is characterized by a deep integration of the goals and functions of the three main organisational types involved in research and development; namely, government, universities and industry. Triple Helix approach has been discussed in the later sections of this chapter.

- There are major differences in the characteristics of South Africa's innovation system from most countries. Compared to other countries, especially innovation leaders, there is a dearth of research spending in South Africa. This is a major flaw within South Africa's innovation system, and one in which the government has attempted to correct through various programmes and by increasing government spending on research.

- Compared to the US, the level of research supported by industry in South Africa is staggering. In the US, the largest share of university research funding comes from the federal government (58%) and only 7% comes from industry. On the contrary, in South Africa, 58% of all university research funding comes from the private sector. The scarcity of research funding for universities has prompted South African academics to seek research funding from a number of sources, especially industry. This situation does not favour the transfer of technology through licensing.

- The legislation by the DST on "Intellectual Property Rights from Publicly Financed Research and Development Bill 2008 [IPR Bill, 2008], gives South African universities an institutional framework very similar to Bayh-Dole. That is, universities have the opportunity to own the intellectual property rights to inventions created with government funds. The success of Bayh-Dole-like legislation (IPR Bill -2008) in South Africa will depend upon whether there will be increased research funding from government to universities, so that universities have a greater opportunity to develop new technologies independent of private sector funding.

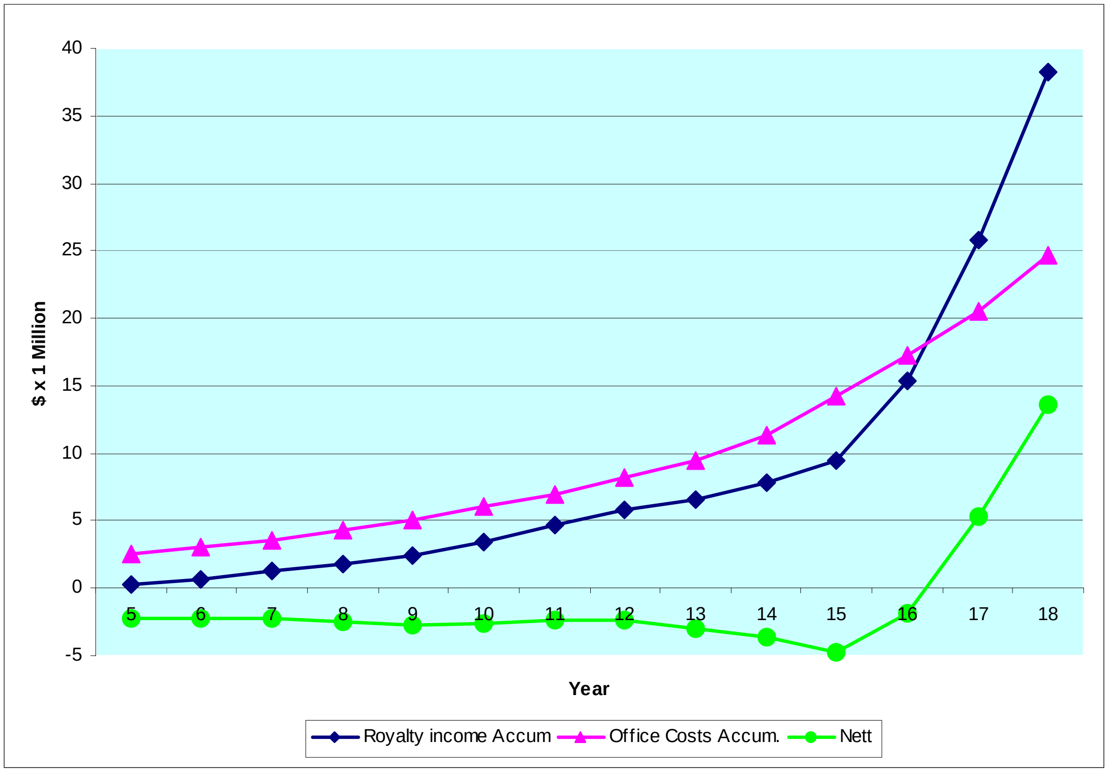


Figure 2.4: University of British Columbia: Break Even after 16 Years of Establishment of TTO

Source: Barnard, P. (2008) SARIMA Workshop: Practising Technology Transfer in SA, Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

This study also draws from Reamer *et., al.* (2003), who argue that significant increase of university patenting and licensing activity in the USA over the past several decades was fueled by two key factors, namely:

- The federal Bayh-Dole Act of 1980, which allows universities to retain patent rights on federally-funded R&D. The law seeks to promote greater technology commercialization and economic growth through permitting universities to create new revenue streams by patenting and licensing technologies developed with federal funds.
- Biotechnological nature of the research and the profitability of commercialization, along with major increases in federal biomedical research funding.

According to Reamer *et., al.*(2003), data below reflect the above factors:

- The annual number of patents granted to universities rose from 589 in 1985 to a peak of 3,340 in 1999 (falling to 3,087 in 2000).
- Universities' share of patents assigned to U.S. inventors climbed from 0.7 percent in 1979 to 3.6 percent in 1999 (falling slightly to 3.5 percent in 2000).
- For 73 major universities and research institutions, between the period 1991 and 2000:
  - The number of licenses yielding income rose from 1,990 to 5,653;
  - The annual number of new licenses executed went from 1,030 to 2,668;
  - An annual licensing income climbed from $149 million to $1.06 billion.
  - The share of university patents going to biomedical discoveries went from 11 percent in 1970 to 50 percent in 1999.
- Under the Bayh-Dole Act, universities and non-profit organizations are to license technologies to small businesses when feasible. Consequently, about two-thirds of licenses from academia and research institutions have been granted to small and start-up firms.

2.6.1 Income from Technology Transfer offices at Global level

Careful consideration of the nature of potential revenues and the merits of Bayh-Dole like legislation are important. Heher (2004) as (cited by Boettiger and Bennett) noted that an estimated 40% to 50% of USA Technology Transfer Offices (TTOs) operate at a net loss, and profitability often depends on income arising from one or more "blockbuster" patents. Figure 2.4 above illustrates this fact. (Break even after 16 years of operations).

In examining technology transfer across a range of countries, Heher (2004) stresses that the success of technology transfer in a country is highly dependent on national investment in research: "Without a well-funded, high quality research system, it is not possible for technology transfer to make any significant contribution to economic development." This is contrary to South African's situation where 58% of all university research funding comes from the private sector.

Heher (2004) also argued that while technology transfer offices produce an average return of 1% to 1.5% on research investment, the main benefits to technology transfer occur at a broader level, through direct and indirect economic impacts. According to Heher (2004), the timescale involved both in building a mature patent portfolio and in generating economic impacts through the formation of startups, the development of a formal technology transfer system may require a long-term commitment of public funding.

2.6.2 Entrepreneurial Nature of Universities in Europe

Burton (1998) made a comparative analysis on how universities operating in different European national systems have transformed themselves into successful entrepreneurial organisations. Burton's starting point was the need for universities to respond to change. Not gradual, controllable change but change of the tumultuous, edge of chaos variety, an endless stream of change driven by exponential growth in knowledge and expectations of universities that far outrun resources and capacity to respond.

According to Burton (1998), to proceed in an age of endemic complexity and uncertainty, entrepreneurially-led organisational transformation is required. The experiences of five European universities, namely: Warwick (England), Twente (The Netherlands), Strathclyde (Scotland), Chalmers (Sweden) and Joensuu (Finland), provided research based exemplars of how different universities have managed to join the entrepreneurial super-highway. Five key elements in each institution's recent history of active, self-instituting effort to change were identified as follows:

- A strengthened steering core, to fuse traditional academic values with stronger managerial perspectives.
- An enhanced development periphery to provide the university with a dual centre in which traditional disciplinary based departments are supplemented by centres that manage new interfaces with the external world.
- A discretionary funding base which is a prerequisite for adaptability, and must involve a will to cross subsidize from the departmental / faculty haves to the have-nots.
- A stimulated academic heartland which must be stimulated in ways which are compatible with disciplinary core values and approaches.

- An entrepreneurial belief that transcends the heroic chief executive or the management team and link up with other institution wide ideas.

Burton (1998) carefully leaves space for variations in organisational missions, markets, histories, strategies and structures. Whatever the local configuration, however, to be successful the elements must constitute “the five key elements” mentioned above.

2.6.3 Triple – Helix Collaborations

Emerging literature that reviews university-industry-government networked infrastructures supports triple-helix collaborations as the key to improving the conditions for innovation in a knowledge-based society include Shapira (2002), Campbell (2005), Leydesdorff (2003), Etzkowitz (2002), and Sutz (1998). Triple helix research partnerships are considered the best promise for establishing long-term organizational structures that allow for short-term intensive collaborative experiences, Campbell,(2005); Etzkowitz (2003); Langford, Hall, Josty, Matos and Jacobson (2005); and Leydesdorff and Fritsch (2005). The most cited excellent example of “triple helix” approach is Finland.

As a classic example and fundamental to Finland’s redevelopment in the 1990s, was the establishment of 22 Science Parks, specifically located on or near universities to promote the creation of new businesses in the regions. Fifteen years of experience has shown that Science Parks foster the founding, growth and internationalisation of innovative high-tech companies and act as conduits in collaboration with universities, companies and local authorities. Science Parks successfully bring together many players in joint research and development projects and actively identify research breakthroughs for commercialisation and technology transfer (Comins, 2008).

2.7 Global Innovation Scoreboard.

Becic (2008) cited International Comparison - Global Innovation Scoreboard, which gives different categories of innovation as follows:

- **The global innovation leaders** include Finland, Sweden, Switzerland, Japan, the US, Singapore and Israel.
- The group of **next-best performers** includes Germany, Denmark, Netherlands, Canada, the UK, Republic of Korea, France, Iceland, Norway, Belgium, Australia, Austria, Ireland, Luxembourg and New Zealand.
- The group of **follower countries** includes the Hong Kong, the Russian Federation, Slovenia, Italy, Spain, Czech Republic, Croatia, Estonia, Hungary and Malta.
- The group of **lagging countries** includes Lithuania, Greece, China, Slovakia, **South Africa**, Portugal, Bulgaria, Turkey, Brazil, Latvia, Mexico, Poland, Argentina, India, Cyprus and Romania.

2.7.1 South Africa Among the Lagging Countries

Among the “lagging countries”, South Africa is weakening in terms of research publications, and is losing ground to countries in Asia and South America, which are emerging as nations with strength in science (Pouris, 2005).

Figure 2.5 provides comparisons with selected countries, namely Brazil, Taiwan and South Korea. These three countries started from a lower base than South Africa in the early 1980s, but in the early 1990s overtook South Africa at an increasing rate (NACI 2006).

Table 2.1 (below) shows that South Africa has the lowest growth factor in research publication output of articles from the selected countries. It is evident that some African countries are doing well in terms of growth as compared to South Africa which appears to be stagnant. Similarly, Sibanda (2008), said by international standards, South African HEIs generally have very low patenting activity which appears to mirror a stagnant research output from its HEIs.

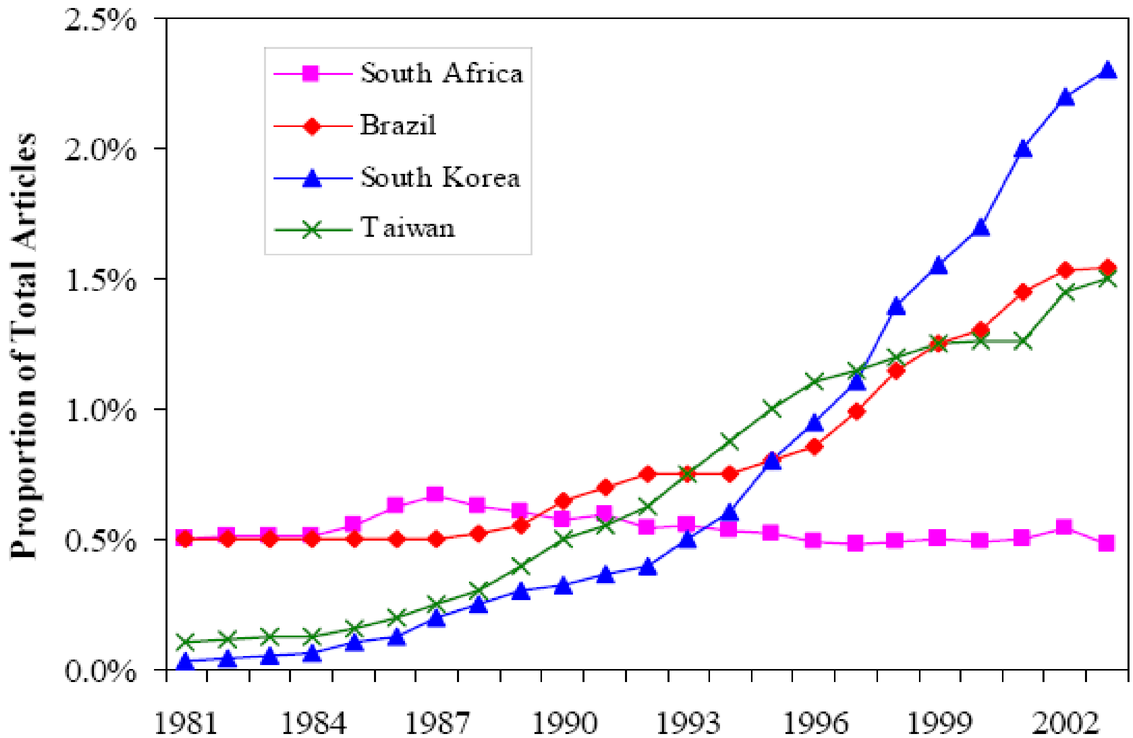


Figure 2.5: Share of World Research Publication Articles: South Africa, Brazil, Taiwan and South Korea (1981–2003)

Source: NACI 2006; The South African National System of Innovation. Background Report to the OECD Country Review. Pretoria.

Country	1994	2007	Growth Factor
China	10576	97846	9.25
Brazil	5630	26832	4.77
India	16580	35347	2.13
Tunisia	339	2032	6.00
Nigeria	830	1695	2.04
Egypt	2154	4063	1.89
South Africa	4300	7065	1.64

Table 2.1: Growth in Research Publication Output of Articles (1994 – 2007)

Source: Naidoo (2008); SARIMA conference Presentation June 2008

Based on the number of utility patents granted to South African inventors by the United States Patent and Trademark Office (USPTO), South Africa is losing ground in the international technological race. South Africa's share of granted patents in the USPTO halved from 0.13% in 1988 to a mere 0.07% in 2001. Finer analysis reveals a small shift towards modern technologies (such as biotechnology, pharmaceuticals, and computers and peripherals) and science (Pouris, 2005).

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
South Korea	943	1161	1493	1891	4259	3562	3314	3538	3786	3944	4428
Spain	141	148	157	177	248	222	270	269	303	264	264
South Africa	101	123	111	101	115	110	111	120	113	112	100
Ireland	48	47	77	71	71	90	121	141	127	163	186
India	27	37	35	47	85	112	131	178	249	341	363

Table 2.2: Numbers of Patents Granted by the US Patent Office to Selected Countries (1994 To 2004)

Source: NACI, 2006; The South African National System of Innovation: Background Report to the OECD Country Review. Pretoria.

South Africa's performance in the area of intellectual property protection and exploitation started from a weak base and has weakened further over the last ten years. Table 2.2 shows that, during the period 1990 to 2001, the number of patents registered in the US Patent Office by South African inventors has remained almost unchanged (114 in 1990 and 120 in 2001). Over the same period, other countries performed significantly better. For instance, Ireland increased its patents in the US Patent Office from 54 to 143, Spain from 130 to 269 and South Korea from 225 to 3 538 in 2001 (NACI, 2006).

South Africa's Technology Achievement Index (as shown in Figure 2.6) was 0.34 in 2000, which was lower than countries such as South Korea (0.666), Australia (0.587) and Malaysia (0.396). The relatively low value of South Africa's index is due to poor performance in the areas of patents, royalties, Internet hosts and tertiary education. The latter reinforces the need to develop South Africa's human capital in order to achieve economic progress and consequently an improved quality of life for all (NACI, 2006).

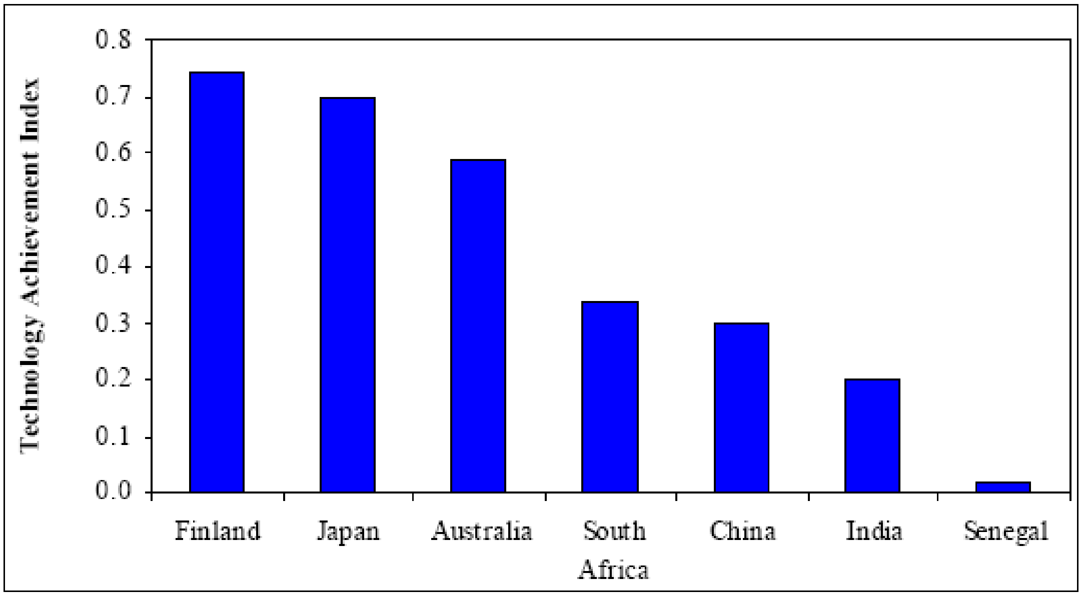


Figure 2.6: Country Comparison Using the Technology Achievement Index (2002)

Source: NACI, 2006; The South African National System of Innovation: Background Report to the OECD Country Review. Pretoria.

Furthermore, income from royalties and license fees has been almost negligible and South Africa has a significant negative balance of payments with respect to intellectual property, hence the description of South Africa as a 'technology colony' (NACI, 2006).

It can be argued that the reason for this decrease could be due to South Africa's technology policies, which could be inferior to those followed in countries such as India, South Korea, Israel, and Brazil, which have enabled them to increase considerably their patent ownership during that period, (Pouris, 2005). This study analyses technology progress in some of the emerging economies like India and Brazil, which at one time were below South Africa in terms of the World share of published articles as shown in Figure 2.5.

2.7.2 Indian Innovation System and its Performance

According to Dutz (2007), India has a strong record in producing basic knowledge, as proxied by internationally referred scientific and technical publications. In 2003, the number of Indian scientific and technical articles published in internationally recognized journals tracked by the U.S. National Science Foundation was 12,774, compared with 8,684 from Brazil, 13,746 from Korea, and 3,747 from Mexico. However, India is lagging behind China (27,816) and Russia (15,782).

A ranking of patents granted in the United States between 1995 and 2004 showed India in 24th place worldwide. Most of the top countries were OECD members. But seven non-OECD economies placed ahead of India include: Taiwan (China), Korea, Israel, Singapore, Hong Kong (China), China, and Russia, in that order. The last two may have been expected, China because of its size and Russia because of its technological legacy. Israel is also a special case, but the high rankings of Taiwan, Korea, Singapore, and Hong Kong indicate the importance that these small economies place on competing in the global market based on innovation (Dutz, 2007).

