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**Determinants that drive commercialisation of potential university  
innovation outputs through technology transfer offices**

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**A research project submitted to the Gordon Institute of Business Science,  
University of Pretoria, in partial fulfilment of the requirements for the degree of  
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## Abstract

The emergence on knowledge-based and innovation-based economy has led to numerous universities restructuring themselves in response to this new economic growth shift. Technology transfer is the process of converting scientific findings into useful products or services for society. The purpose of the study was to identify the key determinants that drives successful commercialisation of university innovations by technology transfer offices.

The research took a qualitative methodology wherein open ended questions in the form of narrative inquiry were posed to experts in the field of university technology transfer to explore and understand the critical determinants that drives successful commercialisation of university innovations. From the twelve themes that emerged as determinants for driving successful commercialisation of innovation, *buy-in by top management of the university, awareness about technology transfer office, enabling environment and financial stability* were considered as highly critical for commercialisation of university innovations by technology transfer offices.

A technology transfer office can create many benefits for the university, industry, and the surrounding community, but it requires carefully planned and consistent long-term financial and administrative support. And above all, it requires technology transfer officers that are able and willing to take risks and university top management that support them.

## Keywords

Technology Transfer, university commercialisation, innovation, technology transfer offices, knowledge-based economy

## Declaration

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

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**Researcher: Mmatheetja Phineas Thosago**

09-11-2011

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**Date**

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*This dissertation is dedicated to:*

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## CHAPTER 1

### 1. INTRODUCTION

#### 1.1 Introduction to Research Problem

According to the global entrepreneurship monitor South African report 2010, (Herrington, Kew and Kew, 2010), South Africa still has a low level of business innovation which impedes growth and wealth creation (Herrington *et al.*, 2010). While it is possible to point to the apparent success in recent years of economic growth and the record numbers of jobs created, this masks the more sobering reality that we are not maximising the gains possible through the exploitation of R&D and innovation, especially when compared to more successful competitors in the world economy (Herrington *et al.*, 2010).

Research and development by universities was pursued largely from a disinterested inquiry perspective (Bozeman, 2000). Today, academic research is increasingly pursued for its commercial potential and value as intellectual property that can be exploited for financial gain (Powers, 2003). Institutions of higher education are extraordinarily dependent on external resources, be it financial resources, legal mandates and economic incentives (Powers, 2003), hence research universities have become increasingly active in the commercialisation of university inventions.

There have been studies on academic entrepreneurial phenomenon (Powers, 2003), some from the perspective that it is a legitimate and appropriate aim given

the need for national and regional economic development (Etzkowitz and Leydesdorff, 2000; Powers 2003). According to Etzkowitz and Stevents (1998) academic patenting of inventions was considered anemic, due in large part to the cumbersome and complicated process by which an institution might obtain the rights to an invention funded from federal sources. The patenting of inventions, it was believed (Etzkowitz and Stevens, 1998), was important for getting more good ideas off of the lab table and into the marketplace via the licensing of a patent to industry. These beliefs caused many governments to believe that changing the incentive system for academic R&D could lead to substantial increases in patenting and, by extension, the licensing of those technologies to industry for exploitation (Etzkowitz and Stevens, 1998).

It is becoming increasingly apparent that in many countries innovation becomes a central theme of national development (Teng, 2010). Universities are being viewed by policymakers in many countries as engines of growth (Teng, 2010, Yusof and Razak., 2009). These encourage universities to reconfigure themselves with structures like technology transfer offices (Swamidass and Vulusa, 2008), which maximize their capacity for innovation. University-enterprise technology transfer activities are increasingly important as a source of economic development and revenue for the university (Teng, 2010).

The rapid rise in university technology transfer and the increased emphasis on transferring technology to the private sector for commercialisation as an economic development has led to a number of universities to develop technology transfer offices (Collier and Gray, 2010). The growth in the commercial

applications of university research has led to an increasing number of universities setting up their institution's technology transfer office (Collier and Gray, 2010).

In the United states following the passage of Bay-Dole Act in the 1980 (AUTM, 2003), the success of the university-industry licensing phenomenon is evidenced by the Association of University Technology Managers annual report (AUTM, 2003), which reported the issuing of 3,933 patents, the execution of 4,516 new licenses and options for a total of 25,979 active licenses and options yielding an income of \$1.31 billion, compared to fewer than 250 patents that were issued to U.S. universities prior to the Bayh-Dole legislation act of 1980 (Rahal and Rabelo, 2006).

According to Rahal and Rabelo (2006) those discoveries were seldom commercialized for the public's benefit, and the primary method for disseminating federally funded research was academic publications. Hence, recognizing the importance of university related scientific and technology research as an important source of long-term economic growth and technological innovation, and faced with the pressure to speed up new product delivery, an ever decreasing product life cycle, and a fast technological obsolescence, many governments have significantly increased their sponsorship and financial support of academic research Rahal and Rahelo (2006).

In response to these growing commercial applications of the university research in South Africa, South African government has formulated two acts namely:

- The Intellectual Property Rights from Publicly Financed Research and Development Act (IPRPFRD Act No. 51 of 2008) (Republic of South Africa, 2008a) and the
- Technology Innovation Agency Act (.TIA Act No. 26 of 2008) (Republic of South Africa, 2008b).

In summary the goal of both acts are to stimulate the promotion of the development and exploitation in the public interest of discoveries, inventions, innovations and improvements in South Africa. In addition according to the IPRFRD Act it is now compulsory for every university and public research institute to have a technology transfer office (Republic of South Africa, 2008a).

The reality is that in the new knowledge based global economy, innovation has become business critical for all sectors (OECD, 1998). In the 21st century companies, science councils, universities, and indeed government departments which do not have innovation embedded in their planning processes and their product/service delivery will fall further and further behind their more successful international competitors (OECD, 1998; OECD, 2005). Countries that do not have innovation enablers will also lose their competitive advantage (Herrington *et al.*, 2010).

Collaboration between university, industry and the public sector (Martinelli, Meyer and von Tunzelmann., 2008) has always been facing challenges when coming to commercialisation of university innovations because all university

commrecilisations resemble heterogeneous pools of actors, each with its characteristics, purposes and structures (Martinelli, Meyer and von Tnuzelmann., 2008) According to Wolson (2007) this gap has been filled by formation of technology transfer office and Intellectual property management offices (Wolson, 2007) which acts as a link between all these actors (Martinelli *et al.*, 2008).

The study by Wayne (2008) indicated that some characteristics that are used to measure technology transfer offices performance includes licensing revenue collected by universities, the number of licenses granted by universities and the number of start-up companies created out of research universities. Literature about university technology transfer and licensing has mostly focused on university patents (Rahal and Rabelo., 2006 ), the organizational structure and university prestige as determinants of licensing and, the practices and performance of the technology transfer office (Sine, Scott and Gregorio, 2003)

According to Breznitz, O'Shea and Allen (2008), in theories of economic development, universities play an important role. Several such theories view the university as an institution that generates knowledge, encourages the diffusion of new ideas on which innovation is based, and creates skilled personnel and entrepreneurs Breznitz *et al* (2008). Critically, in many theories the university is viewed as the basic factor in a knowledge-based economy and a center around which new industrial clusters are likely to emerge Breznitz *et al.*, (2008).

Breznitz et al (2008) has also emphasized that science has emerged as an alternative engine of economic growth in addition to the classic production



factors, thus making skills and knowledge the primary sources of sustainable competitive advantage. Hence, in the rise of a knowledge-based economy, industrializing academic knowledge to foster industrial innovation and competitiveness has become imperative (Breznitz *et al.*, 2008).

A number of literature has indicated that government initiatives like the Bay-Dole act (Etzkowitz and Leydesdorff, 2000; Powers 2003) have played a catalyst role in transforming universities to become more entrepreneurial. Even with the technology transfer offices in place, it still remains a problem to actually determines what really drives the success of university commercialisation by technology transfer offices.

In addition to some of the key performance indicators of technology transfer offices as outlined by Wyne (2008), this study did not indicate the key determinants in relation to technology transfer offices which drives commercialization in University. Hence this study would try and identify what are the key determinants in relation to technology transfer offices that drives university commercialisation.

## **1.2 Research purpose**

The aim of this study is identify what are the key determinants in relation to technology transfer offices that drive the commercialisation of potential university innovations outputs. The study will try to explore whether these determinants are internal processes (clear understanding of goals and objectives of the TTOs

within the university, relationship amongst researchers and technology transfer staff, communications amongst faculties and TTOs, clear understanding of the roles and responsibilities of each actor in the system) or external (external support by funding from the public sector and private sector and legal support) forces.

Therefore in order to improve the efficiency of the technology transfer offices, the research would identify those key determinants in relation to technology transfer offices that accelerates commercialisation of potential university inventions that can be commercialised.

In conclusion, by understanding the key determinants that drive successful commercialisation of university innovations by technology transfer offices, would help in enhancing those determinants for successful commercialisation. The study would also provide guidelines on how to run technology transfer successfully and what are they key factors that must be in place when trying to establish a technology transfer office.

## CHAPTER 2

### 2. LITERATURE REVIEW

#### 2.1 Innovation

Innovation is the commercial application of knowledge or techniques in new ways or for new ends (Teng, 2010). It may involve radical innovation or incremental innovation. In each case the innovator achieves a competitive advantage, at least until another company catches up or goes one better (Roper and Anderson, 2000). Innovation can also be viewed as the development of new ways of thinking, the creation of new ways of doing things, experimenting with them, accepting them and using them in human economic and social activities (Roper and Love, 2006, Teng 2010).

Innovation has been more accepted by many countries as a driver for socioeconomic development (Teng, 2010). It is becoming increasingly apparent that in many countries innovation becomes a central theme of national development. The emergence of innovation-driven economy brings changes in public policy such as public sector reform, education reform, and privatization(Teng, 2010).

Traditionally, innovation has been generally restricted to science, technology and process innovations (Witkamp, Raven and Royackers, 2011). However, there has been significant movement towards a much broader understanding of innovation,

to include innovation within the social and public arenas as well (Witkamp *et al.*, 2011). At the same time, where innovation has traditionally been thought of as being located within high-end research laboratories and academic institutes, there is an increasing role played by open innovation networks. These networks are generally less concerned about protecting intellectual property, as the community developing the solution is generally the same that will be using it (Witkamp *et al.*, 2011).

### **2.1.1 Innovation and economic growth**

The Organisation for Economic Cooperation and Development (OECD) emphasizes that long run economic growth depends on the creation and fostering of an environment that encourages innovation and application of new technologies (Atun Harvey and Wild, 2007; OECD, 2003). Innovative activity underpins economic productivity and growth. Countries that generate innovation, create new technologies, and encourage adoption of these new technologies grow faster than those that do not. Innovation is singled out as the likely factor that drives long-term productivity and economic growth (Atun *et al.*, 2007; OECD, 2005).