The Indian Innovation System can be viewed as a system that is presently going through an evolution phase. The Indian innovation system is continuously adapting itself to the newer ways of conducting R&D and funding the same. India is keen to adopt select features of innovation systems in other countries to improve its effectiveness. In this era of globalization, the Indian Innovation System would be keen to participate in a global innovation system, wherein an idea is generated in one part of the world, prototyped in another and commercialized in yet another part of the world for global consumption
(Joshi, 2005).

India's technological innovation system consists of three broad segments which enables the journey of an idea from human "mind" to "market". The first phase is called the "Birth Phase" where a commercially viable idea gets converted into a workable prototype / process. The next phase is called the "Survival Phase" wherein up-scaling of the prototype to the pilot plant / pre-commercial stage is done. The third phase is called the "Growth Phase" wherein the pilot production is up-scaled to commercial production (Gupta and Dutta, 2005).

2.7.3 Innovation in Brazil

In Brazil, overall research funding has risen from 0.7% of GDP in 1994 to 0.8% of GDP in 2002. By 2004, over 70% of the research conducted in Brazil was performed by public research organizations and the 30% attributable to the private sector was also funded by the government. However, the share of government funding in overall research had declined over the last 15 years, as the private sector had slowly increased expenditures on research since the liberalization of Brazil's economy in the early 1990's (Lehman and Garduno,2004).

The relative roles of the public and private sector in research funding indicated that Brazil's innovation system was largely public research oriented and that the majority of research and development activity in the country was focused in universities and government research laboratories. Brazil has been in the process of making several changes to its innovation system over the last several years. For instance, Brazil has altered its institutional environment, through legislation that brought the overall intellectual property regime up to international standard and other legislation which has clarified the rights and obligations attached to intellectual property developed by university researchers (Lehman and Garduno 2004).

Despite some efforts to facilitate change, technology transfer has not taken root in Brazil. For example, of the 156 universities in Brazil, only 27 provide any kind of support to researchers interested in patenting their inventions (Lehman and Garduno 2004). The Brazilian government in recent years has released many incentives to innovation. These innovation incentives are reaching universities, R&D centers, and private companies. This has increased patenting and technology transfer activities in Brazil and strengthened the relationship between public institutions and private companies, contributing strongly to innovation. Di Giorgio (2007) argued that in recent years, patenting and technology transfer activities have become institutionalized in Brazil. With regard to intellectual property, Brazil was at a crucial juncture. A concrete example was Inova, the technology licensing office of the state university of Campinas. Other public universities and R&D centres have been studying and trying to understand Inova's model, in order to follow its example. Unicamp is not only Brazil’s biggest patentor but also the country’s biggest licensor as shown in Table 2.3, (Di Giorgio, 2007).

No.	INSTITUTION	NO. OF ISSUED PATENTS
1	Unicamp	191
2	Petroleo Brasileiro Sa (Petrobras	177
3	Arno Sa	148
4	Multibras Electrdomesticos Sa	110
5	Semeato Sa Ind .E Com	100
6	Companhia Vale Dorio Doce	89
7	Fapesp	83
8	Brasil Compressores SA	81
9	Dana Ind Ltda	71
10	Universidade Federal De Minas Gerais	66
11	Johnson And Johnson Ind. E Com.Ltda	56
12	Universidade Sao Paulo	55
13	Jacto Maquinas Agricolas	54
14	Minas Gerais Siderurgia (Usiminas)	48
15	Electrolux Do Brasil Sa	45
16	Embrapa	42
17	Conselho Nacional De Desenvolvinmento Cientifico E Tecnologico	42
18	Universidade Federal Do Rio De Janeiro	38
19	Unesp	34
20	Dexie Toga SA	31
	Total	**1561**

Table 2.3: Patenting Activities in Brazil: A Ranking of Institutions (Total Patents Issued From 1999 to 2003)

Source: Di Giorgio, 2007; From University to Industry: Technology Transfer at Unicamp in Brazil. In Intellectual Property Management in Health and Agricultural Innovation: www.ipHandbook.org

2.8 South African Government Initiatives in Innovation Performance

In recent years, the South African government has sought to reverse the Gross Expenditure on Research and Development (GERD) decline, and has adopted a National Research and Development Strategy in 2002, which aims to increase the GERD/GDP ratio to at least 1%. Reaching this target will put South Africa in the same league as Brazil, New Zealand, Spain and the Czech Republic, but still far below the OECD average and that of countries such as Sweden and the US (NACI 2006). The Science Citation indexed 17 South African scientific journals as shown in Table 2.4. This number is equal to or larger than the number of journals published in countries that are substantially more research intensive than South Africa, such as Sweden, Finland and Greece (NACI 2006).

	Australia	Spain	Ireland	South Africa	Sweden	Belgium	Finland
Journals in ISI	64	26	18	17	11	13	11
GERD /GDP	1.55	0.96	1.17	0.76	4.27	2.17	3.42

Table 2.4: ISI-Indexed Journals and GERD/GDP in Selected Countries

Source: NACI (.2006); The South African National System of Innovation. Background Report to the OECD Country Review. Pretoria

While the number of publications may indicate productivity, citations are used to reflect on quality. King (2004) as cited by NACI (2006), argued that a recent comparison of citation rates showed that South Africa is the only African country among the top 31 countries, ranked according to normalised citation rates per article (see Table 2.5). In addition, the data indicate a rising citation rate or impact factor associated with South African articles within the global scientific literature, but below the world average of 1.0.

Country	Australia	South Africa	Greece	South Korea	Brazil	India	Iran
2002	1.09	0.76	0.70	0.64	0.58	0.48	0.42
1993 - 2002	1.01	0.61	0.67	0.61	0.62	0.40	0.44

Table 2.5: Normalised Citation Rates per Article (1993–2002)

Source: NACI (2006); The South African National System of Innovation: Background Report to the OECD Country Review. Pretoria

According to Comins (2005), South Africa was ranked 39th out of 162 countries in terms of technological achievement in 2008. However, it is clear that South Africa is still largely perceived as an adopter rather than innovator of technology. To retain the global player status, South Africa has to augment the imported and implanted technologies. It is imperative to create environments that spur innovation and exploit intellectual property, to feed the technology commercialisation value chain that will ensure revenue generation (Comins, 2005).

However, South Africa still operates its national system of innovation on the basis of a second generation innovation policy paradigm, which emphasises the importance of systems and infrastructures that support innovation. The third generation innovation policy paradigm makes innovation a government-wide policy and aims to maximize the chances that regulatory reform in other domains will support innovation objectives, rather than impede or undermine them (HESA, 2006).

The European Commission report (2002), as cited by HESA (2007), argues that current “second generation Innovation policy”, emphasizes importance of the systems and infrastructures that support innovation. These, however, are influenced by many policy areas, in particular, research, education, procurement, taxation, intellectual property rights and competition policy. But these policy areas are not developed with innovation issues in mind and the need to work together is not recognized. Thus the need for the “third generation innovation policy” so as to maximize the chances that regulatory reform will support innovation objectives, rather than impede or undermine them (HESA, 2007).

The South African government is well aware of the need to stimulate entrepreneurship, innovation and growth amongst knowledge-intensive businesses. Science and technology education, innovation and commercialisation are integral components of South Africa's National System of Innovation (NSI). The key challenges are adequate funding, skilled human resources, improved private sector R&D, protecting and exploiting intellectual property, and integrating a fragmented government science and technology system. The National R&D Strategy of 2002 highlights the "commercialisation chasm" between R&D and business sectors and the need to develop improved technology transfer mechanisms. While there have been significant increases in the R&D spending in South Africa, this will need to result in a commensurate level of exploitation to impact on the economy (Comins, 2008).

2.9 Innovation at South African Higher Education Institutions (HEIs)

OECD (2007b:7), stipulates that governments should promote the capacity of universities to enhance innovation and wider social, cultural and environmental development in their regions in the following ways:

- Universities should be encouraged to adopt a strategic stance and promote a better alignment of their activities with regional priorities. Co-operation with public agencies in Finland and the USA has shown that universities could bring key contributions to this adjustment.
- Universities should be encouraged to widen their portfolio of services to firms and communities. Many universities are not research – intensive but they can be entrepreneurial and develop an integrated approach to firms emphasizing non-technological aspects such as legal, workforce, infrastructure issues and others. Problem- solving and public- space functions could be further developed.
- Many universities are becoming global actors and are developing a network of national and international affiliates. This connectivity should be mobilized to allow regional and local firms to network outside regional boundaries.
- Even if measurement is difficult and controversial, engagement policies will not be improved without sound evaluation processes. There is need to strengthen universities' accountability to society by developing indicators and monitoring outcome to assess universities' regional performance.

OECD, (2007a) argues that regional engagement by universities is beneficial to both local development and the universities themselves. The report further states that universities could play a stronger role in the economic, cultural and social development of their regions. Similarly, OECD (2007b) argues that universities are important players in all national and regional innovation systems, yet they are under-exploited. Furthermore, OECD (2007b:1) argues that contribution of HEIs to developing their home regions has not previously been a major concern for public policy or the HEIs themselves. But this is changing with the expansion of higher education, particularly in the non- university sector, which in some cases has aimed to address regional disparities.

In the South African context, limited evidence previously existed to indicate the extent to which universities were engaging in innovation. The South African Research and Development Strategy ("R&D Strategy") identified disparate practices in respect of ownership, management and commercialization of intellectual property emanating from publicly financed research at these Institutions (DST, 2002). The R&D Strategy proposed a need for harmonization of intellectual property practices and establishment of a dedicated fund to finance the securing of intellectual property from publicly financed research. Since then, some of the institutions have proceeded to develop and implement intellectual property policies aimed at ensuring certainty in respect of ownership, commercialisation and technology transfer of intellectual property developed at the institutions (Sibanda, 2008).

HESA survey (2007) showed that South Africa's Higher Education sector is in the early stages of institutionalizing technology transfer and creating the necessary infrastructure. HESA survey 2007 findings signaled that technology transfer and diffusion activities are taking root in South Africa's public universities. Approximately 60% of the universities that participated in the survey indicated that technology transfer was included in their mission statement, with 80% saying that they had intellectual property (IP) policy. However, only a few universities were found to have regulations requiring their staff to declare different types of intellectual property. Furthermore, only four of the 17 universities that participated in the survey indicated that they had comprehensive institutional strategic plans for business support.

HESA (2007) also noted that in the course of 2006, the DST requested comments on the Intellectual Property Rights from Publicly Financed Research Framework (DST 2006), which resulted in the Intellectual Property Rights from Publicly Financed Research Bill (2007b). The Bill appears to have had a dual impact on the Higher Education sector. The beneficial effect has been the establishment by the majority of universities of their own intellectual property rights regulations, mainly advocated by the framework and the subsequent bill. On the other hand, the bill has been criticized both for being punitive and paying little attention to linking incentives to compliance and performance. This could be responsible for the decrease in the number of disclosures and start–ups in 2006, from HEIs resulting from uncertainty introduced by the process. At this stage of development of National System of Innovation (NSI), any such a bill should be enabling in character and should provide support for the introduction of culture of technology transfer at the country's HEIs (HESA, 2007).

According to HESA (2007) findings, South African universities are over- dependent on industrial funding for their research and development activities. The dependency creates concerns for the universities. For example, in the event of a downturn in the economy, will the HEIs be able to maintain their research activities? How will over- reliance on industrial funds affect HEI character? What will be the consequences of the replacement of direct incentives with indirect ones? The above concerns are reflected by the data shown in Table 2.6. According to NACI (2006), the business sector was a major performer and financer of R&D in the South Africa in 2004 / 2005. The business sector funded 45% and performed 58% of total R&D. The Higher Education sector undertook 21% of all R&D, and government performed 21% but financed 33% of total R&D.

		R & D Performer			
		Business	Government	Higher Education	Total
R & D Funder	Business	4735	296	426	5457 (45.4%)
	Foreign	1280	312	241	1833 (15.3%)
	Government	520	1727	1710	3957 (33.0%)
	Other	430	176	157	763 (9.1%)
	Total	6965 (58.0%)	2511 (20.9%)	(2534) (21.1%)	12010

Table 2.6: Major Flows of Funding for R&D, 2004/05 (R Millions) for South Africa

Source: NACI 2006; The South African National System of Innovation: Background Report to the OECD Country Review. Pretoria.

Further findings from HESA (2007) survey revealed the followings facts regarding the Technology transfer and diffusion in South African HEIs:

- TTOs in South African universities have only fairly recently been established and are understaffed. The median office has been in existence for three years and the average number of staff is 1.17. This is contrary to the USA where most TTOs in universities have existed for more than 12 years, with the median office employing five staff members.
- Invention disclosures and start-up companies were found to be apparently fewer in number in 2006 compared to the previous year. The decline could be as a result of the uncertainty created by the introduction of the DST of the Intellectual Property Rights from Publicly Financed Research Framework (DST, 2006), which led to the introduction of the Intellectual Property Rights from Publicly Financed Research Bill, (DST, 2007b) and became an Act in 2008.
- South African universities produce a small number of patents. A large number of individual universities in the USA produce more patents than all of the South African universities together. The phenomenon could be attributed to lack of support for technology transfer activities and the character of South African HEIs in emphasizing undergraduate teaching social sciences and humanities research.

- Tshumisano Trust and the National Research Foundation (NRF) are institutionalised policy instruments aimed at promoting technology transfer and research respectively in the higher education sector. In achieving their objectives, both institutions fail to exert their full potential influence. Their current approaches create isolated islands of influence and operating in environments not always conducive to their objectives.

2.10 Comparative Analysis of Patenting Activity in South African HEIs

Sibanda (2008), made a comparative analysis of patenting activity to publication output in respect of the most prolific academic inventors and provided some useful insights on the extent to which patenting affects publication. His study reviewed the institutional arrangements for the management of IP and technology transfer at the institutions and various policy initiatives by the DST. His study further suggested that these initiatives are already contributing to changing the culture at South African institutions and proposed some goals to be achieved in order to transform the manner in which research results are handled. Some of Sibanda's observations have been summarised as follows:

- Despite an increase in the filing of provisional patent applications between 2001 and 2007, the number of complete patent applications filed at CIPRO by the institutions and the number of granted patents to the institutions remained fairly stagnant.
- There is a big variation in patenting activity amongst the institutions. The Universities of Stellenbosch, Cape Town, Pretoria, North West, and the Witwatersrand have the most patenting activity amongst the HEIs. However, there is generally a low rate of patenting by South African institutions at both local and International levels. Science councils, particularly the CSIR, have significantly higher patenting rates than HEIs. This is consistent with findings in Europe (Montobbio, 2007), where it was established that public research organisations relatively have higher number of patents than universities.

- Subjective assessment in respect of the skills and capacity at the institutions showed that most of the institutions did not have the required infrastructure to manage the process of invention disclosures, filing of patent applications, and technology transfer. Of particular concern was the lack of institutional policies in respect of intellectual property issues at most of the institutions, particularly at the HIEs. Sibanda concluded that there is limited capacity, based on the skills and experiences of the personnel at the Institutions with TTOs (See Table 2.7 and Figure 2.7).

- TTOs in South Africa are relatively young, with an average age of approximately 3 years. TTOs were more established at UCT, US and UP. However, there has been high staff turnover in those TTOs since their establishment, thus significantly impairing their ability to consolidate the experiences and lessons learnt to strengthen their technology transfer activities. TTOs in South Africa have on average around 2 professional staff compared to 8.7 in Europe (Montobbio, 2007) and most of the technology transfer offices operate as stand-alone cost centres within the institutions.
- Overall, the numbers of publications per higher education institution were higher than the patent applications filed and /or granted patents. One possible explanation for this misalignment was the fact that publications as opposed to patents form the core of subsidy determinations at higher education institutions, by the Department of Education and also promotion of academics at higher education institutions. There is therefore, a disjuncture between the policy approaches of the Department of Education [DoE] and the Department of Science and Technology [DST], with the DoE, supporting and promoting the traditional outputs i.e. publication in peer-reviewed journals while the DST's main emphasis is on the impact of scientific endeavor in the lives of South Africans.

- The top five academic inventors, based on the PCT applications were of the view that the adverse effect that patenting has on publication, is in respect of publication delays necessitated by a need to comply with novelty requirements of patentability. In some cases, where there were protracted delays, some of the publications had to be abandoned as the results had either become obsolete or there was better data. It does appear that whether to prioritize publication or patenting is wholly dependent on a variety of factors, including the type of research being undertaken, and also the technology area, with more commercial or market focused research being more prone to patenting, with possibilities of publication depending on whether the research results can be suitably packaged for a publication.

NO.	**INSTITUTION**	**IP POLICY**	**TTO CAPACITY (Year Established)**
1	University of Pretoria (UP)	YES	Limited (1996)
2	University of Cape Town (UCT)	YES	Limited (2002)
3	University of Stellenbosch (US)	YES	Yes (1999)
4	University of the Witwatersrand (WITS)	YES	Limited (2003)
5	University of KwaZulu - Natal (UKZN)	NO	Being Established.
6	Nelson Mandela Metropolitan University (NMMU)	YES	Limited (2007)
7	North West University (NWU)	YES	Yes (2003)
8	Durban University of Technology (DUT)	NO	NO
9	Tshwane University of Technology (TUT)	YES	Limited (2005)
10	Rhodes University (RU)	YES	NO
11	Walter Sisulu Metropolitan University (WSMU)	YES	NO
12	University of Limpopo	NO	NO
13	University of Fort Hare	NO	NO
14	Cape Peninsula University of Technology	NO	NO
15	Vaal University of Technology	NO	NO
16	University of Johannesburg	YES	Limited (2004)
17	Central University of Technology	NO	NO
18	Mangosuthu University of Technology	NO	NO
19	University of Zululand	NO	NO
20	University of Western Cape	NO	NO
21	UNISA	NO	NO
22	Medical Research Council (MRC)	YES	Yes (2004)
23	CSIR	YES	Yes (2001)
24	Water Research Commission (WRC)	YES	Limited (2003)
25	Agricultural Research Council (ARC)	YES	NO
26	Mintek	YES	Limited

Table 2.7: Existence of Institutional Policies and TTO Capacity at Institutions

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

2.11 Summary

Generally, countries worldwide, including South Africa, are striving to stimulate innovation as a fundamental source of competitiveness and are building on locally generated intellectual property. One aspect of innovation systems is the important role played by HEIs. However, it should be noted that the success of technology transfer in a country is highly dependent on national investment in research. Without a well-funded, high quality research system, it is not possible for technology transfer to make any significant contribution to economic development. South Africa is aware of this fact and is developing an institutional framework as it looks for ways to promote and strengthen technology transfer at its universities.

HESA survey 2007 findings signal that technology transfer and diffusion activities are taking root in South Africa's public universities. Sibanda's recent study indicates that technology transfer offices in South Africa are relatively young, with an average age of approximately 3 years. Evident in this literature is an anomaly in the case of University of KwaZulu – Natal, where there is high publication output and negligible patenting activity as at the end of 2007.

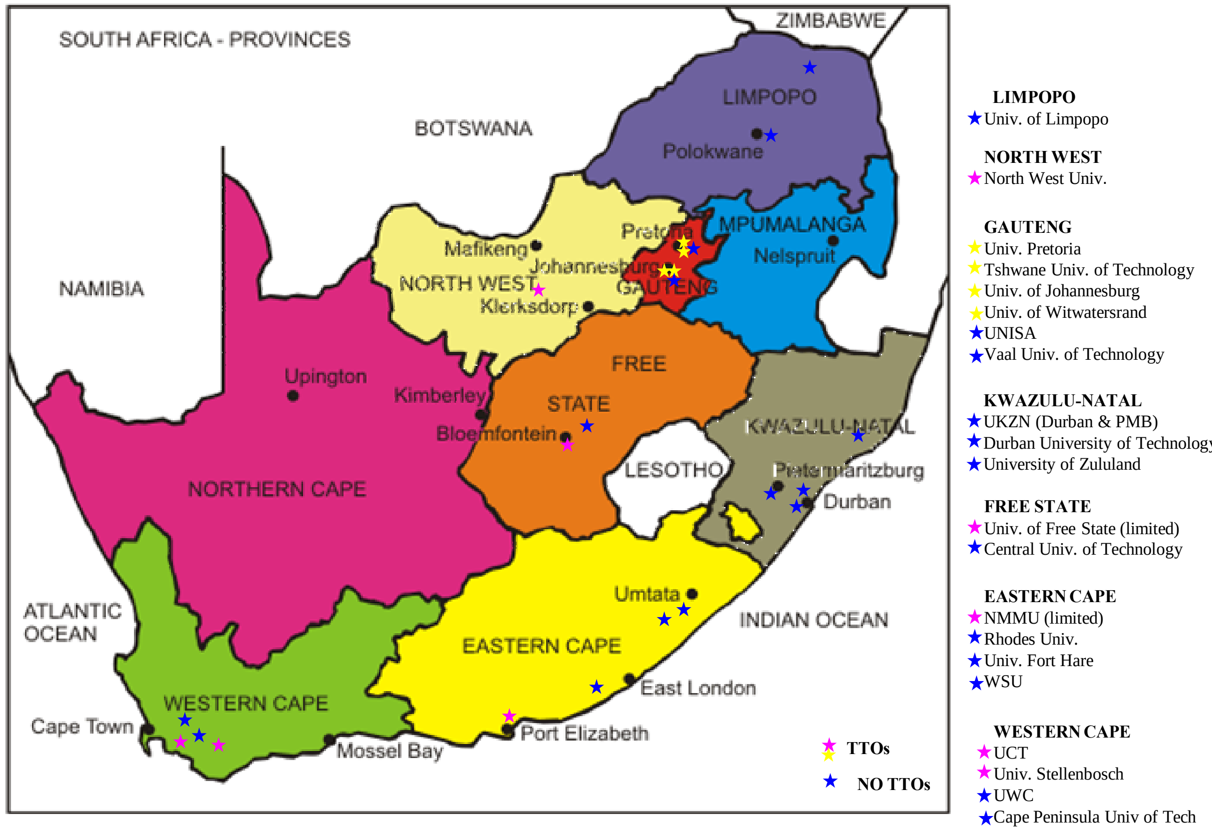


Figure 2.7: Infrastructure of Technology Transfer Offices (TTOS) in South African HEIs (2007)
Source: Sibanda, 2008; SARIMA Workshop; Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

3 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The research methodology presents an account of how the research was carried out. It describes sampling, data collection techniques and analysis of data. This research adopted a case study approach in examining Innovation at UKZN in some detail and sampling some of the HEIs in South Africa. The data collected was mainly qualitative and quantitative in some nature. Therefore, in this study, the research design was dependent on both qualitative and quantitative research techniques that were used.

3.2 Research Design

Research design is the blueprint for fulfilling objectives and answering questions.
In this study, the research design provided answers to questions such as: What techniques would be used to gather data? What kind of sampling would be used? How would time and cost constraints be dealt with?

3.3 Methods and Instruments of Data Collection

The main types of data included both primary and secondary data. Primary data was the new data that was specifically meant for the purpose of this study, whereas secondary data included published summaries that had already been collected for other purposes. Primary data according to Saunders *et.,al.* (2003) is usually collected through observation, interviews, and questionnaires. In conducting this study, both primary and secondary sources of data were used to achieve the study objectives.

3.3.1 Primary Sources of Data

During the study, observation and interviews were the major instruments used to collect the primary data. Churchill (1992) defines observation as a fact of everyday life. He argues that we are constantly observing other people and events as a means of securing information about the world around us. Observation was used in the case study of UKZN as it provided first hand information on the area of the study especially that the observer is a staff member of UKZN Innovation.

3.3.1.1 Interviews

Saunders *et., al.*(2003), consider an interview as a purposeful discussion between two or more people. Interviews in this regard helped in gathering valid and reliable data that was relevant to research questions and objectives.

According to Partington (2001), interviews that are usually conducted for qualitative research rely on the nature of the interactions with the interviewees for quality purpose. Some of the factors that contributed to quality interactions included the importance of empathy and rapport, listening and questioning, restatement, clarification and persistence. The researcher was aware of the powerful influence of these factors on the responses of interviewees. The researcher thus took steps to ensure quality data was obtained by using appropriate interview techniques.

Due to distance, time and cost constraints, the researcher had scheduled the interviews to be conducted via teleconference with the Technology Transfer Officers of the sampled HEIs countrywide. However, an opportunity arose where all the TTOs in South Africa were participating in a two day - SARIMA conference in Cape Town. The researcher attended the conference and had the opportunity to conduct his interviews. The presentations at the SARIMA conference were also relevant to this study and were used as source of primary data. Permission was sought for the interviews and presentations to be recorded and this assisted during the reviewing process.

3.3.2 Secondary Data Review

Secondary data involved the appropriate information from text books, articles on the internet and journals. Any secondary data source on innovation that the researcher came across was evaluated for point-of-view and accuracy to ensure the interpretation was valid for the study. Secondary data was helpful as such a study had been carried out before, thus giving the researcher the necessary background and guidelines to the research. This method could be used to test results from other methods. This method was further used in the study to review literature on research, innovation and technology transfer especially as applied to the study.

3.4 Sampling Design

Sampling design decisions were important aspects of research design and included both the sampling plan used and the sample size. Probability sampling plans lead to generalizability and non- probability sampling designs (though not generalizable) offer convenience and timely information (Sekaran, 2003). For this study, non probability sampling method called purposive sampling (Sekaran 2003), was used to obtain information from specific target group of TTOs from research oriented HEIs, referred to as the "Big Five".

Judgment Sampling (Sekaran 2003), to some extent was also used when making a choice of an additional three HEIs that were most advantageously placed and were in the best position to provide the required information on technology transfer. These institutions included North West University (NWU), Nelson Mandela Metropolitan University (NMMU) and the neighboring -Durban University of Technology (DUT).

The basic idea of sampling was that, by selecting some of the elements in a population, a researcher would draw conclusions about the entire population. There were several compelling reasons for sampling, including lower cost, greater accuracy of results, and greater speed of data collection and availability of population element. The ultimate test of a sample design in this study was how well it represented the characteristics of the population it purported to represent (Cooper & Schindler, 2001).

In measurement terms, the researcher ensured that the sample would be valid, accurate and precise. According to Cooper & Schindler, (2001), "An accurate sample is one in which the underestimates and overestimates are balanced among the members of the sample. This case happens when there are enough elements in the sample". The researcher made sure that, those conditions were met. For example, out of the population of 23 HEIs in South Africa, 11 are traditional universities, 6 are universities of technology and 6 are comprehensives (Eloff, 2008). The sample was represented by both traditionally research oriented universities and universities of technology.

3.5 Sample Size

The sample size was determined by the level of precision and confidence desired in estimating the population parameters as well as the variability in the population itself (Sekaran, 2003). The focus was put on a sample size of 8 out of the population of 23 HEIs that were issued with interview schedules during the Month of October 2008. The interview schedules were developed and sent to the TTOs of the “big five” research oriented HEIs (UKZN inclusive) and other three HEIs in other provinces, namely: North West, Eastern Cape and one other Institution in KwaZulu-Natal province. Six out of eight TTOs availed themselves for the interview, thus achieving a response rate of 75%, which could be considered as good. According to the HESA 2007 survey report, similar efforts abroad usually have lower response rates. For example, response rates for the AUTM licensing surveys in USA and Canada tend to be 65% or lower, (AUTM, 2005, 2006 and 2007 as cited by HESA, 2007). HESA 2007 survey itself had 74% response rate.

3.6 Validity

Validity refers to the evidence that the instrument, technique or process used to measure a concept does indeed measure the intended concept, (Sekaran, 2003). According to Zattman (in Ghauri and Gronhaug 2002), validity is the extent to which an operationalisation measures the concept which it purports to measure.

In terms of internal and external validity, the researcher was concerned about the issue of the authenticity of the cause-and-effect relationships (internal validity) and their generalizability to the external environment (Sekaran 2003).

External validity was ensured in that although the focus of this study was on UKZN, the results could be generalised for other HEIs. The aspect of the accuracy of information from respondents was a priority in this study thus ensuring internal validity. The interview schedule was adopted from that used by the Manley Panel on commercialisation of research and Technology Transfer at the University of Toronto (Manley, 2004). The University of Toronto Commercialisation model could be relevant to the South African HEIs which are adopting IPR Act of 2008 that has been modeled on the USA law, the Bayh-Dole Act of 1980.

The areas covered in the interview schedule included: Business model background and its mandate, comparative performance, institutional structure, management's effectiveness, external relationships, culture, among other factors.

Ghauri and Gronhaug (2002) state that, construct validity is necessary for meaningful and interpretable research findings and can be assessed in various ways;

- Face Validity- tells to what extent the measure used seems to be a reasonable measure for what it purports to measure. A simple test for face validity is to ask for the opinion of others acquainted with the actual topic.
- Convergent Validity- tells to what extent multiple measures of and /or multiple methods for measuring the same yield similar (comparable) results. Co- relational techniques are often used to assess convergent validity.
- Divergent validity- tells to what extent a construct is distinguished from another construct. If a researcher measures, say 'innovation', he or she should be confident of not measuring another construct for example 'organisational resources'.

Against the backdrop of the above definitions by Ghauri and Gronhaug (2002), the researcher sought the opinion of his supervisor and the individuals acquainted with the topic on innovation and its measurement at HEIs. The researcher further developed confidence through review of related literature on innovation.

3.7 Reliability

"Reliability attests to the consistency and stability of the measuring instrument", (Sekaran 2003). According to Saunders *et., al.* (2003), "Reliability is the degree to which data collection method(s) yield consistent findings, similar observations would be made or conclusions reached by other researchers or there is transparency in how sense was made from the raw data". The researcher's interview schedule was designed and pre-tested to ensure that the questions were clear to the respondents and that they yielded results relevant to the research objectives. This ensured that the responses from participating HEIs were all consistent.

3.8 Ethical Considerations

Ethics in business research refers to the code of conduct or expected societal norm of behavior while conducting research. Ethical behavior pervades each step of the research process- data collection, data analysis, reporting and dissemination of information on the internet (if such an activity is undertaken). It also relates to how the subjects are treated and how confidential information is safeguarded (Sekaran 2003).

In this study, the researcher ensured that the ethical issues were strictly complied with. The research was designed in a manner that did not subject the research population to embarrassment or any other material disadvantage. The researcher fulfilled all the necessary requirements and ethical clearance was granted to him by the UKZN Research Ethics Committee. Consent from individual participants was ensured. Ethical issues further looked at the implications for the negotiations of access to the HEIs surveyed. An authorisation letter for data collection was acquired from UKZN and was presented to each HEI to grant permission to do the research. Gate-keepers' letters were obtained from respective HEIs that participated in the survey. The researcher further undertook to safeguard the researched information with the UKZN Graduate School of Business for 5 years.

3.9 Time and Cost Factors

Appropriate decisions on the study design were based on the problem definition, research objectives, the extent of rigor desired and the cost considerations. "Sometimes, because of the time and costs involved, a researcher might be constrained to settle for less than the ideal research design" (Sekaran 2003).

The trade-off between rigor and resources was a deliberate and conscious decision made by the researcher based on the scope and reason for the study. For example, due to limited time, the researcher chose to conduct "one-shot" or cross-sectional studies whereby most data was collected from a two day conference of TTOs held on 27th and 28th October 2008 in Cape Town. This reduced the travel costs of visiting individual HEIs. Data collected at one point in time was sufficient to answer the research questions and for the study to be submitted by the set university deadline date.

3.10 Case Study

Case study is a documented history of noteworthy events that have taken place in a given institution. Case studies involve in-depth contextual analyses of similar situations in other organizations, where the nature and definition of the problem happen to be the same as experienced in the current situation. Case studies usually provide qualitative rather than quantitative data for analysis and interpretation (Sekaran 2003).

Besides using sampling techniques in comparative study, whereby data was collected from several settings of HEIs in South Africa, this study focused on UKZN as a case study. Authentic case studies are difficult to find because many companies or institutions prefer to guard them as proprietary data (Sekaran 2003). Nonetheless, careful scrutiny of the Report of the Manley Panel on Commercialization and Technology Transfer at the University of Toronto (Manley 2004), gave the researcher several clues as to what factors might be operating in UKZN and how the challenges might be addressed.

3.11 Data Analysis

Data was mainly obtained through recorded interviews, conference presentations, observation and secondary sources. Data analysis involved the review and editing of recorded interviews and presentations. Questions in the interview schedule were the main basis along which data was arranged and interpretation of open-ended questions made. Both inferential and descriptive statistics were used to analyze the data. Data obtained by observation method especially at UKZN was analyzed during the data collection process and proper interpretation was ensured. Figure 3.1, was used as a guide for data analysis.

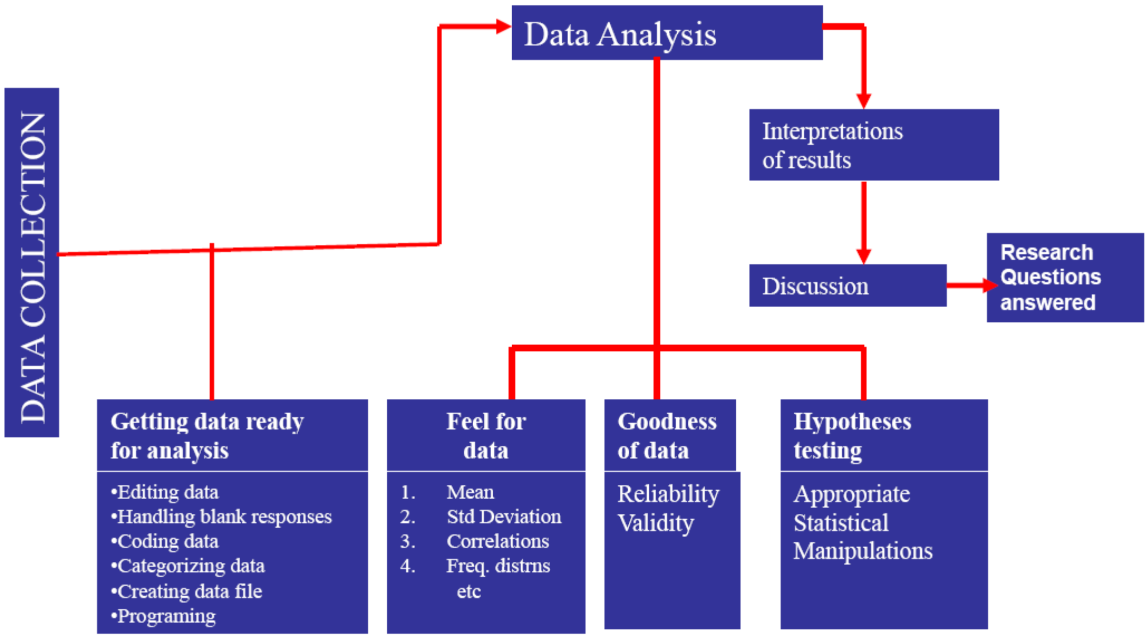


Figure 3.1 Flow Diagram of Data Analysis Process

Source: Sekaran, U. (2003); Research Methods for Business. 4th Edition John Wiley and Sons, Inc.

Nowadays, data analysis is routinely done with software programmes such as SPSS, SAS, STATPAK, and the like. (Sekaran 2003). Those programmes become handy, user-friendly and avoid confusion especially when there are many questions and a large number of questionnaires to analyze. However, for this study, there were less than ten participants and there were few open ended questions to analyze. For that matter, data was analyzed manually. Recorded interviews and presentations were analyzed by use of content analysis which involved a systematic and objective quantitative analysis of message characteristics (Neuendorf, 2002). The Excel programme was used to come up with tabulations, tables, graphs and charts that were used in data presentation.

3.12 Summary

In this chapter, an account on how the research was carried out has been outlined to include the research design, methods and instruments of data collection, sampling techniques, validity and reliability of the selected instruments used for data collection. Ethical considerations, resource constraints and data analysis process has also been discussed in this chapter. It is worth noting that the case study approach has been used to investigate why there is negligible technology transfer at UKZN compared to its peers. This has been discussed in the next chapter.

4 CHAPTER FOUR: CASE STUDY OF UKZN

4.1 Introduction

This chapter gives an overview of UKZN as an institution that thrives in research and academic excellence and defines itself as “the premier university of African scholarship”. Research output by faculty, research policies, institutional effort and challenges for technology transfer in UKZN are discussed in this chapter. Analysis of innovation support model as per relevant sources and detailed interview with the Chief Executive Officer of UKZN Innovation (Pty) Limited is discussed in this chapter.

4.2 Brief Background of the Institution

The University of KwaZulu-Natal (UKZN) which came about through the merger of the former Universities of Durban- Westville and Natal in 2004, is by international standards, a very large and complex institution, with just under 40 000 students spread across five campuses, namely: Westville, Edgewood, Howard College, Pietermaritzburg and a Medical School. UKZN spans two centres, one in the coastal city of Durban and environs, and the other in the provincial capital of Pietermaritzburg, some 80 km inland. The institution has a unique opportunity to exploit these location factors in developing its strategic thrusts (Internet 4.1).

4.3 Research and Academic Excellence at UKZN

One of UKZN’s strategic goals is in research and it states thus: “To build a research ethos that acknowledges the responsibility of academic staff to nurture its postgraduate students, and to be a pre-eminent producer of new knowledge that is both local and global in context, and defines UKZN as the premier university of African scholarship” (UKZN Strategic Plan 2007- 2016).

UKZN, like other research-led institutions, carries out research across the spectrum, from basic, fundamental through to the more applied strategic end, with some presence in the “product related” end. Notwithstanding the upheavals and uncertainties of the merger process, the institution has registered a substantial increase in research output in recent years. For example, overall publication output increased from 880 units in 2004 to 1280 units in 2006, reflecting an increase of 45%. Nationally, in terms of publication count, UKZN ranked second only to University of Pretoria in 2005 and 2006 indicated in Figure 1.2 in Chapter One (UKZN IAP, 2008).

However, despite the success noted above, analysis of research by faculty suggests a somewhat skewed research profile as indicated in Figure 4.1. Only two faculties out of the eight are responsible for significantly a greater portion of publication amounting to 63% of the total publication output. These faculties are: the Faculty of Science and Agriculture and the Faculty of Humanities, Development and Social Sciences. Similar faculties at University of Cape Town account to 50% of the total research output as per UCT Institutional Audit Self -evaluated report (2005) as cited in UKZN IAP (2008). This could be one of the problem areas as to why there is negligible patenting in UKZN as most of the publications especially from humanities with no commercial value do not necessarily need to be patented.