Total factor productivity, also known as the growth residual and which includes innovation and technology application, represents output growth not accounted for by the increases in factor inputs (OECD, 1998). In the period 1970–1990, total factor productivity was the major driver of economic growth in the world: accounting for 41% of the total growth, as compared with 38% for capital and

21% for labor (OECD, 1998). Many studies have explored the relationship between economic growth, competitiveness, innovation and IP (Leisyte and Horta, 2011, OECD 1998, OECD 2005). These studies have generally used R&D investment or the number of patents filed as proxies for innovation (OECD, 1998; OECD, 2005)

In the United States of America the increasing government pressure on universities to generate economic returns from federal research and development (R&D) funding, coupled with unemployment and outsourcing challenges, has led to the debate as to how policymakers and academics can foster technology-based entrepreneurship from universities (Powers, 2003). Analysis of academic entrepreneurship through spin-offs in a comparative context has been particularly neglected yet is of growing importance for both researchers and practitioners (Breznitz *et al.*, 2008)

Knowledge is now recognized as a key ingredient underlying the competitiveness of regions, nations, sectors and firms (Huggins, 2006). At its most fundamental level, the knowledge-base of an economy can be defined as the capacity and capability to create and innovate new ideas, thoughts, processes and products, and to translate these into economic value and wealth (Huggins and Izushi, 2002).

According to OECD (2005), the term “*knowledge-based economy*” results from a fuller recognition of the role of knowledge and technology in economic growth. Knowledge, as embodied in human beings (as “*human capital*”) and in

technology, has always been central to economic development. But only over the last few years has its relative importance been recognized, just as that importance is growing.

Traditional “production functions” focus on labour, capital, materials and energy; knowledge and technology are external influences on production. Now analytical approaches are being developed so that knowledge can be included more directly in production functions. Investments in knowledge can increase the productive capacity of the other factors of production as well as transform them into new products and processes. And since these knowledge investments are characterised by increasing (rather than decreasing) returns, they are the key to long-term economic growth (OECD, 2005)

In recent years, the commercialization of the knowledge and research residing and undertaken in universities and higher education institutions (HEIs) has come to be viewed as an increasingly important stimulant of economic growth (Etzkowitz, 1998; Bok, 2003), and in particular for improving the development capabilities and economic performance of regions

In theories of national and regional economic development, universities play an important role (OECD, 2005). Several such theories view the university as an institution that generates knowledge, encourages the diffusion of new ideas on which innovation is based, and creates skilled personnel and entrepreneurs (Breznitz *et al.*, 2008). Critically, in many theories the university is viewed as the

basic factor in a knowledge-based economy and a center around which new industrial clusters are likely to emerge

In summary, cross-country, country-level and company-level studies show that innovation, as measured by research and development or patenting, has a positive correlation with economic productivity and enhances market share and profitability at company level (Huggins, 2006; OECD, 2003 and OECD, 2005). Benefits are best realised when regimes governing intellectual property rights provide incentives for innovation and do not hinder diffusion of knowledge.

Empirical evidence also shows that innovation diffuses rapidly to competitor firms and is imitated (Breznitz *et al.*, 2008; Siegel, 2008). Hence, IP protection is important to sustain competitive advantage and allow the creators to capture the benefits of their investment in innovation. Effective management of innovation and IP should be a fundamental strategic objective for countries and companies, particularly in knowledge-based and innovation-intensive economies (Breznitz *et al.*, 2008; OECD, 1998)

## 2.2 Commercialisation

Commercialization refers to the series of activities undertaken by firms to transform knowledge and technology (whether developed in Canada or abroad) into new products, processes or services, in response to market opportunities. Highly skilled workers (researchers, engineers, managers, etc.) are critical to the

commercialization process, as is a culture that values innovation and entrepreneurship (Rosa and Rose, 2007).

Rosa and Rose (2007) has also defined commercialisation as an integral part of the innovation process and may be described as putting in place a set of conditions and elements or activities that the firm must necessarily fulfill in order to generate income from goods or services innovations introduced respectively in the marketplace and in the production system.

Commercialization is at the intersection of innovation and entrepreneurship. It comprises processes and activities that bridge the gap between economic value creation and economic value realization (Prebble, de Waal & de Groot, 2008). Increasingly, private, public, and even non-profit organizations are also mobilizing their idle, unexploited, and underutilized discoveries, inventions, and innovations into the open market. Markman, Phan, Balkin and Gianiodis (2005) also indicated that the commercialization of new knowledge, basic and applied research, technology breakthroughs, scientific developments is an ecosystem of research and technology commercialization (Markman *et al.*, 2005).

This ecosystem is essentially a market that includes research joint ventures, strategic alliances, and licensing agreements involving universities, research parks, and firms, as well as the formation of start-up companies that focus on science and technology (Markman *et al.*, 2005)



## 2.2.1 Different Commercialisation Models

Given that a commercialisation processes is an ongoing process in an organisation, and commercialisation is operated differently from one organisation to the other, there is no single model that one can follow, however there are basic components that organisations can follow when involved in commercialisation processes. Therefore no organisations are obliged to manage the commercialization process according to very specific sequences in chronological order, however basic principles of commercialisation must be understood as explained in the two selected models of commercialisation below

### 2.2.1.1 *Randall Goldsmith's Commercialisation Model*

Randall Goldsmith's commercialization model is a road map of strategies and actions for the commercialization of advanced technologies (Rosa and Rose, 2007).

	Concept phase	Development phase	Market entry phase	Market expansion phase
Market	Initial market and opportunity assessment Lead customer identification and engagement	Develop marketing plan including segmentation, channel and customer relationship strategies	Implement promotion plan Perform competitive market intelligence	Target vertical and adjacent markets and increase market penetration Enhance partnership delivery channel and CRM
Business	Identify financial, physical & HR requirements	Secure required financing Establish management team, financial and business plans Determine break-even point	Manage financing, skills and production needs Adjust strategic and business plans to respond to market opportunities	Diversify internal and outsourced skills required to meet ROI objectives Establish international partnerships
Technical	Determine features and performance requirements Perform competitive technology intelligence – Patent search	Move development into prototyping, testing and production phase Source raw materials and establish Q&A systems	Establish manufacturing facilities and product technical support	Determine incremental product development cycle Continuously assess competitive product functionality and emerging technologies for adoption

**Figure 1:** Conceptual framework for the process of commercializing advanced technologies. *Source: (Goldsmith, 1999)*

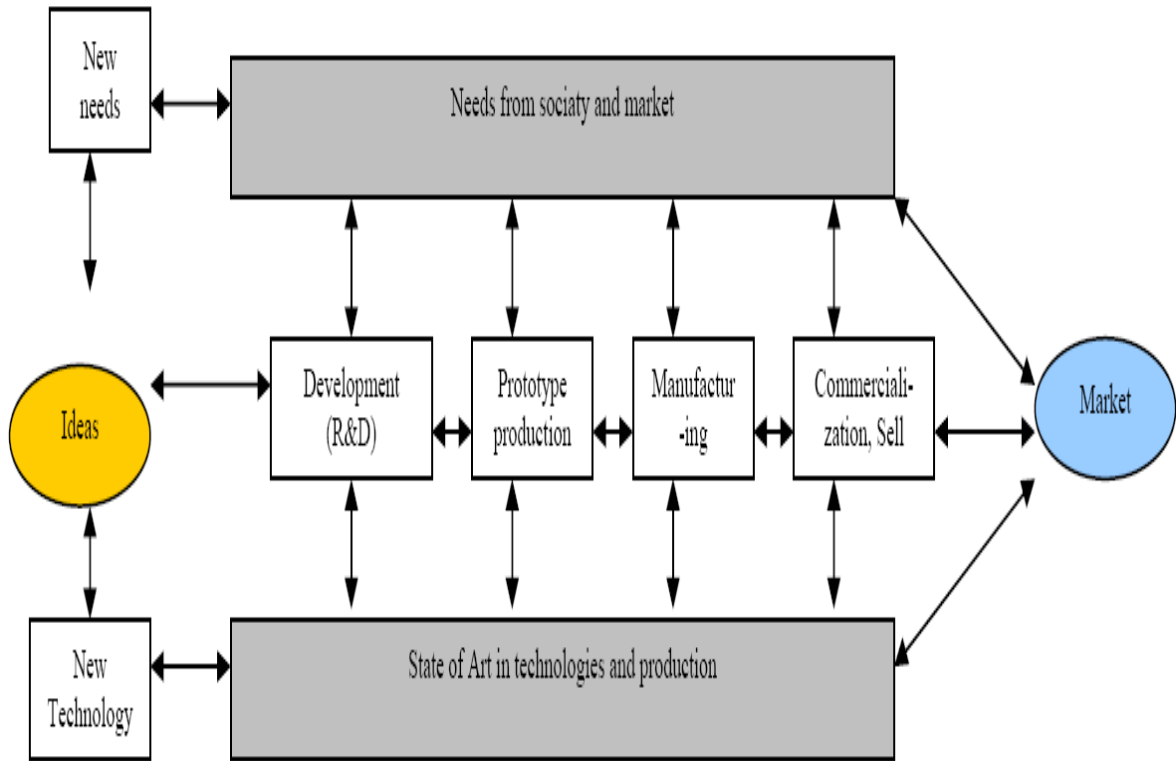
The model breaks down into twelve activities that describe the process to maximize the chances for success. Each sequence has a technical stage, a market stage and a business stage. The model is a framework for measuring progress in the different stages, namely identification of information and technical assistance needs, project development costs and the forecasting of financing requirements. It follows a quite specific, ordered process (Figure 1).

The Goldsmith's model (Figure 1.) was designed to provide a mechanism for commercializing new products, new processes and new ideas (Goldsmith,1999). This framework is not suited to commercialization for technology adoption purposes incremental innovation (Rosa and Rose, 2007). The Goldsmith framework was designed for new product introduction and new company creation

which is most often reflective of emerging and disruptive technologies (Goldsmith, 1999). These emerging and disruptive technologies account for a very small percentage of total innovation where the majority of innovations involve adopting or adapting technologies (Goldsmith, 1999). A deficiency of the Goldsmith model is its lack of flexibility regarding feedback, since it is linear by nature.

### **2.2.1.2 Rothwell and Zegveld's Commercialization Model**

The model (Figure 2.) of Rothwell and Zegveld (1985) shows that commercialization is an integral component of the innovation process. The heart of this model lies in the interaction of its components. According to this approach, it is the combination of market needs (market pull) and technological opportunities (market push) that gives rise to innovation. Like Goldsmith's model, this model is sequential, but it allows feedback between components.



**Figure 2:** The technological innovation and commercialization model of Rothwell and Zegveld (1985)

The R&D and commercialization components interact to create technological opportunities and satisfy the demands of the market. According to Chiasa (2005), from the 1990s to the present, models emphasizing the sequential process of innovation and commercialization have given way to models in which function takes precedence over linearity. In this generation of models, the R&D, commercialization and financing functions interact in no particular order. Throughout this process, suppliers and customers, upstream and downstream in the process, provide continual feedback on the functions (Chiasa, 2005). This type of model also assigns a greater role to horizontal external partnerships.