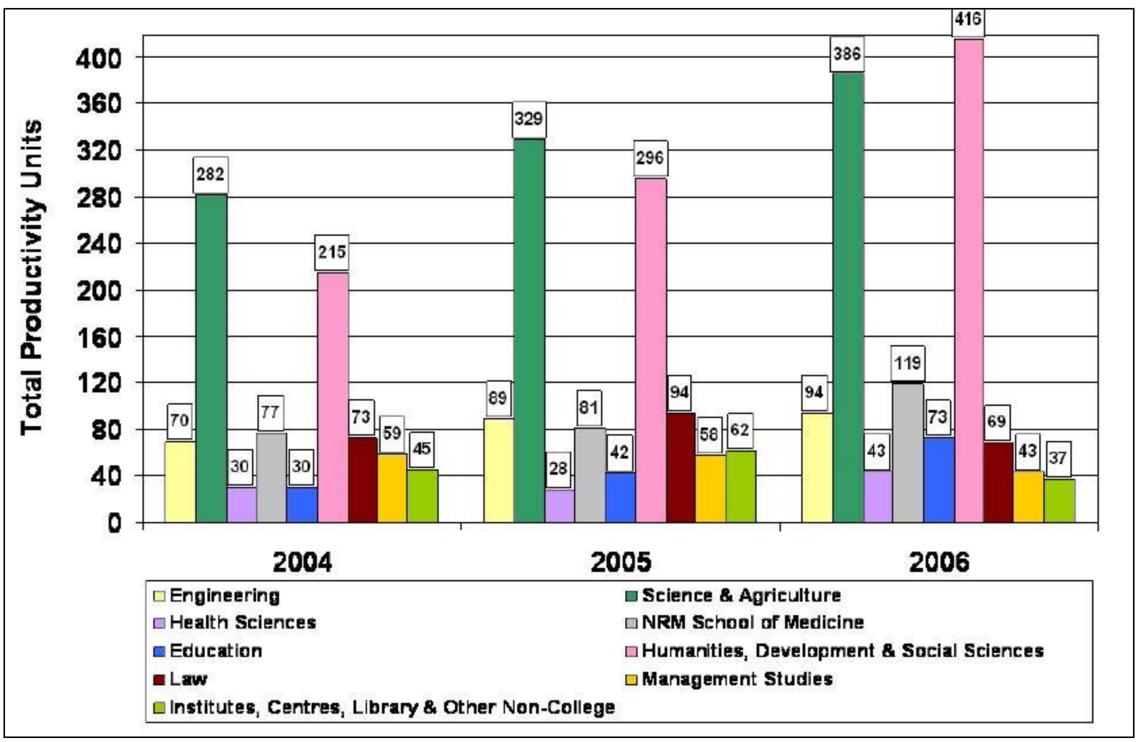


Figure 4.1: UKZN Research Output by Faculty in Productivity Units.

Source: University of KwaZulu-Natal Institutional Audit Portfolio Report (UKZN IAP) 2008.

Further analysis showed that, on average, only 34% of the total UKZN academic staff members publish articles in Department of Education (DoE) accredited journals. Various reasons have been advanced for that situation by a number of schools. For example, "excessive" supervision loads and few staff at the Graduate School of Business, poor salaries that entice staff to engage in more lucrative outside jobs. Centre for Science Access argued that its staff members were appointed to teach and those on the short term contracts did not enjoy the benefit of remission of fees and sabbatical leave, thus they had little time to carry out research (UKZN IAP, 2008).

Likewise, schools in the faculties with relatively good research outputs also reported constraints on improvements. For example, not being able to attract quality researchers to vacant posts due to lack of start-up funds, non –competitive salaries and a retirement age of 60 years, as well as overloaded with teaching (UKZN IAP, 2008).

4.4 Patenting Activity at UKZN

According to Sibanda (Oct 2008), the role of the university is three fold:

- Teaching
- Research (generate new knowledge) and
- Making new knowledge available to society (the knowledge needs protection-patenting).

Sibanda gave an example of South Korea that has made patenting part and parcel of publication. However he pointed out that among the top 5 research HEIs in South Africa, (namely: UP, UKZN, US, UCT and WITS), UKZN was missing in the area of patenting (see to Table 1.1). He attributed UKZN's situation to lack of IP policy and lack of technology transfer infrastructure.

4.5 Research and Intellectual Property Policies

UKZN has research policies and plans in place that are constantly monitored and implemented. The concerns raised above are being addressed by the institution. For example, a new research productivity policy has been referred to the faculties. According to UKZN IAP (2008), the research activities at UKZN are governed by a suite of five policies, namely:

- Research policy I- Framework,
- Research policy II- Developing, Retaining and rewarding Researchers,
- Research policy III- Collaborative Research and Strategic Research initiatives,
- Research Policy IV – Institutes, Centres and Units,
- Research Policy V – Research Ethics.

However, a fundamental policy governing the management of Intellectual Property (IP) was evidently missing in the UKZN research policies portfolio. According to Garduno, (2004), a typical U.S. research university has well-defined intellectual property policies pertaining to the products of any research conducted at the university. Most university intellectual property policies speak to all forms of intellectual property, however, the most relevant for technology transfer purposes are provisions related to patents, and to a lesser extent copyrights as they pertain to software.

The absence of IP policy from the UKZN Research policy portfolio mirrors Garduno's findings in 2004 which argued that: "The University of Natal had made a conscious decision not to incorporate technology transfer into the responsibilities of the university. …… and translated into there being no effort made by the Research Office or any other unit within the university to carry out technology transfer."

Interviews with the Legal advisor to the UKZN Research Office and UKZN Innovation, Schembri (2008), showed that various drafts of IP policy had been written but had not been approved by the University council due to long processes that a proposed policy has to go through before it is approved as a policy.

In light of the above concerns, UKZN through an ongoing review process is developing policies governing the management and commercialisation of intellectual property including the setting up of structures for technology transfer and diffusion. For example, UKZN Senate has adopted as a working document, a Commercial Initiatives Policy, which seeks to develop a framework within which to grow third -stream income via the establishment of UKZN Innovation (Pty) Ltd. The latter has been established as a facility to help researchers develop the commercialisation of research and develop in the area of patents, which is currently weak in UKZN research profile (UKZN IAP, 2008).

UKZN has noted that, “other South African HEI’s have aggressively embraced third stream funding activities, giving them an advantage over UKZN in the competition for staff and excellent students. The development of commercial initiatives within UKZN, and the accompanying opportunities, will assist UKZN in attracting such staff and students” (UKZN -PCIP, 2008).

Nonetheless, “commercialisation of IP motive” at UKZN should be taken with caution and patience. Sibanda (Oct 2008) conceptualised a researcher with an idea or IP to “a farmer with a seed”. A farmer has a seed which he puts in a fertile ground, waters it, protects and develops it to a point where it is attractive for consumers in the market. Likewise, IP is not all about making money but protecting knowledge and making it available to the public. He was in agreement with Wolson (2007), who argued that technology transfer should be acknowledged as a public good activity which facilitates the transfer of useful technologies to the market place, thereby contributing to economic growth.

In similar discussions, Sibanda (2008) argued that technology transfer requires patience. The technology transfer process can take anywhere from 3 to 12 years from filing of provisional patent application to getting the patent to be developed into a commercial product or service which can provide tangible value and benefit before an income stream can be generated. Sibanda (2008) cited Tamai who asserted that Technology transfer is similar to the whiskey business in that it does not yield profits at the early stages. “A whiskey manufacturer must wait for a long period of time from distillation until introducing properly- aged whiskey in the market.”

4.6 Innovation Support Model

Besides having IP and commercialisation policies in place, it is vital to have a Technology Transfer Office (TTO). Most American research universities have an office dedicated specifically to technology transfer. TTOs form a vital link in the commercialisation of university research, by helping to bridge the gap between faculty inventors and the private sector. To do so, TTOs actively encourage faculty participation in the commercialisation of their research, by reaching out to faculty through seminars, newsletters and in some cases, TTO personnel visit with the faculty and other researchers at their laboratories, to further promote the idea of commercialisation and also to "mine" the intellectual property being developed. TTO personnel review the current research and its potential for commercialisation first-hand (Garduno, 2004).

Sub-section 6 (1) of IPR Act No. 51, 2008 stipulates that unless determined otherwise by the Minister in consultation with the minister responsible for higher education, or any other cabinet minister to which an institution reports, any institution must, within 12 months of the coming into effect of this act:

a) Establish and maintain an office of technology transfer, or
b) Designate persons or an existing structure within the institution to undertake the responsibilities of the office of technology transfer.

Section 7 of the same Act stipulates the functions of Technology Transfer Office (TTO) which must be performed by appropriate qualified personnel whom, when considered collectively, has interdisciplinary knowledge, qualifications and expertise in the identification, protection, management and commercialisation of intellectual property and in intellectual property transactions.

The UKZN Commercial Initiatives Policy (UKZN- CIP) stipulates that "UKZN shall cause to be established an 'Intellectual Property Management Office' (IPMO), which shall be the mechanism to manage the interface between UKZN and UKZN Innovation on an ongoing basis". The UKZN- CIP further stipulates that "IPMO shall be a UKZN structure, subject to UKZN policies and procedures which shall in the first instance fall under the direct control of the Deputy Vice-Chancellor, Research, Knowledge Production and Partnerships. The IPMO shall be headed by a Director, who, together with the necessary support staff, shall be responsible for the functioning of the IPMO, and who shall liaise between UKZN and UKZN Innovation. Upon its establishment, the IPMO shall develop a set of policies and procedures to deal with the relationship between UKZN and UKZN Innovation, including but not limited to the commercialisation and transfer of projects between UKZN and UKZN Innovation, which are consistent with this Policy and the policies and procedures of UKZN."

The researcher's interview with the Chief Executive Officer (CEO) of UKZN Innovation, Govender (2008) and the above extract of the commercial initiatives policy show that, there are two entities at UKZN that have commercialisation responsibilities:

- ❖ UKZN Innovation was established in 2006 as the entity responsible for the commercialisation initiatives of the university. The Company is a wholly owned subsidiary of the university and is managed as an autonomous tax - paying entity outside of the administrative structures of the University. The Company however adheres to a governance model approved by the university. UKZN Innovation by the time of Interview had initiated over 50 commercialisation projects due to the following reasons:
    a. Ability to raise funds through non-traditional funding sources such as venture funds.
    b. Creating a structure to spin-off and incubate viable business ventures.
    c. Protecting the University from financial and reputation risks.
    d. The ability to function within a corporate environment to facilitate efficient decision-making.

- ❖ Intellectual Property Management Office (IPMO) was envisaged with the facilitation, the development, protection and management of Intellectual Property within UKZN and to collaborate with UKZN Innovation to facilitate commercialisation. IPMO (also referred to as TTO) started operations in November 2008 when the director of IPMO assumed office. The complementary role of UKZN Innovation and the IPMO is illustrated in Figure 4.2.

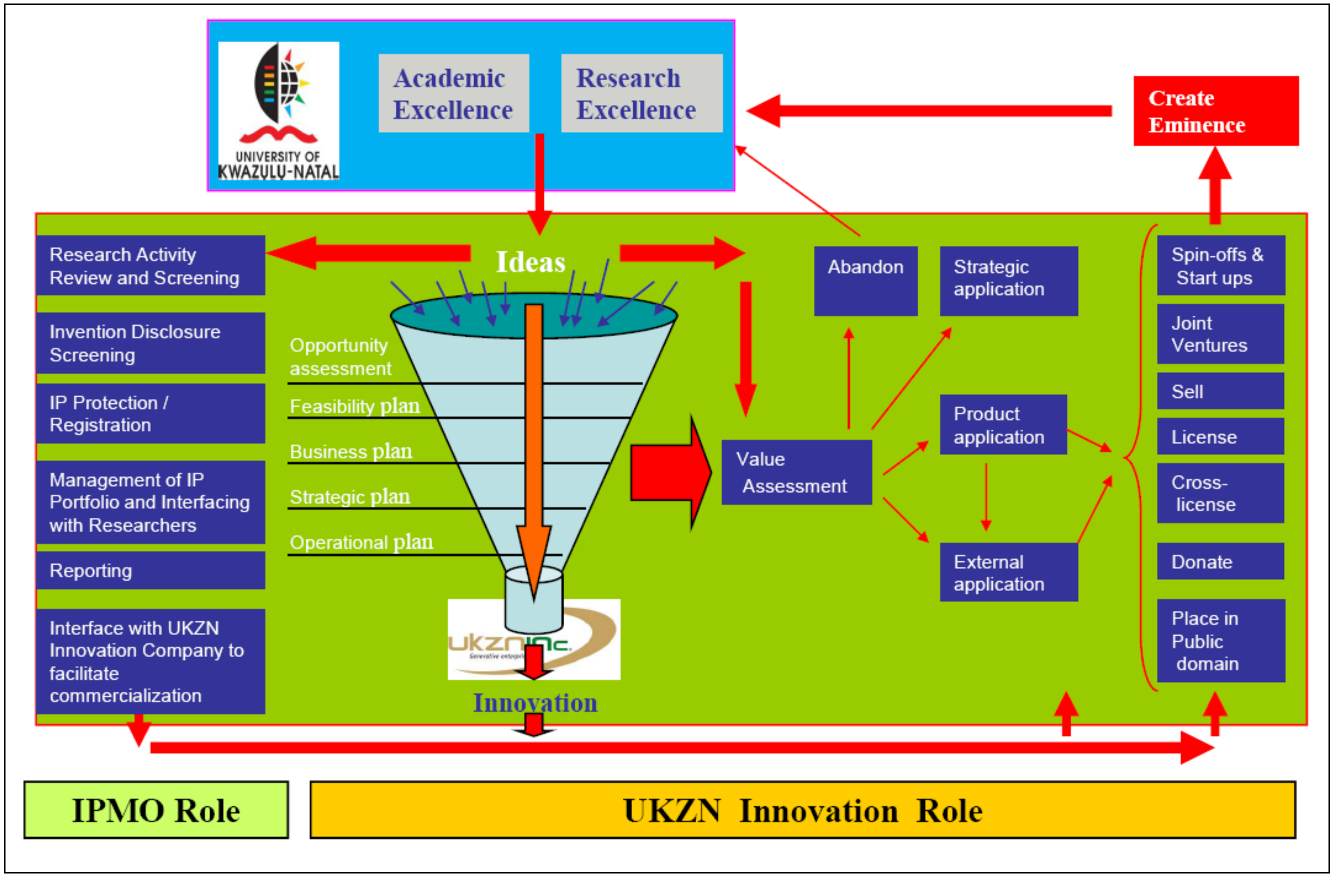


Figure 4.2: The Complementary Role of UKZN Innovation and IPMO

Source: Govender, R. (2008): Interview with Govender R, CEO of UKZN Innovation (Pty) Ltd.

According to Govender (2008), Figure 4.2 provides a holistic view of the complementary role of UKZN Innovation and the IPMO in ensuring the successful transition of projects from research to commercialisation. The operating model works as follows:

- The current and planned research projects for UKZN provide the “feeder” for prospective commercialization projects.
- First level commercial projects are subjected to the development of a proof of concept (PoC) which includes the development of the technology.
- Successful PoC is further subjected to the development of Proof of Value (PoV) which entails the commercial value of the research / application.
- Successful PoV is thereafter transitioned into the commercial projects either through spin-offs and start ups, sell, license and /or cross license, joint ventures, place into public domain or other ways.

A critical success factor for UKZN Innovation according to Govender (2008) is the institutionalization of innovation within the university. The arrangement ensures that academics contribute proactively to commercialization initiatives. The IPMO is seen as the vehicle to meet this objective, as illustrated in figure 4.3.

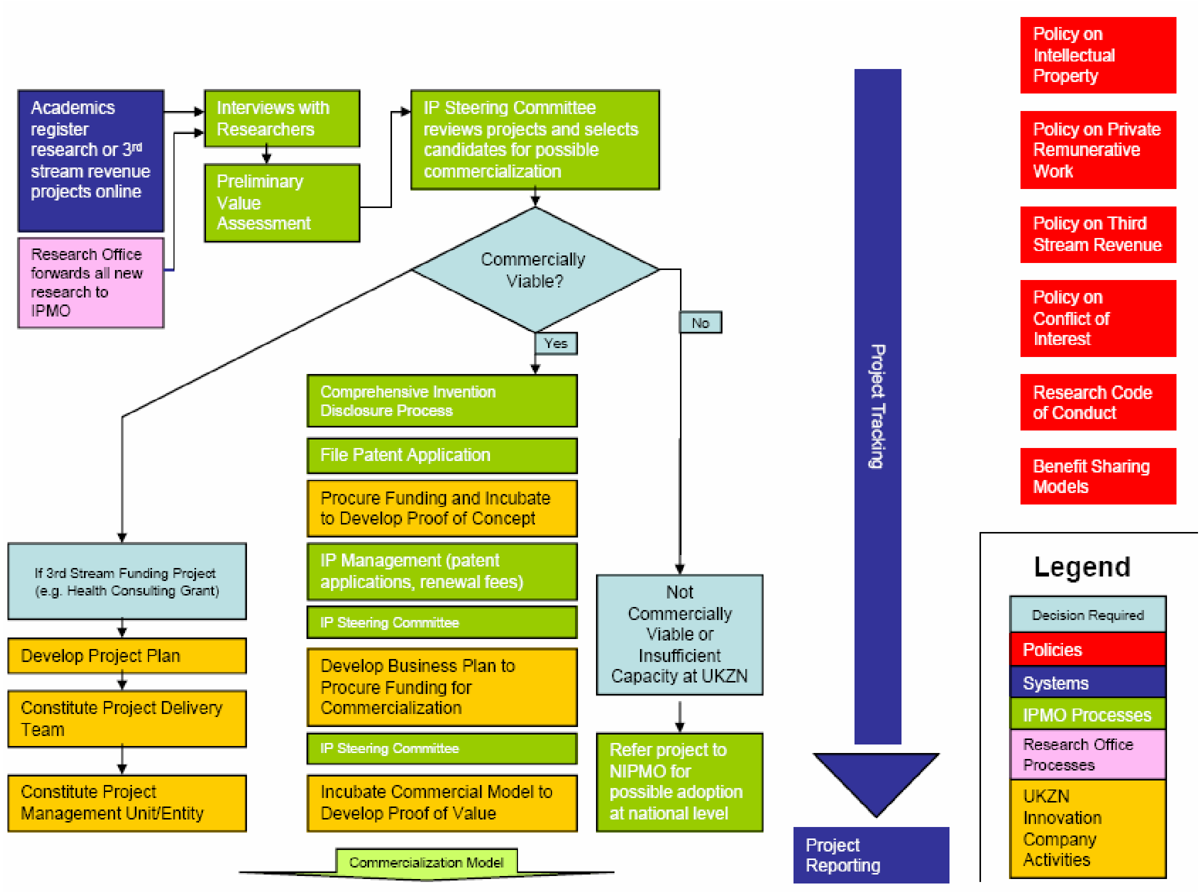


Figure 4.3: IPMO Operating Model

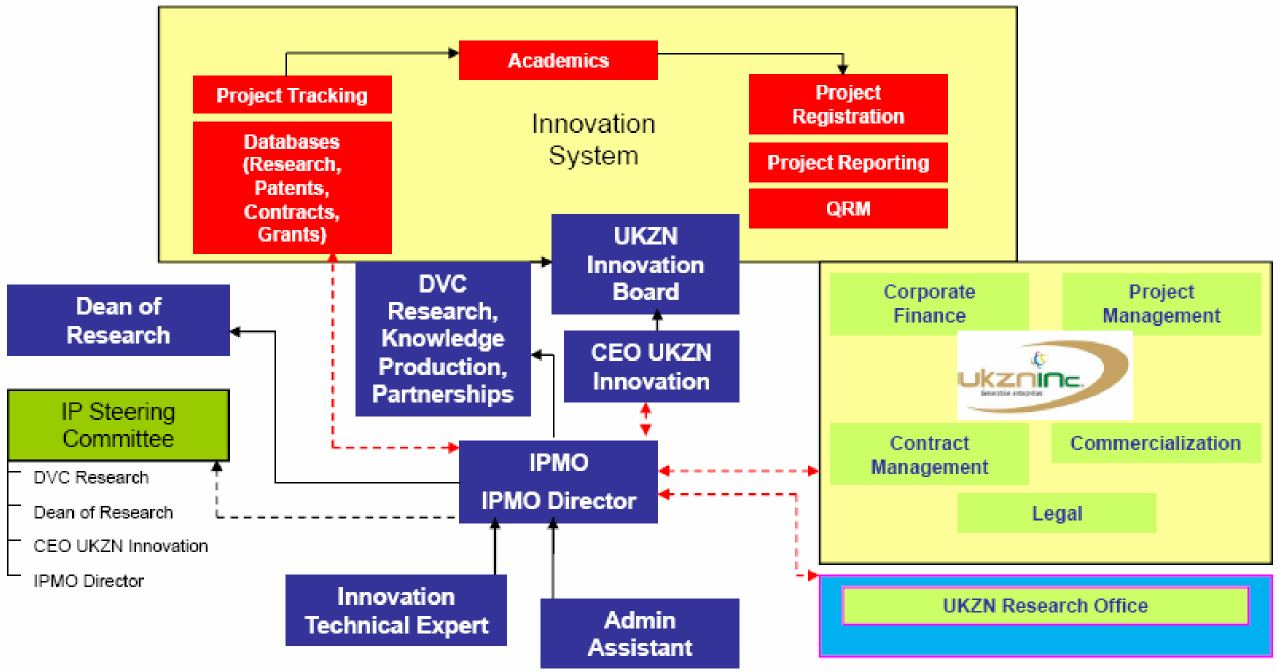
Source: Govender, R. (2008): Interview with Govender R, CEO of UKZN Innovation (Pty) Ltd.

The objectives of the IPMO (or TTO) as per the business plan include the following:

- Develop and manage the university policy and governance model relating to the development and ownership of IP.
- Ensure alignment of UKZN Policies with National IPR Act No. 51, 2008 and other related Legislation, for example, to ensure compliance with sub-sections 7(2) (a) – (h) that relate to the functions of the office of technology transfer.
- Develop and manage the processes and systems relating to the contribution of new research projects with embedded commercial value.
- Contribute to the university's research endeavours in Strategic Research Initiatives.
- Identify research projects with commercial value.
- Ensure the transition between research and commercialization is seamless through a robust technology transfer process.
- Policies, procedures and systems to facilitate technology transfer and IP management.

4.7 Support Structure

Figure 4.4 shows the Structure, governance and leadership of the UKZN Innovation Model. Both IPMO and UKZN Innovation are within the university environment and easily accessible to the university community and researchers. The IPMO director's office for example is within the Research Office to ensure daily interaction with the Dean of Research and falls under the direct control of the Deputy Vice-Chancellor, Research, Knowledge Production and Partnerships (Govender, 2008).



Notes:

1. Innovation Technical Expert and Admin Assistant to be recruited in Year 2.
2. IPMO Director will assume responsibilities for Technical Expert in the first year of operations.
3. The IPMO will interact with the Research Office to trawl the Research databases for prospective technology transfer activities.

Figure 4.4: Structure, Governance and Leadership of UKZN Innovation Support Model

Source: Govender, R. (2008): Interview with Govender R ,CEO of UKZN Innovation (Pty) Ltd.

The IPMO Director who assumed office in November 2008 takes ultimate responsibility for managing the IPMO to achieve the above mentioned objectives. The IPMO director (who will be assisted by Administration support staff to be recruited in 2010) reports directly to the DVC: Research, Partnerships, Knowledge, and Production. IPMO also reports to Dean of Research in relation to other matters, as per Figure 4.4 (Govender 2008) as amended by Moore (2009).

UKZN Innovation provides support to IPMO in terms of skills in the areas of corporate finance, project management, contract management, commercialisation, administrative support and general legal advice. UKZN Innovation is further envisaged to establish operational processes to assist the IPMO in assessing and implementing projects which comprise embedded commercial value. Based on the assessment of IP Steering Committee, projects deemed commercial in nature will be transitioned to UKZN Innovation once a provisional patent application has been filed by the IPMO (Govender,2008).

The IP Steering Committee will ensure integration of the commercialization process across the academic community. The IP Steering Committee will ultimately report to the Council and Council Sub-Structures. The IP Steering Committee will comprise of DVC Research, CEO of UKZN Innovation , the Dean of Research and IPMO director (Govender 2008).

Figure 4.4 as conceptualized by Govender (2008) and revised by Moore (2009) further shows an integrated innovation system to be developed to ensure efficient management processes for contracts, grants, research projects and commercialization projects. The system will ensure that all “projects” are registered on the system. The “projects” are assessed by the IPMO to determine the nature of the project: research, grant, contract, commercial venture. Based on the assessment, the commercial research projects will be assessed for embedded commercial value and thereafter transitioned to UKZN Innovation. The main functionality of the system will include:

- Database management: Research, grants, contracts, projects, IP.
- Project reporting and tracking.
- Project development through “learning rooms”.

- Quality and Risk Management.
- Other objectives have been introduced by Moore (2009) in the revised business plan.

4.8 Challenges at UKZN

The Innovation support model of UKZN looks good, attractive and achievable. Other models or similar model have been used in other institutions, for example University of Toronto (Manley, 2004), Wits Enterprises and University of Stellenbosch. It is worth noting that there is no “one size fits all” model. One of the major challenges according to Govender (2008) that UKZN Innovation faces in carrying out its mandate, is due to lack of clarity, the bureaucratic nature of university policies and procedures which send mixed messages and suspicion among the university community. This challenge according to Govender (2008) will be addressed through conducting road shows, workshops and marketing strategies. In October 2008, a workshop with UKZN researchers was organized by UKZN Innovation and similar workshops and road shows will be organized on regular basis to create awareness to the UKZN community.

Executive responsibility for the research portfolio resides in the Deputy Vice Chancellor: Research, Knowledge Production and Partnerships (DVC: RKPP). The scope of this portfolio includes all research activities, entities supporting knowledge production like library services, UKZN Press, ICT, Audio-Visual centres, UKZN Innovation and Partnerships with other knowledge producing institutions or agencies. (UKZN IAP (2008:141). Such a strategic post of DVC: RKPP has had high staff turnover in the recent past. For example Professor Bawa resigned in 2007, Professor Jacobs was appointed on one year contract in acting capacity and Professor Ijumba assumed office with effect from 1st of January 2009. The post of Director / Dean of Research has been vacant for some time and was filled in late 2008. (UKZN IAP (2008:141). The post of Director of IPMO which was meant to be filled in 2006 got filled in late 2008, thus UKZN Research Office top executives are all new staff. The trend depicted at UKZN Research Office significantly impairs the ability to consolidate the experiences and lessons learnt to strengthen the technology transfer activities. For example, implementing decisions made by Professor Bawa in 2006 regarding the technology transfer office and UKZN Innovation will require fresh “buy in” from the new executives.

According to Sibanda (2008), a high staff turnover has a negative effect on establishment of trust which is an ingredient for successful establishment of a technology transfer office. Sibanda's discussions with some of the top academic inventors in South Africa showed that trust, which is often underestimated, is based on the ability of the technology transfer professionals to demonstrate empathy with the researchers' challenges and being able to proactively assist the researchers to extract maximum value from their research. This study suggests that UKZN should retain such staff for as long a period as possible. This can be achieved by increasing the retirement age from current 60 years to 65 years. Such key posts should have permanent members of staff as opposed to contract staff.

One of the issues according to Govender (2008), which needs to be addressed within the current university research portfolio, is the lack of applied research projects. The strategies developed and implemented by UKZN and UKZN Innovation is the creation of research platforms. Research Platforms have been founded and are multidisciplinary, aimed at developing the human capital. These research Platforms include:

- The Biotechnology Research Platform which is an academic and research platform accredited by Biochemistry, Chemistry, Pharmacology, Chemical Engineering and Microbiology.
- The Sugar Cane Research Platform which is an academic and research platform accredited by Agriculture, Chemistry and Chemical Engineering.
- The Drug Discovery Platform which is a joint venture with the Biomedical Resource Unit, Biochemistry and Chemistry.

Planned Research Platforms according to Govender (2008) include:

- E Health, which is a joint venture with IS&T and Health Sciences to develop health solutions.
- Telecommunications Platform which is a joint venture with IS&T, Quantum Computing, Computer Science and Electronic Engineering.

Commenting on the UKZN community culture, Govender (2008) stated that UKZN researchers have never encouraged patenting, thus there was a challenge for the implementation of the changes. However with the enforcement of IPR Act No. 51, 2008 and establishment of the IPMO, he was positive that technology transfer activity will be successful at UKZN.

4.9 Mandate of UKZN Innovation

UKZN Commercial Initiatives Policy provides guidelines for the creation of a vehicle, the University of KwaZulu-Natal Innovation Company (UKZN Innovation), to actively pursue the promotion, development and implementation of commercial initiatives at UKZN for the mutual benefit of UKZN, UKZN Innovation, and the participants in such initiatives. Drawing on international experience and best practice, UKZN Innovation shall develop a range of models to facilitate the further development and exploitation of identified third stream funding ventures, including but not limited to further separate legal entities to be created by UKZN Innovation, called 'spin-off companies', with UKZN Innovation maintaining strong legal, operational and oversight ties, to be developed by agreement on a case-by-case basis with these 'spin-off companies' (UKZN- PCIP).

Govender (2008), defined innovation as "creation of new ideas" and commercialisation as "taking research to the market". UKZN Innovation was established in 2006, with a goal of creating a culture of innovation and applied research among the UKZN community and to generate additional income to the university. This goal is in line with the university's strategic plan as stipulated in the commercial initiatives policy.

The mandate of UKZN Innovation is therefore "to create a catalyst for applied research". Maximising disclosures is not the ultimate goal of UKZN Innovation. Invention disclosures and assessment is an important function of IPMO which has not been operational until November 2008. This has been reflected in project portfolio of 52 projects for 30 months that UKZN Innovation had been operational with negligible patenting activity. In the interim, UKZN Innovation had sufficient resources to carry out its mandate. The funding came from the private sector, mainly through contracts with commercial partners. No funding came from government (Govender, 2008).

4.10 Governance and Leadership

The interview with Govender (2008), showed that governance and leadership of the UKZN support model builds on the needs of researchers and the business world. A key tenet of the UKZN Innovation Model is focused on building various components of expertise thereby ensuring the entire system functions in harmony. The scientists within the university environment focus on "blue sky" research projects and developing these into technology projects, UKZN Innovation which is the commercial arm of the University was shaped on the best-practice models implemented within the Imperial College in London. UKZN Innovation focuses on implementing the commercialisation model and ensuring the beneficiation of the technology is developed. The IPMO is a lever between the Scientists and UKZN Innovation in terms of identifying projects, protecting the IP embedded within these projects and transitioning these projects to UKZN Innovation. Thus, there is a right mix of both business and science skills. The Board of UKZN Innovation is comprised of esteemed individuals currently occupying high profile positions in business, government and financial institutions (Govender 2008).

4.11 Comparative Performance

Govender (2008) gave various indicators that UKZN Innovation uses to measure its performance as follows:

i. Number of disclosures.
ii. Number of projects managed within the Innovation Portfolio.
iii. The level of efficiency of innovation systems and tools.
iv. Position the university is engaged in break-out research projects.
v. The financial viability of research projects through the successful commercialization of projects and income generated.

In terms of international standards, Govender (2008) mentioned that UKZN has performed poorly. He attributed the poor performance to a short time frame that the support model has been in existence as compared to its peers. However, Govender (2008) summarized the success story of the UKZN support model as follows:

- Developed and implemented a Commercial Initiatives Policy which provides the framework for innovation and commercialization activities.
- Implemented an IPMO within the Research Office with funding procured from the Innovation Fund.
- Developed the various IP management and Innovation Tools and systems which include:
    - Project management database
    - Contract management system

- Contract templates such as Non Disclosure Agreements (NDAs) Memorandums of Understanding (MOU's) Memorandums of Agreements (MOAs) among others.

- Created a patent portfolio comprising of 9 provisional patents and 3 PCT applications till October 2008 as indicated in Table 4.1
- Successfully commercialized 3 technologies. These include:
  - The Quantum Security Technology. UKZN is the first university to implement such a technology within a commercial environment.
  - Active Ageing at Home which is a Health Care Solution for the elderly. This project has been commercialized in partnership with Momentum Health.
  - Pod Casting which has been developed to enhance health care, teaching, tourism and training.
- Identified two hits as part of UKZN Drug Development Platform. These "hits" include:
  a) A SQ109 derivative for TB.
  b) A monoclonal antibody for breast cancer.
- Created two spin-off companies as part of UKZN Innovation commercialization model. These spin-offs generated over R 6, 000,000 in the first 6 months of operations. There are a further 3 spin-off companies in the pipeline.
- Established international credibility based on:
  - UKZN's Collaboration with international partners on innovation projects.
  - UKZN's ability to attract funding from foreign venture funds.
- Established credibility within the institution. This has been measured by UKZN Innovation Portfolio of projects increasing from 15 projects in 2007 to 52 projects in 2008.
- In the process of negotiating 3 licensing agreements for Biotechnology projects.

No	APPLICATION NUMBER	SHORT TITLE	FILING DATE	APPLICATION TYPE
1	2006/05446	“Plectranthus”	30.06.2006	Provisional
2	PCT/IB07/52375	“Plectranthus”	20.06.2007	PCT
3	2007/10901	“Ball-Milling”	14 Dec 2007	Provisional
4	2008/00551	“TRIP Steel Conveyor Sensor”	18 Jan 2008	Provisional
5	On approval	"HFP/HFPO Separation and Recovery"	N/A	Provisional
6	2008/06026	"Viral Entrapment"	10 July 2008	Provisional
7	On approval	“Bioreactor”	N/A	Provisional
8	On approval	“Bacillus”	N/A	Provisional
9	On approval	“Malaria”	N/A	Provisional
10	2008 / 07996	“Load shedding”	N/A	Provisional
11	2007 / 11218	Surgical Hand Support Device	10.12.2007	Complete Patent
12	F2008/ 00050	Surgical Hand Support Device	19.01.2008	Registered Design
13	2007/09425	Brake Lights	11.10.2007	Provisional
14	On approval	Porphyrins For Photodynamic Therapy	N/A	Provisional
15	On approval	Bone China	N/A	Provisional

Table 4. 1: UKZN Patent Portfolio as at October 2008

Source: Govender, R. (2008): Interview with Govender R ,CEO of UKZN Innovation (Pty) Ltd.

4.12 External Relationships

UKZN Innovation. has established various collaborations. The main objectives of establishing these collaborations as per Govender (2008) include the following:

- To buy-in a multidisciplinary array of skills. This ensures application of critical skills in the technology development process and is geared towards market requirements at an early stage in the development lifecycle.
- To work with international and national research institutions in building UKZN's research capacity in emerging technology spheres. These spheres include: Nanotechnology, biotechnology, Industrial biotechnology and convergence technologies.
- To allow the university to tap into vast amounts of early stage development funding.
- To access research infrastructure at minimal cost, thus reducing the cost of development as the university does not have to invest in procuring equipment at an early stage of the development process. This approach also results in minimizing the risks associated with the project as initial investment is lower.

Govender (2008) gave some examples of such collaborations and partnerships to include the following companies / institutions:

- The South African Sugarcane Research Institute (SASRI), Sugar Milling Research Institute (SMRI) and University of Stellenbosch to develop value-added downstream beneficiation of sugar cane.
- BioAlvo, a Portuguese biotechnology company, to develop a drug discovery platform based on natural products.
- Biotechnol, a Portuguese Biotechnology company, to develop a monoclonal antibody for cancer.
- Safripol, a South African polymer company, to develop the technologies to convert ethanol to ethylene and thereafter polyethylene. This partnership has resulted in the procurement of funding as well as a defined route to market.
- Partnering with IST, a Portuguese technology university, to research the development of solar and photovoltaic panels.

- The City of EThekwini in developing UKZN's Quantum Cryptography technology.
- Senetas (Australia) and IQ Quantique (Switzerland) as commercial partners in taking UKZN Quantum Solutions to the market.
- Partnering with 3M South Africa (Pty) Ltd to develop solutions and products in human health. This partnership has allowed UKZN to commercialize its technologies through a credible market channel.
- Partnering with SmartXchange, an ICT Incubator, to incubate UKZN ICT technologies.
- Partnering with Apple to develop technologies around Podcasting. These technologies are founded on the basis on enhancing teaching and learning within education institutions.
- Partnering with CSIR in developing eHealth technologies and solutions.

4.13 Summary

In summary, the current operating innovation support model at UKZN was shaped on best-practice models implemented within the Imperial College in London. The model according to Govender (2008) needed to be adapted to suit the unique environment and culture within South Africa in general and more specifically, within UKZN. However, this study made comparative analysis of other support models at other HEIs in South Africa as discussed in the next chapter.

5 CHAPTER FIVE: INTERVIEW ANALYSIS

5.1 Introduction

This chapter gives an analysis of innovation support models at the "Big Five" research HEIs in South Africa based on the interviews and available secondary data. Eight HEIs were issued with interview schedules. The representatives from the HEIs that were issued with interview schedules included the following:

1. UKZN: Mr. Reggie Govender, CEO; UKZN Innovation (Pty) Ltd.
   Mr. Chris Schembri, Legal adviser to UKZN Innovation and Research Office.
   Mr. Rory Moore, Patent Attorney and the newly appointed Director of IP Management Office (IPMO).
2. UCT: Mr. Piet Barnard, Director; RCIPS (Research, Contracts and IP Services).
3. SU: Ms Anita Nel, CEO; InnoUS (Pty) Ltd.
4. WITS: Dr. Charles Marais, CEO; Wits Enterprises (Pty) Ltd
5. UP: Mr. Dhesigan Naidoo, Director; Research and Innovation Support. (Researcher was referred to Prof. Jonathan Youngleson).
6. NMMU: Ms. Jaci Barnett, Director; Innovation Support and Technology Transfer.
7. NWU: Dr. Rudi van der Walt, Director: Innovation.
8. DUT: Prof. Gerhard Prinsloo, Director; Technology Transfer and Innovation.

Among the eight HEIs that were issued with the interview schedules, six were successfully interviewed, this translated to a response rate of 75%. Four out of six (80%) respondents were among the "Big Five" research HEIs that were targeted for this research. The other two respondents that were interviewed did not fall within the definition of the "Big Five" Research HEIs but were targeted due to the progress they have made in the innovation area. Different open ended questions were asked to establish the extent to which innovation integrates into academic research and to establish appropriate innovation indicators. Details of the questions responded by the interviewees are in the interview schedule in appendices. The interviews were supplemented by the presentations by the interviewees at the two- day SARIMA workshop entitled "Practising Technology Transfer in South Africa." The workshop was held on 27th and 28th October 2008 at Mont Fleur conference venue - Stellenbosch.

UKZN was used as a case study and the interview results for the case study are presented in Chapter Four. Analysis of the other HEIs that were interviewed are presented in this chapter. Interviews were conducted for all the big five except UP. However, available literature indicates that UP is leading in South Africa in terms of research output and it is worth noting the factors that have contributed to its success. Section 5.2 gives a brief overview of UP’s success story.

5.2 Research and Innovation at the University of Pretoria (UP)

The University of Pretoria is the largest residential university in South Africa, and also the country's leading research university in terms of research output per annum since 1997, (See Figure 5.1). More than 50 000 full-time and part-time students benefit from UP's innovative and flexible delivery modes. In 2008, student numbers totalled 57, 409 (38, 934 contact and 18, 475 distance). The University has six campuses and a number of other sites of operation such as the Pretoria Academic Hospital. Central administration is located at the Hatfield campus (Internet 5.1). UP’s diverse student population is representative of all South Africa's cultural and racial backgrounds with a total of about 2400 international students. The University of Pretoria offers 181 qualifications involving more than 1 800 academic study programmes – the widest variety in the country. It also produces the most PhD students (148 PhD students in 2006) in South Africa (Internet 5.2).

Being an internationally recognised South African teaching and research intensive university is central to the University of Pretoria. The department of Research Support plays an integral role in the practical implementation of the university’s research agenda. The department has as its core function, the provision of a range of support services aimed at promoting research development through the support of the individuals who carry it out. Services are offered by two divisions;

- **Research Support** is responsible for the development of young researchers, the facilitation of access to research grants and contracts, the development of research capacity and the promotion of research at the university. In January 2008, a new innovation support function was incorporated in this division. Thus the portfolio under the leadership of Mr. Dhesigan Naidoo is now called Research and

Innovation support. This division manages the overall research portfolio of the university and provides strategic direction to various faculties, schools and centres. The Research Office also manages all external strategic research relationships of the University, including those with the DST, the DoE, other national and provincial governments, the NRF and other science councils, private sector players and universities (UPRR, 2007).