## 2.2.2 University Commercialisation

Traditionally, the roles of the university were to educate students and to conduct basic research (Breznitz *et al.*, 2008). Over the years and throughout the scientific revolutions, universities have taken on another role, becoming central players in regional and national economic development (Breznitz *et al.*, 2008). Bozeman (2000) indicated that university research and development was pursued largely from a disinterested inquiry perspective focusing mainly on the basic research and not applied research.

The university is an institution with a long history and, over the course of the centuries (Powers, 2003) it has gone through several stages in its development (Martinelli *et al.*, 2008). While initially conceived as an institution with a teaching mission, the university later adopted a knowledge generation function (Martinelli *et al.*, 2007). Yusof and Razak, (2009) also indicated that Universities have traditionally been thought of as the places for higher education and basic research.

The emergence of the knowledge-based innovation economy has externally influenced academic structures and internal developments of academic entrepreneurship in the universities (Yusof and Razak., 2009). In recent years, the idea has emerged that the university is assuming a third mission, contributing to society and economic development more directly (Powers 2003).

Today, academic research is increasingly pursued for its commercial potential and value as intellectual property that can be exploited for financial gain (Clark, 2004). Institutions of higher education are extraordinarily dependent on external resources, be it financial resources, legal mandates and economic incentives (Powers, 2003) , hence research universities have become increasingly active in the commercialisation of university inventions and they are becoming more entrepreneurial (Clark, 2004).

Clark (2004) identified entrepreneurial universities as a system that includes : entire universities, their internal departments, research centers, faculties and schools:

*“An entrepreneurial university, on its own, actively seeks to innovate how it goes about its business. It seeks to work out a substantial shift in organizational character so as to arrive at a more promising posture for the future. Entrepreneurial universities seek to become ‘stand-up’ universities that are significant actors on their own terms” (Clark,2004).*

During the past decades, the convergence of a number of social and economic factors has increased the interests of universities, industry and government in the commercialization of universities research output (Hearn and Ordonez, 2004). Governments and universities around the world are taking steps towards identifying marketable products, strengthening links with industry, and creating institutional framework needed to sustain and increase research output and speed the technology transfer process (Hearn, Cunningham and Ordonez, 2004).

The actions vary in degree and scope, from standardizing and enforcing conventional intellectual property protection mechanisms, to creating support mechanisms for spin-offs companies and setting up venture capital funds to support their growth. (Hearn *et al.*, 2004)

Universities, like companies, vary enormously in the extent to which they engage in and experiment with new mechanisms to promote the commercialization of academic research, and in the extent to which they succeed in generating additional income from third stream activities (Geuna and Muscio, 2009).

There are high levels of heterogeneity in the approaches taken by universities to interact with business and society (Geuna and Muscio, 2009). Firm, university and individual researcher characteristics are important in explaining the variety of models. In some cases, strategic decisions have been taken at the university level to invest in the institutionalization of technology transfer activities (e.g. those universities whose home pages describe them as ‘entrepreneurial universities’); in other cases, it is the individual researcher network that explains the success of such interactions; and, finally, the characteristics of the demand side (companies) and the propensity to be open to capturing the flows of knowledge coming from the universities, are crucial (Geuna and Muscio, 2009 and Siegel, Waldman, and Link. 2004)

From the university perspective, knowledge transfer between universities and industry occurs through a variety of mechanisms (Nelsen, 2004). These range from recruitment of university graduates, to personnel exchanges, cooperative

joint research, contract research, consulting, patents and publications, licensing, spin-off companies, and industry funded laboratories and other physical facilities, and also include informal contacts such as meetings and conferences.

In general University commercialisation are the processes by which university research project output is put to good use, and brings with it, if effectively managed, additional benefits to the University, its staff and students and the regional economy and consequently the national economy (Siegel *et al.*, 2004; Swamidass and Vulusa., 2009).

### 2.3 Defining Technology Transfer

Even though technology transfer is not a new business phenomenon, the considerable literature on technology transfer that has emerged over the years agrees that defining technology transfer is difficult due to the complexity of the technology transfer process (Bozeman, 2000). The definitions depend on how the user defines technology and in what context (Chen 1996; Bozeman 2000). According to Cao, Zhao and Chen, (2009), Ramanathan, (2008) Teng,( 2010) who looked at overview of technology transfer offices and different technology models, the following conclusions were made on technology transfer:

- technology transfer may be defined as a mutually agreed upon, intentional, goal oriented, and proactive process by which technology flows from an entity that owns the technology (the transferor) to an entity seeking the technology (the transferee). The transfer involves cost and expenditure



that is negotiated and agreed upon by the transferee and transferor. The transfer may be said to be successful if the transferee can successfully utilize the technology for business gains and eventually assimilate it.

- Technology transfer can be vertical or horizontal technology transfer. Vertical transfer refers to transfer of technology from basic research to applied research, development, and production respectively and horizontal technology transfer refers to the movement and use of technology used in one place, organisation, or context to another place, organisation, or context.
- Technology transfer modes could be deployed depending on how the technology development chains of the transferor and transferee are linked . Technology transfer can commence from a simple level to a much more comprehensive one with time.
- The technology transfer model chosen mainly depend on the corporate strategies of the transferor and transferee and the technological capability of the transferee (Ramanathan, 2007; Teng, 2010; Zhao and Chen, 2009).

Technology transfer is the process of converting scientific findings into useful products or services for society (Cao, Zhao and Chen., 2009, Teng., 2010,). Any country or institution can undertake health or agricultural innovation to varying degrees (Harman, 2010), but some developing countries that are more scientifically advanced are starting to reap the benefits of decades of investments in education, health research infrastructure, manufacturing and production capacity, and regulatory institutions (Krattiger, Mahoney, Nelsen, Thomson, Bennett, Satyanarayana, Graff, Fernandez and Kowalski., 2007). According to

Siegel, Wright, Chapple & Lockett (2008) technology transfer is usually considered within or across firms, such as the dissemination of information through transfers of employees from one division or country to another.

The widely touted success of technology transfer from U.S. universities has attracted interest from universities and research institutes around the world. Such diverse countries as Germany, the Republic of China, South Africa, the United Kingdom, and many others have changed their laws and policies, modeling them after U.S. practices, to allow universities and faculty members to manage and transfer intellectual property (IP) (Nelsen 2007).

Increasingly referred to as innovative developing countries (Nelsen, 2007; Krattiger *et al.*, 2007), these countries are characterized by, among other things, sustained government support for research, the availability of venture capital, functioning regulatory systems, and an ability to partner with local and foreign public and private research organizations (Krattiger *et al.*, 2007, Siegel *et al.*, 2008). All of this requires sound IP (intellectual property) management, which makes such partnerships more effective and allows technologies to be transferred not just in one direction but in more complex and valuable ways, to benefit more people (Nelsen, 2007). Technology transfer is thus a rewarding process for research-based institutions and the people who make it happen. It leads to new products, services, and jobs. But it is also a multifaceted process with important policy, economic, and managerial ramifications.

At the purely academic end of the spectrum, university technology transfer can mean a faculty member's presentation of basic research at a symposium or perhaps the publication of a journal article. At the commercial end, university technology transfer may involve the licensing of university inventions to an industrial firm (Bozeman, 2000). University faculty and students may even be directly involved with such a firm as consultants, shareholders and employees (Bozeman, 2000).

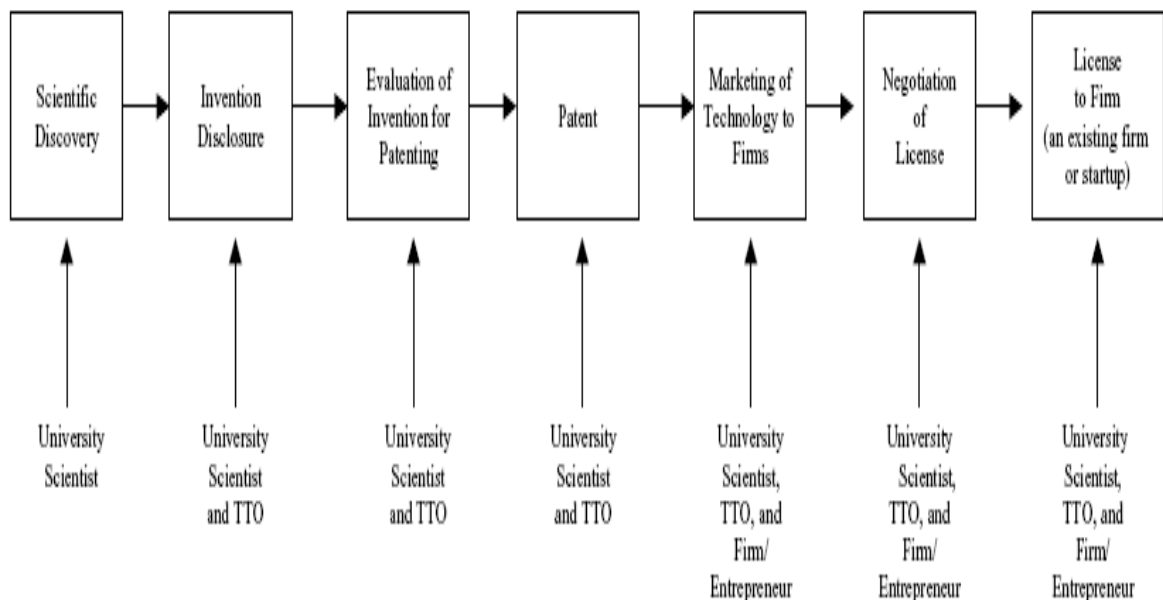
## 2.4 Technology Transfer Office Processes

In recent years, there has been a substantial increase in the rate of commercialization of intellectual property at US and UK universities (Siegel *et al.*, 2004, Siegel *et al.*, 2008). More specifically, universities have attempted to formalize technology transfer and capture a larger share of the economic rents associated with technological innovation by establishing technology transfer offices (Siegel *et al.*, 2008). TTOs facilitate technological diffusion through the licensing of a university-based technology to an existing firm or new venture. Thus, they contribute to the development of new technology infrastructure (Siegel *et al.*, 2008). In the aftermath of the Bayh-Dole legislation, many universities established technology transfer offices (TTOs) to manage and protect their intellectual property (AUTM, 2003).

The process of technology starts when a faculty member, graduate student or staff (the inventor) of a university submits an invention disclosure to the technology transfer office (TTOs) (Siegel *et al.*, 2004). The TTO typically

evaluates the invention’s economic prospects and decides whether to protect the intellectual property (IP) by securing a patent, copyright or trademark or by keeping the invention a trade secret (Cao *et al.*, 2009). The next step occurs when an individual or organization, usually a commercial company, secures a license to commercialize the technology. A license does not technically grant a company the right to make, use or sell the invention, but it is an agreement for the university not to sue the company for patent infringement.

A generic technology transfer process utilized by many universities follows a technology transfer models by Siegel *et al.* (2008) indicated in Figure 3.



**Figure 3:** Technology Transfer from a University to firm or Entrepreneur (Siegel, 2004)

According to Figure 3, the process begin with a discovery by a university scientist in a laboratory, who is working on a research and then the researcher would file a invention closure with the TTO. Officials must then decide whether they will attempt to patent the innovation, which is one mechanism to protect intellectual

property. Interest in the technology by an industry partner often provides sufficient justification for filing a patent. In other cases, the TTO must make a judgement regarding commercialization potential prior to interest being expressed by industry. This is not a trivial decision, because universities have limited budgets for filing patents (Siegel *et al.*, 2004, Siegel 2008 *et al.*, Wayne 2008), which is quite expensive if global patent protection is sought. Universities may choose to apply for domestic patent protection, which safeguards the technology at a much lower cost (Siegel *et al.*, 2004).

Once the patent has been awarded, the TTO can presumably market the technology, sometimes with faculty input. That is, faculty members can help identify potential corporate licensees. The next stage of the model involves working with firms or entrepreneurs to negotiate a licensing agreement (Siegel *et al.*, 2004; Stadler, Castrillo and Veugelers, 2007). This agreement could include such benefits to the university as royalties or an equity stake in a startup. In the final stage, the technology is converted into a commercialized product. The university may continue its involvement with the firm, for instance, by devoting resources to the maintenance of licensing agreements. Moreover, in the case of startups, faculty members may serve as technical advisors or on boards of directors, and may also have an equity stake in the startup (Siegel *et al.*, 2004; Stadler *et al.*, 2007).

Within this context, research universities are increasingly seen as vehicles for technology transfer and a conduit through which knowledge exchange is made more effective (Cao *et al.*, 2009). According to Wayne (2008) research

universities are extraordinarily dependent on external resources however Pfeffer & Salancik, (1978) posit that organizations are by and large driven by forces in their external environments, and thus are not completely autonomous, self-directed entities.

Pfeffer and Salancik (1978) go further in stating that organizations will seek to stabilize their interactions with external actors by establishing alternate relationships or dependencies. Resource dependence theory, institutional theory, resource-based view frameworks have been the theoretical bases for past studies of university technology transfer (Wayne 2008). Much of the research performed to date on university technology transfer has been centered on the internal attributes of organizations (Wayne 2008).

#### **2.4.1 Innovation outputs by technology transfer offices**

Technology transfer offices output are determined by key activities of the technology transfer offices. Technology transfers innovation outputs can be viewed differently by different stakeholders who work TTOs (Siegel *et al.*, 2004). As noted in Siegel *et al.*, (2004), the TTO works with the scientist and firm or entrepreneur to structure a deal. The primary motive of the TTO is to safeguard the university's intellectual property, but at the same time, market that intellectual property to private firms.

Stakeholder	Actions	Primary motives(s)	Secondary motives(s)	Organizational culture
University scientist	Discovery of knowledge	Recognition within the scientific community – publications, grants (especially if untenured)	Financial gain and desire to secure additional research funding (mainly for graduate students and lab equipment)	Scientific
Technology transfer office	Works with faculty members and firms/ entrepreneurs to structure deals	Protect and market the university's intellectual property	Facilitate technologic diffusion and secure additional research funding	Bureaucratic
Firm/entrepreneur	Commercializes new technology	Financial gain	Maintain control of proprietary technologies	Organic/ entrepreneurial

**Figure 4:** Key stakeholders in the transfer of technology from University to the private sector (Siegel, 2004)

Secondary motives may include securing additional research funding for the university via royalties and licensing fees, sponsored research agreements, and an intrinsic desire to promote technological diffusion (Phan and Siegel, 2006; Siegel *et al.*, 2004). The actions and motives of firms and entrepreneurs are relatively straightforward. They seek to commercialize university-based technologies for financial gain. To do so, they desire exclusive rights to these technologies, in order to maintain control. They also express great anxiety about time to market, since the benefits from innovation may depend on rapid development of a new product or new process (Phan and Siegel, 2006; Siegel, 2004)

The last decade has seen tremendous growth in the use of IP protection in business ventures, particularly those concerning biotechnology (Wayne 2008). As a result, more and more institutions are establishing technology transfer offices

(TTOs) to assist in the legal transfer of technology (Stadler *et al.*, 2007).. These offices serve a variety of functions, such as evaluating research results in regard to potential commercialization, advising on IP protection, filing and prosecuting patent applications, assisting in funding issues, conducting feasibility studies, and so on (Stadler *et al.*, 2007).

A number of literatures have indicated that technology transfers activities and outputs are;

- technology commercialisation (Price *et al.*, 2008; Markman *et al.*, 2008), entrepreneurial activities,
- commercialisation and use of university facilities (Lyste, 2011; Martinelli *et al.*, 2008, Powers, 2004; Rahal and Rabelo, 2006),
- advisory work, contract research with non academic clients (Collier and Gray 2010),
- industrial and partnership networking, active alignment of teaching to economic and social needs, flow of academic staff, scientists and technicians between the university and the industry and Non academic dissemination (Prebble, et al., 2008).

#### **2.4.2 Measuring technology transfer successes**

Picking potential winners from a vast range of opportunities presented by research is a tricky and risky business with high failure rate (Nelsen, 2007; Rahal and Rabelo, 2006). This has led to the conclusion that both the producers (licensors) and the acquirers (licensees) of the technology would need best



assessment tools that could help in the assessment, prediction, and identification of those technologies with above average potential for commercial application (Rahal and Rabelo, 2006).

It takes time (eight to ten years) to build an IP portfolio, establish contacts, and develop skills in technology transfer (Dodds and Somersalo, 2007; Nelsen 2007). It may take up to two decades or more before a university technology transfer program (including entrepreneurial spinouts) substantially affects the local economy (Nelsen, 2007). The ultimate impact, however, may be very large both economically and culturally for the university, its graduates, and the wider community (Nelsen, 2007).

It is important to define the TTO's scope of operations as well as how it will be funded and managed from the outset, Because several years can pass before any revenues or royalties would be collected from IP transfers (Dodds and Somersalo, 2007) the office has to operate with the highest possible efficiency. Success or failure will depend mostly on the financial resources, human resources and physical infrastructure available to the office (Dodds and Somersalo, 2007).

According to Association for University technology Managers (2003) given a vast difference of technology transfer activities amongst universities different methods can be used to measure success of technology transfer offices.

Early numerical measures include the number of patents filed, license agreements executed and new companies formed (AUTM, 2003). Later numerical measures include revenues from license fees, royalties and cash from equity investments paid to the academic institutions and the numbers of products successfully introduced to the market. Success has also been demonstrated by the impact the new technology transfer products and processes have impacted on our daily activities of our lives (AUTM, 2003).

Other non-numerical - but equally important - results of technology transfer include a university's ability to retain entrepreneurial faculty, attract outstanding graduate students, contribute to the institutional reputation for innovation, augment its research program through interaction with the private sector and enhance its reputation for providing highly trained students for the industrial work force AUTM (2003).

In the United States following the passage of Bay-Dole Act in the 1980, The success of the university-industry licensing phenomenon is evidenced by the Association of University Technology Managers annual report (AUTM, 2003), which reported the issuing of 3,933 patents, the execution of 4,516 new licenses and options for a total of 25,979 active licenses and options yielding an income of \$1.31 billion, compared to fewer than 250 patents that were issued to U.S. universities prior to the Bayh-Dole legislation act of 1980 (Rahal and Rabelo, 2006).

## **2.4.2.1 Factors that drives successful licencing of university**

### ***Innovations***

The study by Rahal and Rabelo (2006) also indicated that there are some key factors, that translate to successful licensing of university innovations. These factors are classifies as

#### **2.4.2.1.1 Institutional Factors**

The institutional establishment factors are classified as:

- I. Technology transfer office factors
- II. Universities licensing policies
- III. Institutional prestige influence

The decision policies that dictate the managing of the university licensing process have identified the most important determinants contributing to a successful technology transfer and licensing to be the efforts on the part of the licensee, the value (nature and stage) of the technology, the financial issues, and the university licensing policies such as the university's prompt research publications requirements versus the licensee's preference toward secrecy of invention and publication delays (Rahal and Rabelo , 2006). University institutions that are considered prestigious have resulted in successful technology transfer offices. (Shenkar and Yuchtman-Yaar, 1997; Siegel, 2008).

Shenkar and Yuchtman-Yaar (1997) indicated that institutional prestige signals the quality of the organizations' goods where buyers form rational expectations of the quality of goods by observing the sellers' past products and actions, hence

influencing their subsequent purchasing decisions and attribute positive perception of a high prestige organization to their outputs (Shenkar and Yuchtman-Yaar, 1997, Siegel, 2008).

The study by Collier and Gray (2010) also identified that the support of top management mainly at the level of Vice-chancellor has led to a success of many technology transfer offices. The study also found that technology transfer offices with top management support were also financially stable as the management put some budget to grow the office (Collier and Gray, 2010)

An empirical study (Sine *et al.*, 2003) examined the influence of institutional prestige on the licensing of universities' inventions and concluded that "technical attributes alone may be insufficient to explain the likelihood of technology transfer, and that prestigious universities may be better able than less prestigious universities to license their inventions not because the technology produced is better, but because the universities that produce them are perceived as more prestigious (Sine, Shane, and De Gregorio, 2003).

#### 2.4.2.1.2 *Inventor-Related Factors*

The inventor's related factors are classified as:

- I. Inventor involvement and cooperation as a team player
- II. Inventor being recognized as a technology leader
- III. Inventor credibility in the field
- IV. Inventor has realistic expectations about his or her technology

## V. Incentives to inventor by the licensor.

In a survey of a sample of the Licensing Executive Society's members (Thursby and Thursby, 2000, Thursby and Thursby, 2003) identified that, personal contact or involvement between university inventors and industry are the most important source of technology transfer and commercialization success. This led to a conclusion that by establishing and nurturing such a relationship through some sponsored research, a company may develop an ongoing awareness of university research activity while the research group gains an efficient channel for marketing new results. Thursby and Thursby (2003) further explained that at least 71% of inventions require further involvement by the academic researcher if they are to be successfully commercialized.

The survey also determined that 48% of the ideas are in proof of concept stage, 29% have a prototype available on a lab scale, and for only 8% is manufacturing feasibility known. The authors also suggest that there is a moral hazard problem in which the inventor is likely to provide too little effort for the development of the technology. This moral hazard problem can be partially solved by offering the university royalties on sales resulting from the invention or equity in the licensing firm (Thursby and Thursby, 2003). Their studies have also identified that, the inventor's credibility in the technological field, his or her ability to deliver the technology know-how, the realistic goals of the research, and the strength of relationship and ties between the parties (Allen, 1997) as crucial variables that can affect technology transfer and licensing (Thursby and Thursby 2003).

#### 2.4.2.1.3 *Technology-Related Factors*

A survey of 62 universities by Jensen and Thursby (2001) to identify the characteristics of an invention found that the vast majority of university inventions licensed are embryonic or early stage technologies, and no one knows their commercial potential because they are in such an early stage of development. The survey determined that only 12% of licensed inventions were ready for commercial use, while 75% lacked a working prototype (Jensen and Thursby 2001, and Jensen, Thursby and Thursby 2003). The survey determined that the continued effort by the inventor is a critical determinant for the further development and for commercial success, and tying the inventor's compensation to the licensee's output would guarantee his or her continued involvement (Jensen and Thursby, 2003).