- **Contracts and Intellectual Property Office** has two main focus areas:

  i. Protection of IP and its successful commercialisation.
  ii. Management of the research contracting process.

  IP protection includes all the aspects of intellectual asset management, from assessing inventions for patenting through to licensing these inventions to interested licensees. The office affords all researchers at the University an equal opportunity to obtain protection for their inventions. This division works closely with Legal Services, Human Resources and the Department of Finance. All contracts – especially those that contain clauses which are unacceptable are sent to Legal Services for comments and adjustments if necessary. Research Contracting may also be undertaken via the campus company, Business **Enterprises at UP (BE@UP).** Contracts and IP office and BE@UP consult with each other regarding the most appropriate route for the management of research contracts (Internet 5.3).

Very often a campus company is also an appropriate vehicle for co-operative ventures. A structure for "**Campus enterprises"** was established in 2000 to enable the UP to position itself as a leader in the fields of contract research, training and consulting, thereby facilitating and enhancing its interaction with the private and public sector. Several campus companies have since been established to perform some of the University's business functions and to act as instruments for managing the University's interest in its alliances (Internet 5.3). Some are wholly owned by the University, such as those responsible for continuing education and consultation, while other companies are partly owned, such as those tasked with the commercialisation of intellectual property. The campus companies support the University's vision and mission and must adhere to the University's quality requirements. The governance and management structures and delegations of the campus companies are aligned with those of the University. The University has a 100 %

shareholding in the following three active companies, namely:

- Continuing Education at University of Pretoria (CE@UP) (Pty) Ltd
- Business Enterprises at University of Pretoria (BE @ UP) (Pty) Ltd
- TuksSport (Pty) Ltd (High Performance Centre – hpc).

According to the UP's Research report 2007 (UPRR, 2007), the performance of UP in terms of technology transfer in 2007 was as follows:

- Seven disclosures of potential inventions were recorded
- Three provisional patent applications were filed
- Two South African patents were registered
- Two PCT applications were filed
- Two licenses were awarded to industry.

UP claims to be at the forefront of tertiary education in the country and they collaborate with world-class partners to ensure continued excellence in learning and teaching. The greatest number of instances of collaborations was with the SADC countries (53%). The EU was second (24%), followed by the USA (12%) and Oceania (2%). The rest are made up of collaborations with Central Africa, Canada the Far East, Europe, South America, Asia, Middle East, Eurasia, North Africa, Eastern Europe, Central American and the Caribbean countries (UPRR, 2007).

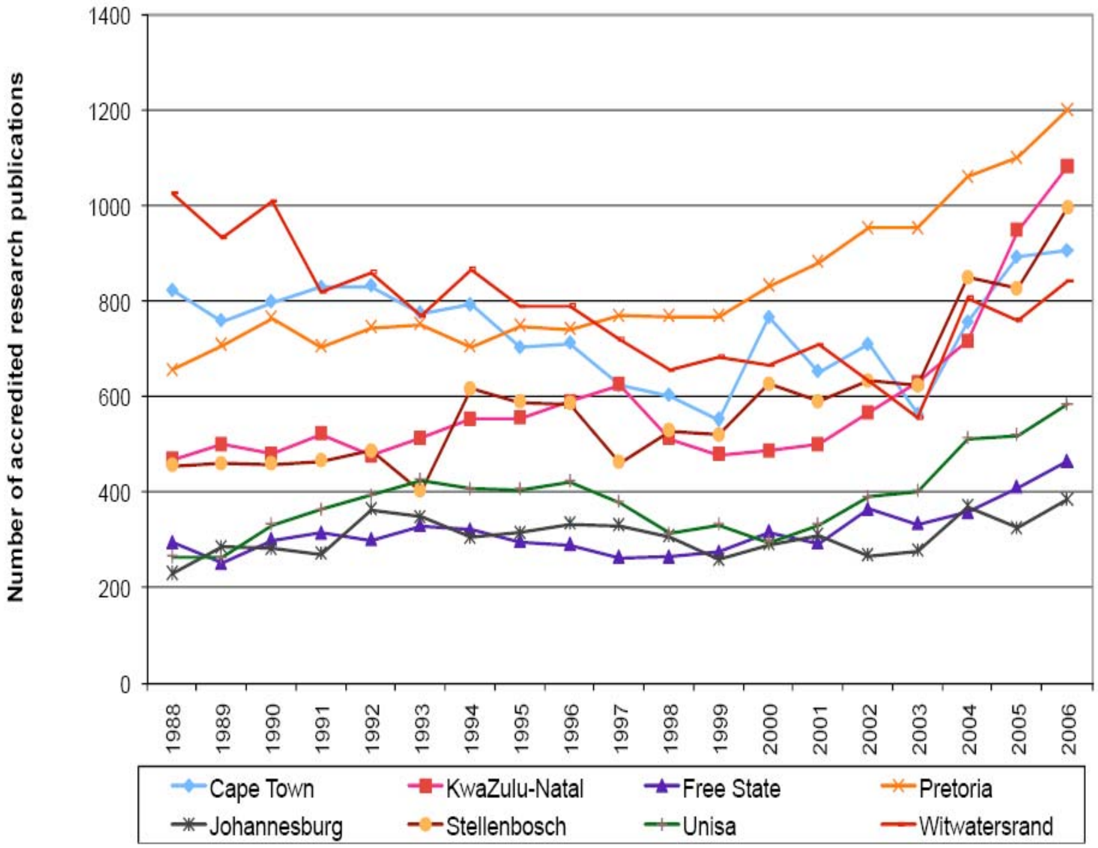


Figure 5.1:Research Output of Selected HEIs

Source: University of Pretoria Research Report, 2007.

5.3 Innovation at UCT

The University of Cape Town (UCT) is one of the oldest universities in South Africa which has established a tradition of academic excellence and is recognised worldwide. It has more than 21,000 students, with 6,000 studying for postgraduate degrees and over 4,000 International students from 104 countries. Research at UCT includes fundamental and applied research in science and engineering, health sciences, humanities and in the growing field of policy research, as South Africa maps out the future of its new democracy. UCT has four of the 15 national research units funded by the Human Science Research Council's Centre for Science Development. In the Health Sciences, UCT has the highest concentration of research centres funded by the South African Medical Research Council. The National Research Foundation identified UCT as one of South Africa's leading research universities in science, engineering and technology (Internet 5.4).

According to Barnard (2008), a historic overview of the technology transfer model of University of Cape Town (UCT) dates back to 1987 when a UCT trust for applied research and organisation for applied research were established. In 1998 an office of industry liaison as part of the Department of Research and Development (DRD) was founded, followed by establishment of UCT Innovation in 2000. In 2002 a private company called UCT Innovation (Pty) Ltd (dormant) was registered and a patent fund was established in 2003. However, in 2005, there was a review of UCT Innovation which eventually resulted in restructuring and name change in 2006 to “Research Contracts and Intellectual Property Services” (RCIPS). The current technology transfer model at UCT is within the university’s formal structure and falls under the Department of Research and Innovation as illustrated in Figure 5.2 .

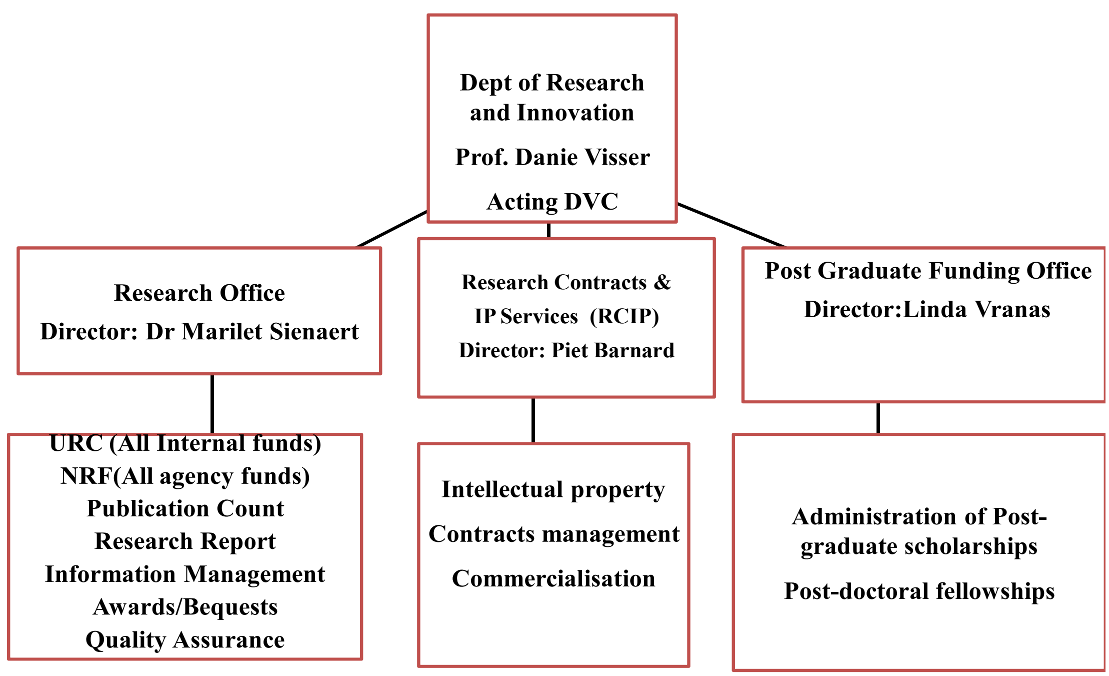


Figure 5.2: Research Management at UCT

Source: Barnard, P. (2008); SARIMA Workshop; Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

The researcher's interview with Barnard (2008) and the respondent's presentation at SARIMA conference showed that UCT uses several technology transfer approaches as discussed below:

- The **service model** which emphasises service to faculty rather than income generation, and each disclosure or case receives the same attention.
- The **income model** with emphasis on licensing to established companies as this generates more revenue, sooner and with more certainty than starting a new company. In this model, rigorous selection of inventions is carried out thus reducing the investment required and increasing the probability of success, but can decrease faculty satisfaction.
- The **economic development model** emphasises new company formation and job growth. The generation of income is usually delayed and is riskier and "lumpy". As a smaller proportion of opportunities are commercialisable, satisfaction measures in the academic community may be lower.

Barnard (2008) argued that UCT uses pro-active approaches in fostering innovation as listed below:

- **Awareness Creation & Marketing.** This involves dissemination of information through: Information Booklet, Website, Presentations/ Seminar, Schedule/Discussions with Research Groups, Newsletter, and Collaboration with other HEIs, Innovation Day and On-line Store.
- **Reward & Recognition**. Examples include: Monday News, Inventors Award, Award ceremony and acknowledgement in research report.

- **IP Scouts** is an initiative to be implemented in the course of 2009 and it will see the appointment of an "IP Scout". This is aimed at providing researchers in specific departments with a person within their department who is knowledgeable in IP management practices at UCT and can speak to them in their own 'technical language'. The primary objectives of the pilot initiative include the following:
    - To develop an overview of researchers and research in specific departments at UCT.
    - To generate a pipeline view of potentially protectable IP, allowing RCIPS

to engage as early as possible with researchers to plan the protection so as to ensure that the IP protection does not impact negatively on publication and thesis submission.

- To increase the level of IP awareness in the department in which the IP Scout is deployed.
- To provide a 'first point of call' for researchers in a department to find out about RCIPS's processes and to deal with preliminary enquiries regarding patentability. More complex issues would be referred to RCIPS.

Performance of the UCT Innovation model for the last five years as indicated in Table 5.1 shows progress. However, there are still some researchers in UCT who are against patenting and put emphasis on publication rather than commercialisation. Regarding the leadership and governance of the UCT innovation model, there has been high labour turnover within the research department. For example, at time of interview, the DVC Research had just been appointed (Barnard, 2008).

Particulars	**2004**	**2005**	**2006**	**2007**	**2008 (till 15 Oct)**
Disclosures	**20**	**20**	**7**	**9**	**28**
Applications Filed	**26**	**26**	**23**	**50**	**57**
National Phase Granted	**2**	**9**	**6**	**3**	**3**

Table 5.1: UCT Innovation Performance

Source: Barnard, P. (2008); SARIMA Workshop; Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

5.4 Innovation at Stellenbosch University (SU)

InnovUS was established in 1999 to facilitate the exploitation of intellectual property emanating from Stellenbosch University's faculty members and students. Initially it was called "Office for Intellectual Property". After research of mainly UK and USA models, formulation of proposals for institutional changes to support commercialisation were made. The name changed in 2004 to InnovUS with the inplementation of an IP Commercialisation Policy in the same year. InnovUS became more proactive and commercially focused in 2006 (Nel, 2008).

According to Nel (2008), the vision of InnovUS is to become the best TTO in Africa, a benchmark of excellence and to get their technologies to where it makes a difference to society. The goals of InnovUS are in line with the University of Stellenbosch's strategic plan especially "Vision 2012" and being "your knowledge partner". The progress towards achieving those goals can be measured through: number of disclosures, number of industry contacts, investments attracted, number of licensing deals and income, press releases on success stories among others.

Nel (2008), summarised the core responsiblities of InnovUS to include the following:

- Application of SU technology to the benefit of society,
- Service to faculty and increased awareness of technology transfer among faculty, researchers and students,
- Maximising third stream income for SU through commercialising IP,
- Value creation within and growth of SU portfolio of spin off companies,
- Raise profile of SU as performing university – attract top researchers.

The interview with Nel (2008) revealed that the mandate and the business model of InnovUS is achievable and consistent with the goal of maximising disclosures as per the requirements of the national IPR Act 2008. The IP policies are easily accessible to the researchers on the InnovUS- website. However, InnovUS would require more resources to carry its mandate. The University of Stellenbosch and the Patent Support Fund are the two major sources of funding for InnovUS. The leadership and the staff of InnovUS have a right mix of business and the science skills. For example, the Director of InnovUS has a

Masters of Science degree and was in venture capital for 5 years investing in start-up companies. To stretch their capacity, some specific projects are outsourced to qualified consultants. The management of InnovUS has been constantly improving and succesful in engaging with the university community (Nel, 2008).

Nel (2008) argued that InnovUS has been operating within the University of Stellenbosch's structure as shown in Figure 5.3. However, the structure has changed and InnovUS is now an independent autonomous entity as shown in Figure 5.4. The decision for the change of structure was made due to the following reasons:

- Integration and simplification of ineffective commercialisation structures within SU into one entity;
    - To reduce "conflict of interest" problem around university's primary mission and commercialisation.
    - To significantly reduce risks, including risks regarding corporate governance.
    - To clearly define roles and responsibilities.
- Last environment to be restructured as part of the decision in 2004.
- Role in achieving SU vision.
- Creation of an empowered environment for commercialisation, not only with the aim to generate income, but to play a role in implementing science in a knowledge-based economy.
- Faster decision making and implementation of decisions.
- Increased credibility from an industry perspective.
- A more corporate approach within a commercial entity with measurable output and performance.
- No tax implications.
- Improve probability of raising external funding.

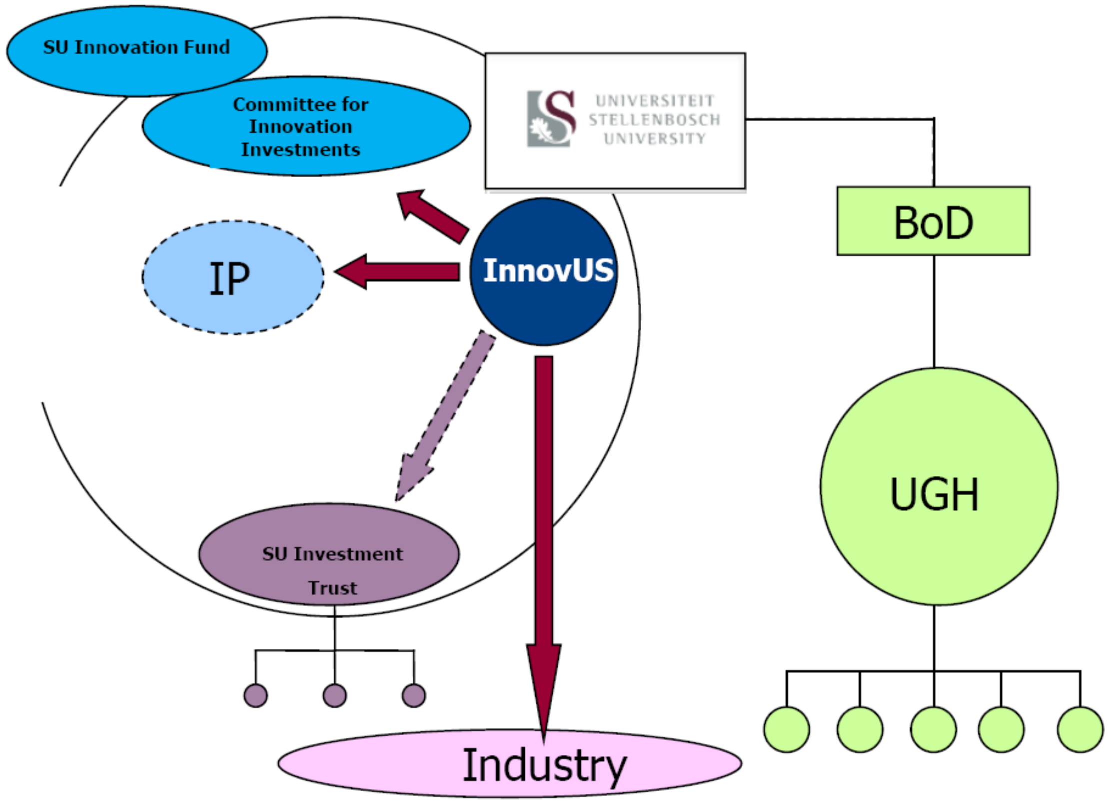


Figure 5.3: InnovUS Old Operational Structure

Source: Nel, A. (2008): SARIMA Workshop; Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

UGH = Unistel Group Holdings

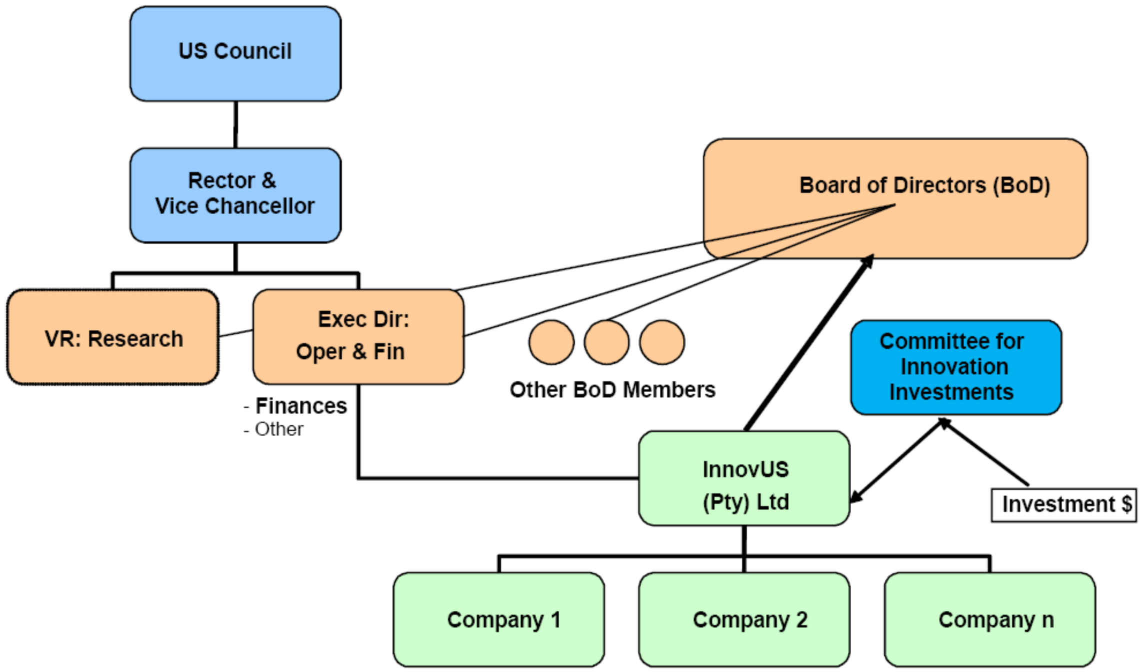


Figure 5.4: InnovUS New Operational Structure

Source: Nel, A. (2008): SARIMA Workshop; Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

InnovUS performs relatively well compared to its peers, although it is difficult to measure perfomance due to lack of information. Number of disclosures and breakthrough to industry are some of the ways to measure performance. When performance falls short, there is need to get relevant contacts with investors and industry. From January to September 2008, InnovUs facilitated an investment of worth over R 8,000,000.00 in a private company. It also negotiated a shareholders' agreement and took 15% (post money) shareholding in another company worth over R1,200,000.00. By the time of the interview, negotiations with 5 spin-off companies were in process (Nel, 2008). Other performance indicators are shown in Table 5.2.