#### 2.4.2.1.4 *Market and Commercialization-Related Factors*

Technology commercialization is a process of acquiring ideas and augmenting them with complementary knowledge, developing and manufacturing saleable goods, and selling the goods in the market (Bozeman, 2000). Successful technology commercialization allows firms to satisfy markets' needs by introducing new innovative and quality products in a speedy manner and at competitive pricing. Meseri and Maital (2001) studied how Israeli universities' projects were being evaluated and sought to examine the criteria for choosing technology transfer projects in Israeli universities and whether those criteria were compatible with the industry. They determined the most important determinants in

the project's evaluation were market needs and size, the existence of a patent; the success chances in R&D, the level of innovation, and the maturity of the idea. It was also determined that product uniqueness and its sustainable significant and identifiable benefits are key elements of superior innovative technologies (Maseri and Maital, 2001).

#### *2.4.2.1.5 The Intellectual Property-Factors*

According to Shane and Ulrich (2004) a patent will help the competitive advantage of the intellectual property by restricting and excluding unauthorized entities from the protected technology, and the patent can help recover returns from the R&D when commercializing a new technology. Shane and Ulrich (2004) examined the influence of patent effectiveness on the licensing and commercialization using historical data of 1,397 MIT patents between 1980 and 1996. This empirical study provided a conceptual framework to explain which university inventions are most likely to be licensed, commercialized, and generate royalties, as well as determine who will undertake that commercialization. The study concluded that university patents are more likely to be licensed when patents are effective, and that the effectiveness of patents increases royalties earned when inventions are licensed to non-inventors. Licensing back to inventors has shown to have increased the likelihood of license termination, and reduced the likelihood of invention commercialization (Shane and Ulrich, 2004).

## 2.5 Challenges facing technology transfer offices

Dodds and Somersalo (2007) have indicated that one of the challenges facing any technology transfer offices, especially at the beginning, is deciding which inventions to protect, and to what extent. No office has the resources to patent all inventions, especially if they are not likely to generate revenue for some time. As a rule of thumb, ten invention disclosures may lead to one patent, and one license might come from ten patents. In other words, only 10% of patents provide royalties. It is critical, therefore, that the technology transfer offices invest in only those inventions that are both truly innovative and appear to have commercial value.

## 2.6 Conclusion

The literature has given a baseline on how universities commercialise their university innovations. It was clear from literature that Technology transfer offices would operate differently from one university to the other, however their end results is to ensure that the innovations that comes out of the university have impact on economic growth and better social enhancement of the public.

The literature would help the study in terms of the baseline factors that one must look in driving successful commercialisation of university innovations through technology transfer offices.





## CHAPTER 3

### 3. RESEARCH QUESTIONS

In order to understand the key determinants that drives commercialisation of university innovations through TTOs and the challenges faced by the TTOs in driving commercialisation in the university, the following research questions were formulated as follows:

**Research Question 1:** What are the key determinants in relation to technology transfer offices that that drives successful commercialisation of potential university innovations outputs?

**Research Question 2:** How do these determinants in relation to technology transfer offices influence the commercialisation of potential university innovation outputs?

**Research Question 3:** Which of these determinants in relation to technology transfer offices are rated as crucial for driving commercialisation of potential university innovation outputs?

## CHAPTER 4

### 4. RESEARCH METHODOLOGY

#### 4.1 Introduction

The research design was qualitative and exploratory in nature. The aim of the study was to explore the underlying determinants that drives the successful commercialisation of potential university innovations outputs via technology transfer offices. In addressing this problem, the research approach would took the qualitative approaches. This section describes the methodology that was followed in order to answers research questions in section three

#### 4.2. Justification of the Qualitative Research

In order to answer the research questions as indicated in section three, the study by Leedy and Ormrod (2001) recommends a qualitative design when a researcher is attempting to interpret a certain phenomenon. Leedy (2001) also emphasises that to answer some qualitative research questions it is not possible to skim along the surface, hence the researcher needed to dig deeper in order to understand the core of the problem.

Luciano (1999) also emphasises that, when trying to understands complex research problem, qualitative research methods are valuable in providing rich descriptions of such complex phenomena, tracking unique or unexpected events,

illuminating the experience and interpretation of events by actors with widely differing stakes and roles, expertise, giving voice to those whose views are rarely heard.

Luciano (1999) further explains that qualitative research are important in conducting initial explorations to develop theories and to generate and even test hypotheses; and moving toward explanations. Luciano also emphasises that the qualitative research, be systematic using methods such as Narrative inquiry and Constant Comparative method (Zikmund., 2003) and rigorous, so as to reduce bias and error and to identify evidence that disconfirms initial or emergent hypotheses.

Zikmund (2003) also supports Luciano (1999) by emphasising that the nature of enquiry results in large amount of rich and deep data being produced from a variety of sources. Therefore in order to have an understanding of the determinants that drives the successful commercialisation of potential university innovation this can only be done through the exploratory research that is being proposed. This will then help in uncovering important variables in the certain area and thereby formulating hypothesis for further study (Luciano., 1999)

#### 4.3 Population and Unit of Analysis

According to Wolson (2007) institutional TTOs are a relatively new development in South African universities and research organizations, and are not yet found in all South Africa Universities and research institutes. According to the Intellectual

Property Rights from Publicly Financed Research and Development Act (IPRPFRD Act No. 51 of 2008) (Republic of South Africa, 2008a) all public research institutes and University are required to have a technology transfer offices. Similar structures within this institutes were available but not formally called Technology transfer offices, mostly they were called intellectual property management offices (IPMO). Hence the population of this study included those South African Universities that have formal technology transfer offices or formal technology transfer structures (Appendix 1). The unit of analysis was the technology transfer office of respective universities.

Therefore South African Universities that did not have formal technology transfer offices or technology transfer structures were excluded from this study.

#### 4.4 Size and nature of the sample

A judgmental sampling technique (Zikmund 2003) was used. This was based on the fact that individuals that were interviewed were expert and had extensive knowledge expertise with relation to university commercialisation and technology transfer processes. Hence the sample of the study was directors of technology transfers offices and senior managers of technology transfer offices of the. In total one on one seven open ended interviews with directors of technology transfers offices were conducted.

The respondents were selected based on the following criteria

1. Must be a senior manager at a technology transfer offices of the university

2. Must have a previous work expertise involving technology commercialisation
3. Must be involved in TTOs strategy formulation, implementation and monitoring
4. Must be experts in the field of technology transfer and commercialisation
5. The respondents should have the knowledge of IPRPFRD act and TIA act and its impacts on TTOs

According to Leedy (2001) when conducting qualitative research it is not the number of the people interviewed but the required quality of data that emerge from the enquiry and the management of data. Staphorst (2010) also emphasizes the point of “data saturation” as a generally accepted numerical guideline for the number of themes extracted from a sample of interviews or qualitative surveys as a percentage of all themes present in the interviews or qualitative surveys for the entire population of analysis. In the literature done by Staphorst (2010), there was evidence that samples as small as four individuals can provide extremely accurate information with a confidence level as high as 0.999 if participants possess a high degree of competence for the domain of inquiry.

#### 4.5 Data collection process

In order to achieve the required quality of results during data collection process the principles as suggested by Leedy (2001) was followed. The data collection process was undertaken through one-on-one open-ended in-depth interviews

with seven directors of University technology transfer offices in South Africa. The interviews were conducted on an exploratory manner and unstructured basis, in order to enable the participants to express their opinions without being limited or influenced by specific or leading questions. This approach also allowed the flexibility to follow lines of enquiry that proved promising. The study therefore aimed to ascertain the unbiased subjective view of the participants with regard to their views in respect to research questions in section three.

#### 4.6 Data analysis

The data analysis of the study used a combination on Narrative inquiry, comparative analysis and frequency analysis. The motivations for the use of these three methods are as follows:

##### *Narrative Enquiry*

This method is applicable where respondents are reliving certain experiences through the stories they tell, it is important to search for the hidden meanings behind the words. Thematic narrative analysis was conducted. With the thematic analysis approach the researcher treats captured narrative as data and analyse it to identify themes that clarify the content, as well as hold within or across narratives from multiple respondents study.

##### *Constant Comparative Method*

The iterative nature of the data collection, data analysis process demands a constant comparative data analysis method, wherein a new set of data is compared to the previous data. This method was used after the narrative analysis of each interview. With this method the researcher takes one piece of data and compares it to all other pieces of data that are either similar or different in some way (Staphorst, 2010)

### *Frequency Analysis*

This is a detailed examination of the contents of the data, in this case the interview notes/transcription, the frequency of use of certain words would be analyzed. This method was used in conjunction with the other methods

## 4.7 Data Validity and Reliability

The use of reliability and validity are common in quantitative reliability and validity are conceptualized as trustworthiness, rigor and quality in qualitative paradigm (Golafshani, 2003). In order to test for validity and reliability of the qualitative research that has been undertaken, the method of triangulation was used (Golafshani, 2003).

According to Golafshani (2003) “triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches. Engaging multiple methods, such



as, observation, interviews and recordings will lead to more valid, reliable and diverse construction of realities (Golafshani., 2003).

To improve the analysis and understanding of construction of others, a triangulation technique was utilized. Triangulation is a step taken by researchers to involve several investigators or peer researchers' interpretation of the data at different time or location. Triangulation may include multiple methods of data collection and data analysis, but does not suggest a fix method for all the researches. The methods chosen in triangulation to test the validity and reliability of a study depend on the criterion of the research (Golafshani., 2003). In the literature conducted by Staphorst (2010), the study indicated that there are five types of triangulations methods as described below:

*Data Triangulation:*

This method involves testing for reliability and validity of qualitative research by comparing data and information collected from different sources.

*Investigator Triangulation:*

Testing for reliability and validity through this triangulation method involves having multiple investigators extract data or information from the same source.

*Theory Triangulation:*

Multiple professional perspectives on a collected set of data or information forms the basis of this triangulation method.

*Methodological Triangulation:*

This triangulation method involves having data or information collected from the same source using various research instruments.

*Environment Triangulation:*

With this method the source of data and the research instruments are kept the same while the environment (such as location and time) of the collection of data is varied.

A methodological triangulation method was used to test the validity and reliability of the method. After the interview, the respondents were asked similar questions by means of an email.

#### 4.8. Research Limitation

- The population was limited to those universities with technology transfer offices that are older than five years. This excludes those universities which currently do not have any technology transfer offices
- The study only focused on university technology transfer offices, hence technology transfer offices of other public research institutes were not involved in the study.
- The sample of the population included only the technology transfer directors, hence based on this sample selected, the study only

focused on the view of technology transfer directors and excludes other key stakeholders in the commercialisation value chain which includes, researchers, university top management, administration, faculty and the industry.

## CHAPTER 5

### 5. RESULTS

#### 5.1 Introduction

This section discusses the data collected through a face-to-face narrative style interview. A list of technology transfer directors is presented in Appendix 1. A total of seven face-to-face narrative style interviews were conducted during August and September with directors and Managers of university technology transfer offices. The data was collected through a process of in-depth open-ended interviews with each of the respondents. Probing open-ended questions were posed in an attempt to gain a deeper understanding of key determinants that drives successful commercialisation of university innovations by technology transfer offices. An introductory question whereby the respondents were asked to give their roles and responsibilities as the directors of university technology transfer offices was asked in the beginning of the interview. This question was asked to allow the respondent to comfortably articulate his/her key roles/activities as the director of the technology transfer office, and hence allowed for smooth transition in asking follow up of research questions from section three.

The researcher took notes throughout the interview and an audio recording was made available, however the audio recording was not utilised since six of the seven respondents did not feel comfortable with the use of audio recording. The interviews were roughly an hour and half to about two hours. All interviews took

place at the respondent’s place of work. The notes were collected and captured for further analysis. A methodological triangulation was used, whereby respondents were asked the same questions, and given an opportunity to responds by an email. The face-to-face interview responds were compared with the email responds for validity. Narrative inquiry and constant comparative methods were used in order to answers research question 1 and 2 (Section 3) and frequency analysis to answers research question 3. Themes and trends were identified and their frequencies were determined and analysed.

### 5.1.1. Characteristics of the sample

In total seven face-to-face open-ended interviews were conducted, resulting in the total number of seven respondents. Majority of the respondents were white male (5 white male) one black female and black male. All the technology transfer offices has been in existence for the past five years. Different universities had different names for their technology transfer offices (Table 1). however they all performed similar activities as listed below

**Table 1:** A list of University Technology transfers offices that took part in the in the study

University	Technology Transfer office name
Tshwane University of technology	Office of technology Transfer
University of Johannesburg	Commercialisation office
University of Witwatersrand	Wits enterprise
University North West	Technology Transfer and Innovation
University of Cape Town	Research Contracts and intellectual property services

University of Cape Town	Research Contracts and intellectual property services
University of Pretoria	Innovation Support

In response to an opening question on the roles, responsibilities and activities of the of the technology transfer offices, the following activities listed below emerged as common activities undertaken by technology transfer offices:

- Responsible for university technology commercialisation
- Primary link between the industry and the university
- Negotiating and managing license agreement
- Manage university disclosures, patents filing and patents portfolio management
- Intellectual property management
- Contract research management
- Market research and market assessments
- University IP policy formulation
- Advisory services to both University and the industry
- Educating and awareness on IP
- Generate income from university commercialisation

## 5.2. Results from Research Question 1

Research question one was asked in order to identify key determinants that the directors of technology transfer offices viewed as important for successful

commercialisation of university innovations. A combination of Narrative Inquiry, Constant Comparative Method and using literature as a baseline, were used to extract themes emerged from the interview with the respondents (Table 2.).

**Table 2:** Extracted themes that emerged during interviews

Respondent	Key determinants
1	<ol style="list-style-type: none"> <li>1. Good relationship with faculty</li> <li>2. Buy in Top University management</li> <li>3. Financial stability</li> <li>4. Recognition and rewarding of inventor</li> <li>5. Technology readiness</li> <li>6. Awareness about the TTO</li> </ol>
2	<ol style="list-style-type: none"> <li>1. Buy in by top university management</li> <li>2. Financial stability</li> <li>3. Awareness about the TTO</li> <li>4. Enabling Environment (IPRPFRD act)</li> <li>5. Industry relationship</li> </ol>
3	<ol style="list-style-type: none"> <li>1. Recognition and rewarding of inventor</li> <li>2. Financial stability</li> <li>3. Manage disclosure and pressure to publish</li> <li>4. Buy in by top university management</li> <li>5. Technology readiness</li> <li>6. Industry relationship</li> </ol>
4	<ol style="list-style-type: none"> <li>1. University and TTO culture</li> <li>2. Buy in by top university management</li> </ol>

	<ol style="list-style-type: none"> <li>3. Awareness about the TTO</li> <li>4. Nature of the TTO</li> <li>5. Enabling environment (IPRPFRD act)</li> </ol>
4	<ol style="list-style-type: none"> <li>1. Prestigious university (11)</li> <li>2. Buy in by top university management</li> <li>3. Awareness about the TTO</li> <li>4. Enabling environment (IPRPFRD act)</li> <li>5. Financial stability</li> </ol>
6	<ol style="list-style-type: none"> <li>1. Manage disclosure and pressure to publish</li> <li>2. Buy in by top University Management</li> <li>3. Enabling environment (IPRPFRD act)</li> <li>4. Awareness about the TTO</li> <li>5. University and TTO culture</li> <li>6. Prestigious University</li> </ol>
7	<ol style="list-style-type: none"> <li>1. Prestigious University</li> <li>2. Financial stability</li> <li>3. Enabling environment (IPRPFRD act)</li> <li>4. Buy in by top university management</li> <li>5. Good relationship with faculty</li> <li>6. Industry relationship</li> </ol>



### 5.3 Results from Research Question 2

In understanding how the key determinants that were identified in research question one influence the commercialisation strategy, further probing was posed to the respondents to indicate how the identified key determinants influence commercialisation of university innovations by technology transfer offices. Twelve themes were extracted as indicated in Table 3 and were each probed to understand fully how they influence university commercialisation.

**Table 3:** Example quotations, captured from respondents' responses related to each theme

Theme identified	Selected response quotations
Good Relationship with faculty	<i>“Faculty and Departmental support is required for the notion of IP management, the recognition of the need to disclose inventions and to seek proper advice when managing IP”.</i>
Buy In by Top Management of the University	<i>“Top management buy-in is required to obtain effective support for policies that create the smooth environment for the office to operate, support from top management means that the role of technology transfer offices can be incorporated within universities' core vision and mission”</i>
Enabling environment	<i>“The Act has definitely helped to increase awareness</i>

<p>(IPRPFRD act)</p>	<p><i>about IP and innovation, helped universities to own their IP and negotiate better win-win deals. The administrative overhead and ambiguous restrictions and obligations and legal uncertainty that accompanies the Act currently may or may not lead to overall outcomes that are worse than before the Act – time and evolution of the system will tell”.</i></p>
<p>Manage disclosure and pressure to publish</p>	<p><i>“As much as it is important for the university to publish it is also important that, the successes that arise from university patents and income generated by the technology transfer are well communicated and celebrated with the entire university community. The lack of proper examples of actual innovation from university patents is more problematic as there is limited practical support for the usefulness of university patents”.</i></p>
<p>Awareness about the TTO</p>	<p><i>“The biggest mistake that many technology transfer offices make is that, as soon as the office is launched, the office tries hard to market themselves to the private sector and the industry in order to raise extra capital without marketing themselves within the universities. The key success factor is to market the technology transfer services of the office to the university internally before you can even think of going to market the office</i></p>

	<i>externally to the private industry. There more the whole university as a whole is aware of the office and the services, the more you will get the support from different part of the university”.</i>
Recognition and rewarding of Inventor	<i>“Proper rewarding and recognition of the researchers is critical especially where you have just build a new relationship with a new industry. In many cases the industry is more close to the researcher than the office hence it is important that the researcher is well rewarded with new licence agreement that the office concludes with industry”.</i>
University and TTO culture	<i>“Universities with history of entrepreneurial culture find it easy to support technology transfer offices”.</i>
Nature of the TTO (Independent company or part of University)	<i>“the moment the university make a technology transfer office a private company, you must know that the purpose of that entity is therefore to generate income rather than knowledge transfer, this illustrates how different universities would position their commercialisation strategy differently from one another depending on what they want to achieve through technology transfer offices.”</i>
Prestigious university	<i>“private companies do not come to the technology transfer offices, because the technology transfer office is doing a good job, private companies go to those universities with a previous good track record with</i>

	<i>technological innovations, therefore if you are a technology transfer office of a prestigious university with good track record, you are well positioned to create good links with private companies.”</i>
Industry Relationship	<i>“Established industry is much more able to adopt new technology and develop new products especially where the IP leads to evolutionary improvements. In this aspect which covers the bulk of innovation, relationships with industry are key to successful commercialisation of university innovations”.</i>
Financial Stability	<i>“The long lead times to deals, and very early stage of most university IP means that without investment from the University or other sources a TTO will be severely limited in the activities it can undertake thus reducing the likelihood of actual technology transfer and also increasing the wastage of patenting costs”.</i>
Technology Readiness	<i>“The higher the degree of readiness the greater the prospects to licence IP – especially in South Africa where many industries do not routinely develop technology. But this requires much more investment which universities typically don’t have”.</i>

## 5.4 Results for Research Question 3

In answering research question three, the respondents were asked to indicate which of the determinants that they have mentioned earlier are considered either,

- i. Highly critical
- ii. Critical
- iii. important

for the successful commercialisation of university innovations by technology transfer offices. In addition to their responses to research question three, a frequency analysis were carried out to identify the theme that all the respondents commented on and mentioned highly critical, critical and important from the total number of all twelve extracted themes. The results were also compared with the email responds from the respondents to test the reliability and validity

**Table 4:** Key important determinants as identified by respondents and through frequency analysis

<b>Theme Identified</b>	<b>Total number of respondent on the theme</b>	<b>How critical is the determinant</b>
Buy In by Top Management of the University	<b>7 (100%)</b>	<b>Highly critical</b>
Awareness about the TTO	<b>5 (71%)</b>	<b>Highly critical</b>

Enabling environment (IPRPFRD act)	<b>5 (71%)</b>	<b>Highly critical</b>
Financial Stability	<b>5 (71%)</b>	<b>Highly critical</b>
Prestigious university	<b>3 (42%)</b>	<b>Critical</b>
Industry Relationship	<b>3 (42%)</b>	<b>important</b>
University and TTO culture	<b>2 (28%)</b>	<b>Important</b>
Manage disclosure and pressure to publish	<b>2 (28%)</b>	<b>Important</b>
Good Relationship with faculty	<b>2 (28%)</b>	<b>Important</b>
Recognition and rewarding of Inventor	<b>2 (28%)</b>	<b>Important</b>
Technology Readiness	<b>2 (28%)</b>	<b>Important</b>
Nature of the TTO (Independent company or part of University)	<b>1 (14%)</b>	<b>Not important</b>

In answering, the research questions three to determine which determinants were regarded as highly critical for successful commercialisation of the university innovation the following determinants were regarded as highly critical (Table 4);

- i. Buy In by Top Management of the University
- ii. Awareness about the TTO
- iii. Enabling environment (IPRPFRD act)
- iv. Financial Stability

Other determinants such as industry relationship and prestigious universities were considered critical, whereas managing disclosure and pressure to publish were considered important and whether the technology transfer office is a privately owned or is part of the university did not play a crucial role in determining the success of university commercialisation.

## 5.5 Conclusion

The results generated from analysis of data from the three research question questions identified twelve themes that emerged as key determinants that drives successful commercialisation of university commercialisation within the South Africa context. The findings concur with some of the literature with regard to successful technology transfer offices and other two themes bring in the new meaning of successful technology transfer offices within the South African context wherein technology transfer is still a new concept as compared to other developed countries like the USA and Europe. The next chapter would discuss in details the meaning of the findings and use the literature in understanding of the results.