Year	Disclosures	Licence Agreements	Royalty Income
2003	14	0	R315 456
2004	9	1	R512 678
2005	8	0	R578 514
2006	8	1	R313 071
2007	43	0	R653 981
2008*	30**	6	R1 264 066

Table 5.2: InnovUS Performance Indicators from 2003 to 2008.

Source: Nel, A. (2008): SARIMA Workshop; Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

*Updated 19 September 2008, **Corresponding figure in 2007 was 26.

In concluding remarks, Nel (2008), argued that there are no right or wrong answers; decisions taken for innovation support models depend on many factors, ranging from institutional support, historical background and experience, culture and other factors.

InnovUS had been given a mandate to appoint a competent and empowered Board of Directors to structure and empower their support model. Other responsiblities given to InnovUS included technology transfer in general, compliance with IPR legislation, running short courses, managing IP, spin-off companies and commercialisation.

5.5 Technology Transfer Model at WITS

Wits Enterprises is structured as an autonomous, self-funding commercial company reporting to the Deputy Vice-Chancellor- Research. It has specialist full-time and contract staff who provide the requisite business, financial and administration support which frees academics from these activities, so that they can concentrate on creating and developing new and useful ideas. Wits Enterprise offers a variety of valuable business services that help academics get in touch with commercial and government customers, enabling them to apply their wealth of intellectual capital and knowledge to assist their School, the

University and themselves to generate additional funds and to effectively manage the business processes (Internet 5.5).

In accordance with the University's IP policy, Wits Enterprises provides a one-stop service in the area of Intellectual Property Rights (IPR), patent support and commercial development to WITS academics and students. The benefits of these activities accrue to both the IP originator and the university in a designed sharing ratio. For example, 70% of the net proceeds of the income accrues to the inventor and the university gets 30%. Wits Enterprises takes a flexible 'case-by-case' approach to technology transfer projects. The university owns the IP and Wits Enterprises facilitates the exploitation of the IP. Besides compliance with the IPR legislation, the goal of Wits Enterprises is to generate third stream income to the university. This can be measured through disclosures, patents, income and licensing deals (Marais, 2008).

One of the challenges encountered by Wits Enterprises in accessing the university community is communication. This is being addressed by creating awareness through various modes including seminars, website adverts and newsletters. There are also ongoing disagreements with various schools on the aspect of Wits Enterprises running short courses, which can be administered by the schools, however, with the University's mandate, a big progress has so far been made. Another challenge that Wits Enterprises faces is a "Lazy culture" of the university community with too much freedom. This undermines the operation of the model, making it difficult for uniformity (Marais, 2008).

Wits Enterprises has a total of 17 members of staff. The Chief Executive officer and one consultant specialise in technology transfer. Some services are outsourced to qualified consultants due to lack of right mix of business and science skills. The company is wholly owned by the university with tax exempt status. The funding is not sufficient and is mainly derived from running short courses and contract services fees. Wits Enterprises is located within the university, however, due to limited space, some offices have been rented outside the campus. Regarding governance and leadership, Wits Enterprises engages business professionals, academics are kept out of the boardroom to generate more excellent and innovative ideas (Marais, 2008).

Marais (2008) argued that measurement of innovation performance should not be limited to the contribution towards the public good. The money aspect should not be overlooked since money is required for employment of resources such as labour, rent, equipment to mention but a few. Thus ideal yardstick for measuring performance includes several variables such as: disclosures, patents, licensing deals, number of spin –off companies and revenue. The patent suite for Wits is shown in Table 5.3.

Provisional SA applications:	28
Complete SA applications:	16
Granted SA patents:	14
ARIPO Applications:	5
PCT applications:	9
PCT applications proceeded to national phase:	15
European patent applications:	9
Granted European patents:	2 (1 validated in France, Germany and UK; 1 validated in UK and Switzerland)
US patent applications:	11
US patents:	1
Japanese patent applications:	4
Other national applications:	3 suites of patent applications
Total patent suites: 67	

Table 5.3:Wits Enterprises Patent Suite (As of 27 June 2008)

Source**:** Internet 5.5:www.wits.ac.za

5.6 Innovation at NMMU

NMMU was established in 2005 through the merger of the University of Port Elizabeth and Port Elizabeth Technikon. It is the largest HEI in the Eastern and Southern Cape, with some 20,000 students enrolled. It is one of the most culturally and linguistically diverse universities in Southern Africa. The merger of the two esteemed institutions strengthened research niche areas and centres of excellence, thereby boosting new and exciting research synergies, (Internet 5.6). Research is usually left to languish on a shelf in a thesis or commercialised elsewhere in the world after publication in the open literature. There was a need to effectively manage the NMMU's IP which resulted in the establishment of an Innovation Support and Technology Transfer Department within the Research Office in April 2007 as shown in Figure 5.6, (Barnett, 2008).

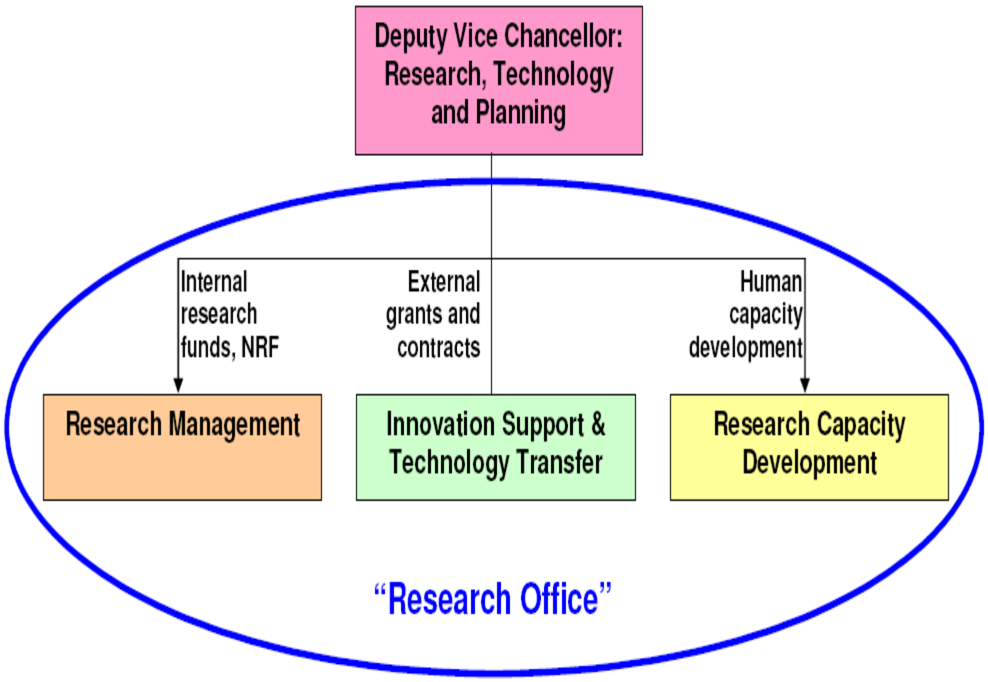


Figure 5.5: Innovation Support and Technology Transfer at NMMU

Source: Barnett, J. (2008); Interview with Barnett, J - Director: Innovation Support and Technology Support, NMMU.

Note: NMMU Innovations (Pty) Ltd which was established by the University as a commercial entity has been dormant and could be used in future as a spin-off company, (Barnett, 2008).

According to Barnett (2008), the primary purpose and function of the department is to support innovation and technology transfer activities inside the NMMU and to promote and give effect to the new national legislation on the protection and exploitation of IP developed at publicly funded research organisations. The Department has two key activities:

- Grant and contract management for externally-funded research-related projects**:** assisting researchers in obtaining and negotiating external research grants and contracts.
- Management and commercialisation of NMMU Intellectual Property: transferring technology to industry and society by managing and commercialising the intellectual property of the NMMU.

These areas are linked as research-related projects for external parties usually include intellectual property considerations which must be negotiated and research outputs are transferred to industry and society. Research grants from funding bodies often lead to intellectual property which creates a "pipeline" of intellectual property which must be managed and commercialised (Barnett, 2008).

The goal of innovation support and technology transfer department at NMMU is to maximise research outputs and to benefit the society from public funds invested in NMMU. This is in line with the IPR legislation which gives effect to the establishment of TTOs in South African HEIs. The DST through the Innovation Fund has embarked on technology transfer capacity building at three universities, (namely; TUT, UKZN and NMMU), thus NMMU's Department of Innovation Support & Technology Transfer is funded by DST. The successful innovation and technology transfer is not about money but the impact and benefit to the society by creating jobs and increasing economic wealth (Barnett, 2008).

According to Barnett (2008), it was too early to tell the performance of Innovation Support and Technology Transfer Department at NMMU compared to its peers nationally and internationally. However, by October 2008, it had 14 disclosures. It had also reached an agreement with an investment partner, Afrepell Manufacturing Pty (Ltd), to commercialise a range of insect repellent products developed by the NMMU's Institute of Chemical Technology.

Barnett (2008) argued that the IPR Act 2008 has given the HEIs in South Africa a lot of negotiating power with the business sector. She was optimistic that Innovation Support and

Technology Transfer at NMMU will be successful. However, her department did not have sufficient funds to carry out its mandate. There were only two members of staff and plans were underway to employ an IP Manager and Proposal and Development Manager. The innovation model at NMMU was inward focused, aimed at serving the university community. Some skills such as legal were being outsourced. The challenge that Innovation model at NMMU faced was that a huge number of academics were not doing research. Nonetheless, the pipeline of skills was being built through research funding and funds from the Innovation Fund.

5.7 Innovation at North-West University (NWU)

NWU came into being in 2004 through a merger of the former University of the North-West in Mafikeng and Potchefstroom University in Vanderbiljpark. NWU has three main campuses (namely; Mafikeng, Potchefstroom and Vaal Triangle) spread across the North-West and Gauteng provinces. Each campus operates as a business unit with a managerial structure, but is supported by an Institutional Office situated in Potchefstroom. NWU's vision is to be a "pre-eminent university in Africa, driven by the pursuit of knowledge and innovation". It aspires to implement research results and expertise, both commercially and community-directed, for the benefit of the country, the continent and the world. It also aspires to be recognised internationally as a well managed and innovative university, with a client focus and a quality focus, by creating an enabling environment that enhances and improves the university's core business. It further aspires to create a financially viable institution which is able to transform continually to meet the country's social and economic needs (Internet 5.7).

According to Van der Walt (2008) and (Internet 5.7), Research, Innovation, and Entrepreneurship are the lifeblood of NWU, as shown by the following achievements:

- An Innovation Office was established in 2003 to exploit the IP emanating from research.
- A group of researchers from the Potchefstroom Campus of NWU are part of the international High-Energy Stereoscopic System (HESS) group that won the much sought after European Union Descartes Prize for Research for 2006.

- NWU is involved in developing the Heat Transfer Testing Facility for the Pebble Bed Modular Reactor Group (Pty) Ltd, with this project being one of the country's most important nuclear energy initiatives.
- NWU earns more than R1.4 million a year from royalties and licensing income and spends over R 1.6 million) more on patents than any other university in South Africa. NWU exports more than R 4,000,000 worth of high quality machine components per annum.
- NWU owns 14 spin- off companies / subsidiaries and associated companies since 1999 which include: Glob-Ed Systems (100%), CFAM (20%), Afriforté (13%), AeroEnergy (10%), Psybergate (20%) and Ergon Networx (10%).
- Patents, designs and plant breeders rights include : 28 RSA granted patents, 8 Internationally granted patents 6 USA granted patents (plus 6 in examination phase), 2 RSA registered designs and 3 Plant Breeders Rights.
- Involved in 47 countries in portfolio.
- Has 11 active licenses.
- Patents with big potential include: Continuous Spark Ignition, Pheriods, Ozone Generator and other fast switching MOSFET applications.
- NWU won the 2008 National Innovation Competition as the most innovative HEI in the country.

Van der Walt (2008) argued that there is progress in the establishment of TTOs in South Africa in light of the following:

- Government's stronger drive and emphasis on innovation
- Industry's "commitment" to Corporate Social Investment
- Positive issues in new IPR Act 2008
- More accessible national and international marketing instruments

However, Van der Walt (2008) noted the following challenges for the TTOs in South Africa:

- DST's trend to focus more on IP administration rather than commercialisation (negative issue in IPR Act).
- Lack of experienced TTO practitioners (very small pool in SA).

- Lack of understanding within universities.
- Inappropriate structures for TTOs.
- TTOs often more of an irritation than a need to management (not a core business of a university).

Lessons learnt from NWU are summarized in Table 5.5

Parameter	**Successes**	**Failures**
Championship	Zeal, passion and commitment to alliance with NWU Many sensitive issues negotiated upfront Open/sharing/listening In-time information Balanced interests (win / win situation)	Hidden agendas / side issues / greed / egoism Too many university "chiefs" Too much emotion initially Lack of information, including financials
Planning	Well-defined vision with technology platform as basis Well-structured upfront agreements	Initial product is (was) the only offering Poor or no agreements Ad hoc approach

Table 5.4: Lessons Learnt From NWU Innovation.

Source: Van der Walt, R. (2008): SARIMA Workshop; Practising Technology Transfer in SA: Mont Fleur Conference Centre, Stellenbosch 27-28 October 2008.

5.8 Summary of the Analysis

Innovation as part of HEIs Mission	One out of six interviewed had innovation as part of their Mission. (Despite the HEIs having innovation models only 16% of them had Innovation as part of their mission)

IP Management and Commercialisation policies	Five out of six (83%) HEI interviewed had IP management policies established and the 6th one was in the process of establishing IP Management Policies
TTOs at HEIs	Most of the TTOs were undergoing a transition process with some having established structures while others had limited capacity and others in the process of being established. On average, there are 2 to 3 employees dedicated to technology transfer in each HEI. TTOs in South Africa are still young with limited capacity
Entrepreneurial Culture	Most of the respondents had challenges in accessing their respective HEIs in regard to Technology Transfer. Most HEIs focused on publication, patenting and commercialisation is regarded as a secondary function. Thus absence of entrepreneurial culture.
Response to IPR Legislation	Most interviewees argued that the IPR Bill (IPR Act) has given HEIs negotiating powers when commercialising their research, but test of the legislation was on the implementation rather than compliance.
Innovation performance Indicators	Performance indicators according to the respondents include: patents, disclosures, revenue generated, benefit to the society, breakthroughs to the industry among others. However, emphasis on disclosures and patenting so as to comply with the IPR Act is in the agenda of all the HEIs that participated in the interview.
Structures	HEIs generally have 3 types of innovation support structures, namely; within the university environment, separate entity or hybrid of the two.
Challenges	Lack of skills (mix of science and business) most of the support models outsourced some skills; Lack of funding, anti- patenting culture, limited market focused research. Lack of information in RSA for benchmarking

Table 5.5: Summary of the Interview Analysis

Generally, there is low rate of applications for IP registration (for example patent applications) by South African HEIs at both local and international level. The extent of patenting appears to be dependent on the type of research being undertaken; basic research leads to publication only whereas applied research (especially with market focus) has a possibility of both patenting and publications. The bulk of research from the 'Big Five' is skewed towards basic research as per UKZN's research output analysis by faculties. Although research output from NWU is low as compared to the 'Big Five', based on the survey by Sibanda (2008), NWU is focused on mainly applied research with commercial value as per its vision and goals. Nonetheless, Venter (2008) asserts that very few HEIs in South Africa commercialise their research results, and if they do, success has been patchy and no institution can claim to have generated sufficient capital from their IP to fund research. This is generally caused by lack of an innovation strategy and IP strategy, manpower and enthusiastic support by the top management of the HEIs.

Existence of IP management policies at HEIs and patenting activity appears to be correlated; HEIs with established IP policies and structures like UP, SU, UCT and NWU performed better in terms of patenting. This study indicates that although UKZN is making progress on commercialisation of its IP and establishing structures, an IP policy is not yet in place. Other HEIs already have IP policies established and easily accessible to researchers. It is also evident that the age of a University's TTO has an impact on patenting; this study indicates that UP, UCT and SU had been in the patenting business even before formally establishing Technology Transfer Offices. These findings are consistent with the study made by Garduno (2004) and Sibanda (2008). Successful IP management is a prerequisite for successful commercialisation of the IP, thus a TTO should not be regarded as an 'irritation' but should be given all the necessary support it needs by the senior managers at HEI and academics.

Among the issues raised by HEIs were insufficient funds to finance the patenting costs and lack of right mix of staff with science and business background. According to Venter (2008), many universities and colleges in USA are completely self sufficient and in some cases like MIT and Harvard, income close to a billion dollars is generated annually from IP and sponsored research. Venter (2008) argued that, in South Africa, the success is limited due to lack of proper management of IP. For example most institutions have a relatively archaic, small and non-commercialised patent portfolio, while others have large non-commercially viable patent portfolios with high patenting costs. Successful commercialisation of IP emanating from research at HEIs rests largely on quality infrastructure and the availability of highly skilled and creative research leaders and proper management of potentially valuable IP. Competition between institutions for high level researchers is at an international level and intense. Without world-class facilities, funding and equipment, it is difficult to attract these researchers.

According to this study, commercialisation of research has dominated many discussions at HEIs. Structures that favour management and commercialisation of IP are being established. For example, commercial entities, separate from the university environment have been established. These include BE@UP, Wits Enterprises, InnovUS, Glob-Ed Systems, UKZN Innovation (Pty) Ltd, UCT Innovation (Pty) Ltd and NMMU Innovation (Pty) Ltd. Most of these companies are 100% owned by the respective Universities. However, some of these companies such as UCT Innovation (Pty) Ltd and NMMU Innovation (Pty Ltd have since their establishment been dormant for various reasons. There are both advantages and disadvantages of using such companies and a trade-off should be established. However, tax issues should not be used to avoid using these companies. The fact that a typical TTO can only break even after 10 to 20 years, based on experiences from USA and UK, is an indication that such companies regardless of their tax status, will not be liable for any taxes once they are in a loss situation. The benefits of using such companies outweigh the disadvantages as per Nel's arguments in section 5.4.

Nonetheless, there is no 'one size fits all' structure. Whatever the local configuration, to be successful, an innovation model should constitute "an irreducible minimum" of five elements of an entrepreneurial culture. These elements include: a strengthened steering management core, an enhanced development periphery, a discretionary funding base, a stimulated academic heartland and an integrated entrepreneurial culture (Burton 1998). The space for variations in organisational missions, markets, histories, strategies and structures was carefully left out by Burton (1998). His argument was that, irrespective of the structure of the innovation model, the five elements listed above constituted the entrepreneurial culture.

Mulder (2008), argued that TTOs in South Africa were faced with common challenges and they include: getting the institutional leaders to embrace technology transfer activity and not merely paying lip service; loss of IP due to lack of awareness by researchers; not enough visits to the relevant units around the country; lack of funding for patents; lack of funding for product development and commercialisation; difficulty in market penetration (both local and international markets) and limited human resources. These challenges according to Mulder (2008), can be addressed by: use of awareness raising to solicit invention disclosures; audit units to identify inventions, give due attention to all invention disclosures; evaluation based not only on commercial potential but also social benefit; patent where applicable (full due diligence required before committing significant resources to patenting); licensing out for further development and Spin-outs where appropriate. However, based on the findings and available literature this study made conclusions and recommendations in Chapter Six.