## CHAPTER 6

### 6. DISSCUSSION OF RESULTS

#### 6.1 Introduction

In this chapter the results for all three research questions from chapter 3 are discussed in detail, with reference to literature in chapter one and chapter two. The research results are analysed in order to address the research question in chapter 3 namely:

- What are the key determinants in relation to technology transfer offices that that drives successful commercialisation of potential university innovations outputs?
- How do these determinants in relation to technology transfer offices influence the commercialisation of potential university innovation outputs?
- Which of these determinants in relation to technology transfer offices are rated as crucial for driving commercialisation of potential university innovation outputs?

At the beginning of the interview, the respondents were asked their roles and those of the technology transfer office in the respective universities. This question was asked as a form of introductory question to allow follow up and probing of key research questions. A general list of activities as mentioned in section 5.1.1 regarding roles and responsibilities was compiled and was comparable with the



activities as defined by work of Cao, Zhao and Chen, (2009), Ramanathan, (2008) Teng,( 2010), when defining technology transfer office.

It also emerged from the discussion that different university technology transfer offices follow different commercialisation model, which is in line with the study by (Rosa and Rose, 2007). The study by Rosa and Rose (2007) indicated that there is no standard commercialisation model that the technology transfer offices follow, but there are number of models that different technology transfer offices can adopt and adapt it to their specific situation.

## 6.2 Discussion on Results for Research Question One

The aim of research question one was to try and find out what are the key determinants that drives successful commrecilisation of university innovations by technology transfer offices. In analyzing these results, theme extraction was used during open ended narrative inquiry. During the extraction methods about twelve themes emerged that were further analyzed with literature on measures and determinants that drives successful commercialisation of university innovation by technology transfer offices (Rahal and Rabelo, 2006).

A list of extracted themes (Table 2, in section 5.2) indicates different themes as indicated by respondents during interview. There was a clear commonalty on responses and data saturation when reaching the fourth respondent. This data saturation at an early stage also confirms the work done by Staphorst (2010) which indicates that, when conducting qualitative research with sample of

experts, a sample as small as four individuals can provide extremely accurate information with a confidence level as high as 0.999 if participants possess a high degree of competence for the domain of inquiry. In this case the sample consisted of directors of university technology transfer offices. The follow up question was to ask the responded to indicate how different key determinants with regard to technology transfer office have influence on the successful commercialisation of university innovation.

The subsequent section (6.3) would outline key themes extracted from the narrative inquiry with the respondent and how they influence successful commercialisation of university innovation.

## 6.3 Discussion on Results for Research Question Two

Research question two aimed at answering how the key determinants identified from research question one influence successful commercialisation of university innovation through technology transfer offices. The key determinants were also compared with literature to look for similarities and differences that emerged. The following is a list of key themes that emerged and a discussion on how they influence commercialisation and their comparison to with literature.

### 6.3.1 Good Relationship with faculty

Two of the respondents clearly indicated the importance of good relationship with faculty as important to successful operation of technology transfer office. One respondent said

*“without the faculty then there is no need for technology transfer office for commercialisation, whereas the faculty can exist without technology transfer offices”.*

Hence this indicated that the important of building a good relationship with faculties especially those that have potential to bring new innovations like, life sciences, engineering were emphasized. The literature by Siegel (2004) clearly indicates that the key stakeholders of technology transfer offices are the university scientist from the faculty and the industry. Phan and Siegel (2006) also suggested that the technology transfers offices need to clearly understand their stakeholders’s motives in commrecilisation on new innovations. Therefore this theme concurs with literature on the importance of building good relationship with your key stakeholders. Collier and Gray (2010) also emphasized that effective innovation (commercialisation) relies on two principal elements: relationships and people. And relationships rely on people, so everything, essentially, relies on the quality, skills, experience and character of the people involved in the commercilisation process. The emphasis on people also suggests that there is a risk that some universities are inclined to apply procedures adapted for conventional university management (Collier and Gray 2010).

### 6.3.2 Buy in by Top Management of the University

It became evident during the interview that buy in by top management, is regarded as the key determinant for successful commercialisation by technology transfer directors. This is the only theme that all responded commented on and indicated its crucial importance in driving commercialisation. One technology transfer director commented as follows

*“Top management buy-in is required to obtain effective support for policies that create the smooth environment for the office to operate, support from top management means that the role of technology transfer offices can be incorporated within universities’ core vision and mission”*

The study by Collier and Gray (2010) and Rahal and Rabelo (2006) also identified that the support of top management mainly at the level of Vice-chancellor has led to a success of many technology transfer offices. The study also found that technology transfer offices with top management support were also financially stable as the management put some budget to grow the office (Collier and Gray, 2010).

Literature on entrepreneurial universities (Martinelli *et al.*, 2008) have indicated that universities can provide an environment supportive of technology transfer and commercialisation, but a culture of entrepreneurship is unlikely to permeate throughout the organisation unless there is strong support at high levels, particularly from the Vice Chancellor and members of the University Council

(Martinelli *et al.*, 2008). Martinelli *et al.*, 2008 and Rahal and Rabelo 2006 also emphasized that entrepreneurship including entrepreneurship in the social, environmental and arts categories should also be seen as a university-wide concern, and not the preserve of faculty in the engineering, biotechnology, ICT or business fields. However, the present situation is that engagement is not consistent across any university, it is driven by individual researchers in individual faculties and technology transfer offices.

### **6.3.3 Enabling environment (IPRPFRD act)**

As indicated by respondents, the need for enabling environment by means having of clear and sound intellectual property policies both at a government level and university level for smooth operation of technology transfer offices has been identify as a key driver for successful commercialisation of university innovations. One respondent indicated that

*“running a technology transfer offices without enabling environments like intellectual property policies in place, is like driving a school bus in the evening without lights on”.*

Most of the respondents indicated the importance of as an enabler for university commercialisation by technology transfer offices. However there were mixed responses as far the implementation of the South African IPRPFRD act is concerned. Although the policy is been created as enabler for successful commrecilisation by technology transfer offices, some respondent were

concerned on how the industry would look at the policy, especially for future partnership with industry. The study by Staphorst (2010) has indicated that ownership of intellectual property rights is one of the key deciding factors when parties are engaged in commercialisation partnership.

In the United states following the passage of Bay-Dole Act in the 1980 (AUTM, 2003), the success of the university-industry licensing phenomenon is evidenced by the Association of University Technology Managers annual report (AUTM, 2003), which reported the issuing of 3,933 patents, the execution of 4,516 new licenses and options for a total of 25,979 active licenses and options yielding an income of \$1.31 billion, compared to fewer than 250 patents that were issued to U.S. universities prior to the Bayh-Dole legislation act of 1980 (AUTM, 2003).

Therefore the introduction of IPRPFRD act which is similar to the Bayh-Dole legislation act of the USA is seen as an enabling mechanism which will allow technology transfer offices to enter into win-win deals with the industry. The study by Nelsen (2007) also points out that public research institutions have much to gain if they are permitted to protect their inventions. A system that allows technologies to be patented and that encourages institutions to license them will both help countries to reach their economic goals and better serve the poor (Nelsen, 2007). Shane (2004) also emphasized that a patent will help the competitive advantage of the intellectual property by restricting and excluding unauthorized entities from the protected technology, and the patent can help recover returns from the R&D when commercializing a new technology.

#### 6.3.4. Managing disclosure and pressure to publish

Respondents have indicated that one of the key drivers for successful commercialisation of university innovations is management of disclosures and the primary mandate of the universities, which is knowledge creation for the public good. One of the respondents stated that

*“The publication vs patent debate is misleading as patents are also publication. There is a small overhead attached to applying for a provisional patent before publishing. The lack of proper examples of actual innovation from university patents is more problematic as there is limited practical support for the usefulness of university patents”.*

It became evident that as universities are becoming more entrepreneurial, the management now opens space for invention disclosures and patents filing. The study by Powers also emphasizes that today academic research is increasingly pursued for its commercial potential and value as intellectual property that can be exploited for financial gain (Powers, 2003). Universities are being viewed by policymakers in many countries as engines of growth and that they need to be more entrepreneurial (Teng, 2010, Yusof and Razak., 2009). These encourage universities to reconfigure themselves with structures like technology transfer offices for the purpose of commercialisation (Swamidass and Vulusa, 2008).

There is often a potential conflict between the need to maintain some degree of secrecy in order to preserve intellectual property rights for technology transfer

and commercial purposes and the desire of academics to publish. Publications also have a significant influence on promotion prospects when it comes to university academic employees. This indicated that indeed there was a clear need for the university and the technology transfer offices to clear put measures in place to manage university publications and intellectual property management.

### **6.3.5 Awareness about the Technology Transfer Office**

One of the key theme that came out strongly as a key determinant for successful commercialisation of university innovations by technology transfer offices, was the awareness of the technology transfer offices within the university. Awareness of the technology transfer offices was considered a key success measure of a fully functional technology transfer office within the South African context where technology transfer topic is still very new. One technology transfer director indicated that

*“According to this office, success is measured by the number of new clients, especially researchers and head of faculties and departments enquiring about the services the office is offering. The more students, lectures and industry call and try to find out more about the office, the more we feel that the word about this office is going out to the university and public at large”.*

A lot of literature measure success based on income generated from licensing agreements and spin-off created from the universities (Wayne, 2008). Hence this



theme emerged as new as compared to literature where technology transfer office success is measured by means of income.

### **6.3.6 Recognition and Rewarding of the Inventor**

Respondents have indicated that researchers are the primary stakeholders of the technology transfer offices since they are the actual inventors of technologies. It was evident that there need to have clear policies and mechanism of making sure that researchers are rewarded either financially or somehow are put in place. Failure to have such policies would demoralize researchers and leading to few inventions coming out. One technology director indicated that

*“recognition and rewarding does not mean financial and monetary rewarding, but it can mean allowing researchers to be part of the industry that they are working with, and also involving the researchers during the whole life cycle of license agreements”.*

Hence recognition and rewarding of researchers is seen as key driver for incremental innovation. The study by Thursby and Thursby (2000) and also by Thursby and Thursby (2003) identified that, personal contact or involvement between university inventors and industry are the most important source of technology transfer and commercialisation success. Their studies (Thursby and Thursby, 2003) also emphasised the fact that, since most of the inventions are still at the early stage, there is a need to build a good relationship and reward the researchers as they are likely to further develop the invention.

It was also clear from the respondents that the most important component in successful commercialisation is the human component. Without adequate incentives to engage in commercialisation, academic staff may not participate with enthusiasm. Incentives are of two principal types: those that provide a benefit to individual academics; and those that ameliorate some adverse consequence. Benefits to academics come in several forms, the most usual being relief from teaching obligations, monetary reward, enhanced reputation, and promotion.