6 CHAPTER SIX: CONCLUSION & RECOMMENDATIONS

6.1 Introduction

This chapter summarises and provides conclusions to the findings of the study. The chapter relates to the findings by the researcher on 'Comparative Analysis of Innovation Support Models at HEIs' attained from the interviews and case study analysis. The chapter further stipulates recommendations that Innovation Support Models at HEIs (with emphasis on UKZN) could implement for effective technology transfer of research and successful commercialisation of IP. However, these conclusions and recommendations should be considered as additional guidelines to the decision makers at UKZN and other HEIs. The recommendations are not meant to dispute the current existing strategies and structures. Some of the recommendations could already be in use but there could be a possibility of improvement.

6.2 Conclusions and Recommendations

Resultant findings and conclusions from UKZN case study and interviews with other HEIs were basically in several areas ranging from institutional research backgrounds, IP management policies, resources (both human and financial), support structures, governance, leadership, external relationships, culture comparative performance, performance indicators and others. Each of the identified areas has been discussed with possible strategies recommended concurrently in the following sub-sections.

6.2.1 Background

The case study suggests that UKZN is indeed one of the top five leading research institutions in South Africa. However, despite the high research output, UKZN does not have the stature that it should have as being a superb research institution that creates economic activity and social benefits through technology transfer of its inventions and research ideas. No patent has been granted to UKZN in recent years, yet patents are technological indicators worldwide and used by DST in South Africa to monitor performance. Similarly other HEIs, though better than UKZN in the area of patenting, performed poorly as compared to their peers internationally.

This study recommends that UKZN should work towards achieving an alignment between research excellence and commercialisation efforts and attitudes of its staff. This will ensure that research output is an integral and prominent part of UKZN's aspiration to be one of the superb research universities in South Africa that creates economic and social value out of its research. This can be achieved through fostering a clear goal of maximizing disclosures of research discoveries, which is hard to recognize in the early stages. Through disclosures, the private sector and industry will see a large throughput of ideas with commercial potential thus developing as many valid candidates as possible, (Manley, 2004). Likewise, other HEIs should make their goals of maximising disclosures very clear. Lack of clarity in areas such as revenue sharing ratios may send mixed messages to researchers, hence encountering resistance to technology transfer activity.

6.2.2 IP Management Policies

Existence of IP management policies at HEIs and patenting activity appears to be correlated. HEIs with established IP policies and structures performed better in terms of patenting. This study agrees with findings by Garduno (2004) and Sibanda (2008), which argued that there is no Intellectual Property management policy operational at UKZN. However, a framework for IP commercialisation is stipulated in the Commercial Initiative Policy that was approved by UKZN senate in 2008. Lack of IP Policy has contributed to negligible patenting activity at UKZN compared to its peers. It is also important to note that the number of patents completed and granted to the HEIs in South Africa was lower than the provisional patent applications made by the institutions. A good example of such a scenario is WITS (as shown in Table 1.1), out of 69 provisional applications, only 3 patents were granted. Nevertheless, Moore (2009) argued that filing of provisional patent applications is a common phenomenon which is quick and a relatively cheap way of securing a priority date and starting the patenting process so that publication can take place.

This study recommends that UKZN should introduce and implement IP management policies that comply with the IPR Act 2008. Other HEIs that already have IP policies should consider revising their policies to comply with IPR Act 2008. This study cautions the HEIs not to go on a patenting spree just for the sake of patenting and end up with a large number of non- commercial, archaic and expensive patents. It is therefore necessary to involve qualified staff with both science and commercial skills, who should be able to advise whether a particular invention is novel with commercial value. Generally, patent attorneys recommend filing of provisional patent application within two weeks of disclosure without necessarily carrying out due diligence process which is costly and leads to delays in publications. Due diligence can then be carried out before the PCT application is filed. The PCT application leads to International Search Report which is very useful in assessment of patentability and value of an invention (Mulder 2008; Venter 2008; Moore 2009). This study therefore recommends such a procedure to be carried out before committing significant resources to patenting.

6.2.3 Resources

Successful IP management is a prerequisite for successful commercialisation, thus technology transfer activity is a complex process which requires funding and a right mix of skills, performance, motivation and cooperation between researchers and TTO staff. However most HEIs indicated there were challenges in the area of funding to finance the patenting costs and a lack of the right mix of staff with science and business backgrounds. The root cause of insufficient funding stems from lack of entrepreneurial abilities by the universities, whose core objectives are teaching, research and outreach.

This study recommends the HEIs to implement strategies adopted from Manley (2004) as follows:

- Develop in-depth knowledge on what research is being done and assess its commercial potential before patenting.
- Educate researchers on how to protect their ideas, build trust and comfort with the idea of commercialisation.
- Try to attract private sector interest for both licensing technologies and creating start-up companies.
- Promote linkages with other functions such as contracting basic research with the aim of enhancing value of the original research idea.
- Introduce Bachelor of Innovation in Business Administration (BIBA) in South African HEIs to provide students with both business and science skills. The

curriculum should be tailored such that graduates of BIBA will develop the critical thinking skills, multi-faceted team oriented skills and basic innovation background to ensure that they can effectively compete in the changing career landscape in areas driven by innovation. Short courses in the similar field could also be introduced and administered by Innovation Support Models at HEIs to generate third stream income. A range of Bachelor of Innovation (BI) programmes should be considered in South Africa to meet the skills shortage. BI programmes are already offered in other international institutions such as University of Colorado at Colorado Springs -UCCS (Internet 6.1).

The above are long term strategies, however, in the short term; the HEIs should look for funding from DST to support innovation activities. Transaction fees as well as revenue from licenses, contracts and other transfer activities could be a source of revenue to develop and maintain the critical mass needed internally to provide service levels and the expertise needed to carry out technology transfer and commercialisation. UKZN Innovation currently uses this approach and has not yet benefited from Innovation Fund financial resources (Govender, 2008).

6.2.4 Support Structures

The Innovation support models at South African HEIs are in three forms:

a. Integrated within the university environment as a department or a division within the Research Office, as is the case with UCT and NMMU.
b. Autonomous separate entities independent from university administration structures but owned by the university as in the case of Wits Enterprises and now InnovUS which initially operated within the university environment.
c. Mixture (Hybrid) of the two above as is the case with UKZN and UP.

Each type of structure has its own unique challenges and has implications in areas such as financial resources, infrastructure and expertise, IP protection, rate of decision making process, to mention but a few. This study recommends the position argued by Burton (1998) that, whatever the local configuration, to be successful, an innovation model should make reference to an entrepreneurial culture.

6.2.5 Governance, Leadership and External Relationships

Governance and leadership of innovation support model depends entirely on the structure as summarised in section 6.2.4 above. Getting the institutional leaders to embrace technology transfer activity is a challenge for most HEIs interviewed. Other interviewees described the governance and leadership in the institutions as bureaucratic with "too many university chiefs"; others paid just lip service, while members of some governing boards kept the academics out of their boardrooms.

However, it is essential that the board members of the support structure act as true partners to build a collaborative environment. They need to understand and balance both the needs of researchers and those of the business world. The ability to draw on the insights of experienced and skilled people in the private sector (with the right mix of business and science backgrounds) and from other parts of the research community would also be hugely beneficial. The creation of an Advisory Board with involvement of members outside the university community would provide valued advice to the leadership of the innovation support model and would represent a keen interest in the social and economic benefits of research to the community. There should be a need for serious engagement by the most senior officials of the HEIs including the Vice Chancellors and Deputy Vice Chancellors in charge of Research and Innovation. Regular review of the success of the commercialisation effort should be accepted as an important element of the Vice Chancellor's activities (Manley, 2004).

6.2.6 Culture

The HEIs surveyed especially the "Big Five" have a reputation of being the top research institutions in the country and in the continent of Africa. The entrepreneurial drive is often secondary. Some of the HEIs such as UKZN have a culture that does not support technology transfer as portrayed by lack of IP policies and delays in implementing decisions. Others regard TTO as an irritation rather than a need. In some HEIs, there is a lot of freedom while in others 50% of the professors were not involved in research.

This study recommends that HEIs should adopt a culture in which technology transfer and commercialisation are encouraged, respected and rewarded for the economic and societal benefit. This is in line with the IPR Act 2008 which calls for establishment of TTOs at HEIs and stipulates the functions of TTOs. The government of South Africa through DST expects returns from public funds invested in HEIs, not necessarily in financial terms, but in terms of new technologies, new treatments and medications, thus benefiting the society. For the case of UKZN, cultural issues are part of the reasons that have led the country's second largest research output producer to under- perform in the area of patenting. With these recommendations, this study argues that the leadership of the UKZN needs to take all necessary steps needed to make positive attitudes to technology transfer and commercialisation central elements of its culture.

6.2.7 Comparative Performance

Analysis of interviews showed that there is low rate of patenting by South African HEIs at both local and international level. Existence of IP management policies at HEIs and patenting activity appears to be correlated in that the HEIs with established IP policies and structures like UP, SU, UCT and NWU performed better in terms of patenting. Furthermore, the bulk of research from the 'Big Five' is skewed towards basic research as per UKZN's research output analysis by faculties. However, NWU appears to focus mainly on applied research with commercial value as per its vision and goals. In general, despite low patenting activity coupled with low conversion of these patents into commercial ventures, there is progress by the HEIs in terms of setting up the IP policies, TTOs and structures that favour technology transfer and commercialisation.

This study recommends that the HEIs should improve on infrastructure and have world class facilities and equipment so as to attract skilled and creative research leaders. Moving an idea from the laboratory to commercial application involves providing a service to the inventor and success is commensurate with the quality of that service. The officials responsible for technology transfer and commercialisation must be skilled at finding and packaging technologies inside the HEIs and introducing the technologies to the best private-sector matches for further commercialisation. Furthermore, the service providers must build a climate of trust and innovation culture through having closer and on-going ties with the researchers while focusing on their needs.

6.2.8 Performance Indicators

The interview analysis showed that HEIs used more than one indicator to measure their performance. These include: Number of disclosures, number of patents, number of breakthroughs to industry, number of projects managed within the Innovation Portfolio, the level of efficiency of innovation systems and tools. Other indicators include financial viability of research projects through the successful commercialization of projects and income generated.

While all the mentioned variables are good indicators to measure the success of an innovation support model, patent system is accepted internationally as a good yardstick. Patents can be used to analyze the technological activities of inventors, firms, regions and countries. They are valuable because they provide the researcher with a coherent set of data across countries and specific technological fields for long time series. Moreover, patents show a high level of correlation with R&D at the firm level and this suggests using patents as an 'input' indicator that measures the technological effort of companies and non-firm organizations to create new products and process (Montobbio,2007). In South Africa, patents are one of the technological indicators monitored by the Department of Science and Technology (Pouris, 2005). This study therefore recommends patents as a yardstick for measuring innovation in general. This is due to the fact that proper use of the patent system could result in additional publications to the researchers and could facilitate the transfer of new technology to industry as indicated in the next sub-section.

6.2.9 Publishing, Patenting and Commercialisation

There is evidence that high quality research and high quality researchers tend to go together with patenting. The Murray and Stern (2007a) paper as cited by Montobbio (2007), shows that patented research is on average more cited and keeps on being cited even if at a lower rate. Case study evidence suggests that patenting is becoming important for having bargaining power to exchange and share protected tools and materials. However, the relationship between patenting and publishing may be negative at the individual level mainly due to a 'publication delay' effect and /or a 'basic-applied trade-off.

Despite delays in obtaining patents, the patent system has the benefit of securing the researchers a far earlier date for their research work, namely the “priority date” on which the first patent application (for example a provisional patent application) is filed, (Hurlin,1985; Sibanda, 2008; Moore, 2009).

Regarding the commercialisation of research, some lessons can be drawn from the literature surveyed. For example, companies’ absorptive capacity is extremely important and companies in various industries have to be ‘connected’ with the HEIs in order to be able to absorb new ideas and discoveries. Montobbio (2007), argued that knowledge transfer between university and industry is based on a lot of different forms of interaction. Most of the research has focused on life sciences and biotechnology where basic research is very close to commercial applications. In these fields, there has been an impressive growth of university patents. However, technology transfer mechanisms vary considerably according to the scientific field, to the stage of development of the invention and across regions because they adapted to different institutional setting and research systems. Reamer *et., al.*(2003), Mowery and Sampat (2005) and Montobbio (2007), point out that the explosion of university patenting in the US is to great extent related to the biotechnology revolution that in turn has is roots in the considerable amount of federal funds dedicated to medical research.

This study therefore, recommends that technology transfer professionals in the HEIs should be in close contact with both the researchers and the industries with the aim of commercialising the research from the HEIs. Without any bias to other fields, emphasis on life science, biotechnology and basic research with commercial applications should be exploited and commercialised. The government of South Africa should follow the example of US federal government by increasing research funding in general, with emphasis on life science, biotechnology, biomedical and any basic research with commercial applications.

6.2.10 Other Factors

Apart from the above factors, this study established that, there are other challenges that the TTOs in South Africa are faced with. These include: loss of IP due to lack of awareness by researchers; not enough visits to the relevant units around the country; lack of funding for product development and commercialisation; difficulty in market penetration (both local and international markets). Other factors include: the stage of development of the technology, the extent to which the patent addresses a large potential market, lack of systems that support venture creation, dearth of venture capital investors who really understand the technology offering and lack of seed funding for preliminary proof of concept work to increase success of licensing and technology transfer activities.

Recommendations based on the TTOs experiences include: Use of awareness raising to solicit invention disclosures, establish audit units to identify inventions, give due attention to all invention disclosures; evaluation based not only on commercial potential but also social benefit; licensing out for further development and Spin-outs where appropriate. The study by Sibanda (2008) suggests that successful technology transfer requires a regulatory and institutional support framework which must include policies regarding ownership, protection and transfer of new technology. The transfer of technology to industry is a complex function requiring diverse skills some of which may have to be outsourced from outside HEIs. The technology transfer process takes time and requires patience; undue pressure should not be placed on technology transfer professionals based on unrealistic monetary expectations. With the technology transfer concept being new in South Africa, researchers in HEIs have tended to focus on other mechanisms such as secrecy, publications and contract research. However the HEIs now have the support from the government of South Africa through the IPR Act 2008. All the researchers using public funds need to comply with the IPR Act.

6.3 Conclusion

This study addresses the extent to which innovation integrates into academic research. The possible yardsticks for measuring innovation at South African HEIs are summarised in section 6.2.8 above. However, comparative analysis of innovation can be hampered by scarcity of appropriate data and lack of good indicators with a wide coverage. Patents counts, weighted by citations are regarded in South Africa as good indicators for measuring and assessing the value of innovations.

This study therefore, recognizes that the path to achieving research and innovation excellence in South African HEIs, especially UKZN, will not be an easy task. It will involve breaking down existing barriers within and outside the institutions, place building links, trust and a collaborative spirit. Successful innovation at HEIs rests largely on quality infrastructure and availability of highly skilled and creative researchers and technology transfer professionals, thus reflecting a truly entrepreneurial and innovation culture.

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8 APPENDICES

8.1 LETTER OF CONSENT

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS

Dear Respondent,

MBA Research Project
Researcher: Mr. Silvester Olupot, Tel: 072 8560301
Supervisor: Prof. Manoj Maharaj, Tel: 0312608023
Research Office: Ms P. Ximba, Tel: 031-2603587

I am Silvester Olupot, MBA student, at the Graduate School of Business, of the University of KwaZulu -Natal. You are invited to participate in a research project entitled "**Comparative analysis of innovation support models at Higher Education Institutions (HEIs) in South Africa**" The aim of this study is to ascertain why there is high research publication output and almost negligible Innovation activity at the University of KwaZulu -Natal as compared to its peers.

Through your participation I hope to understand how innovation support models integrate into academic research and what would be used as a measure of successful innovation at HEIs in general.

The results of the survey are intended to contribute to Improvement of Innovation support model systems at HEIs in South Africa.

I do not know of any risks to you if you decide to participate in this survey and I guarantee that your responses will not be identified with you personally. 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. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Graduate School of Business, UKZN.

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

Along with this letter is an Interview schedule for your attention. Kindly read through the interview schedule and let me know of your availability for the interview which should take 20-30 minutes to complete. The interview shall be in the form of teleconference or face to face. I hope you will avail yourself for this survey.

Yours Sincerely.

Investigator Date_________________
Silvester Olupot
Email: Olupot@ukzn.ac.za Fax: 031 2604276

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS

MBA Research Project

Researcher: Mr. Silvester Olupot, Tel: 072 8560301
Supervisor: Prof. Manoj Maharaj, Tel: 0312608023
Research Office: Ms P. Ximba, Tel: 031-2603587

CONSENT

I…………………………………………………………………………(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.
I understand that I am at liberty to withdraw from the project at any time, should I so desire.

……………………………………. ………….................

SIGNATURE OF PARTICIPANT DATE

8.2 INTERVIEW SCHEDULE

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS

MBA Research Project
Researcher: Mr. Silvester Olupot, Tel: 072 8560301
Supervisor: Prof. Manoj Maharaj, Tel: 0312608023
Research Office: Ms P. Ximba, Tel: 031-2603587

INTERVIEW SCHEDULE

Title of Survey: Comparative analysis of innovation support models at Higher Education Institutions (HEIs) in South Africa

The purpose of this survey is to solicit information from Innovation Support models at HEIs in South Africa regarding Research and Innovation activities. The information you provide us will go a long way in helping us identify ways of improving performance of innovation support models at HEIs in South Africa.

The interview should only take 20- 30 minutes to complete. This research project has been approved by the Ethics Clearance Committee at the University of KwaZulu-Natal. All results will be used for academic purpose only.

Background

- Kindly give brief background of the innovation model.
- What challenges has it encountered in accessing the University Community?
- How are (were) these challenges addressed?

Vision and Goals of the innovation support Model.

- Briefly outline the vision and the goals of the innovation model?
- How can progress toward those goals best be measured?
- Are the goals in line with the University's strategic plan.?
- Briefly comment on the Intellectual Property Rights from Publicly Financed Research Bill.

Mandate and business model

- Is the mandate of the business model clear, achievable and consistent with the goal of maximizing disclosures?
- Does the innovation model have sufficient resources to carry out its mandate?
- What are the sources of funding?

Support Structure

- Please give a brief overview of the support model structure in terms of physical, legal, organizational and operational structure.
- How is the support model integrated to the University and what are the legal and tax implications of the current structure?
- Are the intellectual property (IP) and commercial initiatives policies (if any) underlying the structure appropriate and easily accessible to the researchers?

Governance and Leadership.

- Does the governance and leadership of the innovation model build a collaborative environment between the needs of the researchers and those of the business world? How?
- Does the leadership and the staff of innovation model have a right mix of business and science skills?
- If not, are these skills outsourced and from where?

Comparative Performance.

- How does your innovation model perform as compared to its peers in South African universities and international institutions?
- What would you regard as appropriate yard stick to measure innovation model's performance?
- Kindly provide statistics that relates to performance if available?
- If its performance falls short, how might it be improved?

Management Effectiveness:

- Are current activities in line with the goals of the University's strategic/business plan?
- Is its management effective?
- How successful has the innovation model been in engaging the university research community?

External Relationships:

- How has the innovation support model developed and benefited from the outsourcing and networking relationships available to it?
- How successful has it been in optimizing technology transfer and commercialization efforts among private and public institutions?

Culture

- Briefly comment on the university community's culture and what impact it has on the innovation support model's effectiveness.

Closing

- It has been a pleasure interviewing you. Is there anything else that you think is important and was left out?

End of the Interview

Thank you for participating!

8.3 ETHICAL CLEARANCE APPROVAL LETTER