### **6.3.7 University and Technology Transfer Culture**

Respondents indicated that there are universities with entrepreneurial culture, hence this kind of universities act as key drivers for successful commercialisation by technology transfer offices. A number of respondent have indicated that a due to lack of university entrepreneurial culture, technology transfer offices were at a disadvantageous state. One respondent commented on the importance of organizational change from leadership

*“Organizational cultures tend to be enduring and difficult to change, and any (gradual) change in attitudes and behavior requires strong leadership, role models, processes and rewards that encourage entrepreneurial activities. Organizational change may also require an injection of new blood – hiring new faculty who already have an interest in innovation and commercialisation”.*

Collier and Gray (2010) also indicated that universities need to have various types of programs to encourage entrepreneurial behavior and acculturate academics and students to commercialisation. One of the technology transfer office director indicated that

*“Since commercialisation is an activity additional to the usual academic load, it has to be streamlined if faculty are to embrace it. A university instigating technology transfer and commercialisation policies and procedures that are complex or difficult to follow may well stifle initiative. However, even in universities with a recognized commercialisation culture, the number of departments involved is relatively low, and few staff actively engaged. Many academics consider that the prime role of a university is to improve the public good through high quality research and subsequent knowledge transfer via teaching, publication and public service”.*

### **6.3.8 Nature of the technology transfer office**

There was a clear varying differences of how technology transfer offices were operating. A university can decide what form its technology transfer should operate, it can either be independent private company or be in cooperated within the university administration. On technology transfer director indicated that

*“the moment the university make a technology transfer office a private company, you must know that the purpose of that entity is therefore to generate income rather than knowledge transfer, this illustrates how*

*different universities would position their commercialisation strategy differently from one another depending on what they want to achieve through technology transfer offices.”*

A number of literature on technology transfer offices has focused more on the offices that operates within the university administration (Rahal and Rabelo, 2006). Hence this theme also emerged as a new theme with regards to determinants that drives commercialisation by technology transfer offices.

### **6.3.9 Prestigious university**

There was indication that the more prestigious the university, the likelihood that its technology transfer office would be successful in commercializing university innovations. An empirical study Sine, *et al.* (2003) examined the influence of institutional prestige on the licensing of universities' inventions and concluded that technical attributes alone may be insufficient to explain the likelihood of technology transfer, and that prestigious universities may be better able than less prestigious universities to license their inventions not because the technology produced is better, but because the universities that produce them are perceived as more prestigious (Sine, *et al*, 2003).

### **6.3.10 Industrial relationship**

Industrial relationship with the private sector is the actual ultimate goal of every technology transfer offices, as the respondents view the industry as their customers or clients. It was clear from the respondent that building a relationship with the industry was not as easy as it sounds, due to early stage technologies that are produces by university. The indication was that the industry is constantly in need of ready to market products.

The study conducted by Maseri and Maital (2001) has indicated that key factors that technology transfers offices should consider when considering relationship with the industry is to indicate, the market need, market size, costs and the availability of patents within that sector as universities with products pipeline showing those characteristics are better positioned to get into partnership with the industry.

### **6.3.11 Financial Stability**

There was a serious concern from many technology directors that, without financial support, the technology transfer office cannot function properly. Most of the respondents indicated that it can take up to ten years before the technology transfer office can realize financial returns and income from licensing agreements or royalties. This indicated that there was a pressure for the technology transfer offices to get extra finance from the industry and other stakeholders. The other technology transfer director responded by saying

*“The long lead times to deals, and very early stage of most university IP means that without investment from the University or other sources a TTO will be severely limited in the activities it can undertake”.*

Nelsen (2007) also had similar results which indicated that building a robust technology transfer program may take sustained financial investment. The study also indicated that It can take eight to ten years to build an IP portfolio, establish contacts, and develop skills in technology transfer (Nelsen, 2007). AUTM (2003) study also indicated that it may take up to a decade before a technology transfer office can realize financial returns. The study by Nelsen (2007). further explains that it may take up to two decades or more before a university technology transfer program, including entrepreneurial spinouts substantially affects the local economy. The ultimate impact, however, may be very large both economically and culturally for the university, its graduates, and the wider community (Nelsen, 2007).

### **6.3.12 Technology Readiness**

A common response from most of the respondents was that about 80% of university inventions are at very early stages with no clear market application. This also affects how the technology transfers offices sell the idea to the private industry. One of the technology transfer director indicated that

*“The aim of the entering into a license agreement with the industry is not to initially make income immediately, but to work closely with the industry and understand which problems the industry is encountering and then develop solutions targeted at those problems. This means that our initial license agreement with the industry is the first step in further license agreement to follow and building relationship”*

The respondents concur with that of the study by Jensen and Thursby (2001) who found that the vast majority of university inventions licensed are embryonic or early stage technologies, and no one knows their commercial potential because they are in such an early stage of development.

In summarizing all the twelve themes that emerge from the study, there was an indication that ten themes were comparable with similar conclusion to previous work. The two themes that emerged as new to this study were;

- Awareness of the technology transfer
- Nature of the technology transfer

#### 6.4 Discussion on Results for Research Question Three

Research question three aimed at identifying which of the key determinants that have been identified by the respondents are considered crucial or critical in driving successful commercialisation of university innovations by technology transfer

offices. Based on the results obtained from section 5.4 (table 4) , the following determinants:

- i. Buy In by Top Management of the University
- ii. Awareness about the TTO
- iii. Enabling environment (IPRPFRD act)
- iv. Financial Stability,

were considered to be the highly critical in driving successful commercialisation of university innovation by technology transfer offices.

## 6.5 Conclusion

The study produced the results with key determinants that were comparable with the literature. Ten determinants were comparable with current and recent literature with only two determinants emerging as new. There was clear commonality from the respondents, indicating that the four key determinants identified are crucial and are well linked especially when looking at the South Africa technology transfer space which is still considered new.

The explanation behind the following,

- i. Buy In by Top Management of the University
- ii. Awareness about the TTO
- iii. Enabling environment (IPRPFRD act)
- iv. Financial Stability,

to be considered as key determinants was that: Firstly when change is driven from top management, in this case, change is moving towards entrepreneurial



university, then the top management would include technology transfer office and commercialisation in their vision and mission statements. Secondly by incorporating commercialisation into the overall university vision and mission, this increases the awareness on the technology transfer office so that the entire public can be aware of the commercialisation process. Thirdly, the university would put in place intellectual property rights policies in line with government policies to enable the smooth environment for the technology transfer to operate and finally, having the process being driven from top management, there would also be financial support for the overall running on the office

There was a common understanding that other factors are also important however those are mainly related to technology transfer offices which have been running for decades and they are more like operation processes but not the key building factors when considering establishing a new technology transfer offices..

## CHAPTER 7

### 7. CONCLUSION AND RECOMENDATION

#### 7.1 Introduction

The aim of this research project was to employ qualitative methodology to identify the key determinants that drive successful commercialisation of university innovations outputs by technology transfer offices and determine how those determinants influence the commercialisation of university innovations. This chapter would highlight key conclusion that came out of this study and then indicate the implications of the findings with regards to university commercialisation by technology transfer offices. The chapter would also outline recommendations to universities and university technology transfer offices based on the key findings from the research project.

#### 7.2 Conclusions from research findings

As indicated in the previous literature and from this study, the need for universities for becoming more entrepreneurial is increasing. A number of policies by different countries to enable university entrepreneurial culture have been widely reported, especially in the USA and Europe. As part of these policies, universities have created technology transfer offices, for catalysing commercialisation of university innovations. The literature and the findings have clearly indicated that they are number of factors that the lead to successful commercialisation of university innovations by technology transfer offices. In addition to those key determinants, that drives successful commercialisation of

university innovations by technology transfer offices, there are certain determinants that if not given attention would lead to non-functional of the technology transfer offices.

Of the twelve themes that emerged from the research study as key determinants that drives successful commercialisation university innovations by technology transfer offices, it emerged that at least ten themes were comparable with current literature and only two emerged as new themes. The two themes that emerged as new were awareness of the technology transfers and the nature of technology transfer (independent technology transfer office and university technology transfer office incorporated within the university administration).

Given the nature and the early history of technology transfer office within South African context, there is a clear commonality amongst different university technology transfer offices that, the key determinants that drives successful commercialisation of university innovations by technology transfer offices are;

- i. Buy In by Top Management of the University
- ii. Awareness about the TTO
- iii. Enabling environment (IPRPFRD act)
- iv. Financial Stability,

These findings presented a conclusion that, since technology transfer topic is new within the South African context, there need to be a clear understanding of this topic by university top management and university council so that they can now bring in a new culture of university entrepreneurship. Based on the findings,

It is concluded that in order for change to happen, it needs to first happen at the top management level and the cascade down to the bottom at the operation level. In cases where technology transfer activities are initiated by the faculty or individual researcher, it as was evident from the findings that, it is was still highly critical that the initiative are communicated to the top management and university council to get their full support.

In cases where technology transfer offices are operational but non-visible, active marketing of the technology transfer offices internally was seen as more important before, the office can be marketed externally to the industry. It was evident that, some of the technology transfer offices, irrespective of being operational for more than five years at the university, they were still not noticed, and their offerings were unnoticed by broader university community. These raised an important issue of technology transfer awareness at the university community as a whole. The evidence also suggested that those university technology transfer offices that are well known within their university community were considered very successful. This indicated an important issue within the South African university technology transfer topic that, communication about technology transfer offices in the broader university context is crucial for successful awareness of the technology transfer offices.

As has already been indicated earlier with regard to the early stages of technology transfer topic within South African context, introduction of IPRPFRD act by the South African government has been viewed positively by the university technology transfer offices as an enabling environment to support

commercialisation of university innovation. Given that the intellectual property policy has been driven from government side, this is viewed as a positive move towards building a culture of innovation and supporting entrepreneurial activity by government institutes. This would also help the management to think about the university as a source of knowledge generation and economic growth generation

As evident from literature and from the research findings, technology transfer offices need a substantial amount of financial assistance for a very long period of time before they can become financially self sustainable. Hence one of the critical important key determinants is the availability of finance to run and operate the technology transfer offices for a longer period of time before becoming financially sustainable. Therefore when top management and the university council has adopted a culture of university entrepreneurship, they would strategically positioned technology transfer offices as their core business and would be allocated a sufficient budget to operate efficiently

A integrated approach that involves university top management, university council and technology transfer directors to build an entrepreneurial university culture is seen as the key determinant for driving successful commercialisation of university innovations.

### **7.3 Recommendations**

Viable strategies to successfully commercialise university innovations by technology transfer offices must firmly be grounded on universities' key vision, mission and goals. The conclusion is that conclusion that for technology transfer

to succeed, it is critical for university administrators to think strategically about the process. The findings indicates that university administrators are often more concerned about protecting intellectual property rights and appropriating the fruits of technology transfer than they are about creating the appropriate context or environment in which such activities are to take place. This implies that they must address numerous formulation and implementation issues. A key formulation issue is the establishment of institutional goals and priorities, which must be transparent, forthright, and reflected in resource allocation patterns.

Based on the findings from this research project, the following recommendations are suggested:

- Technology transfer offices activities and initiatives should be supported and driven from the universities' top management and council
- There should be clear mandates from the university to help technology transfer professionals choose among competing priorities and the ever-present trade-offs between business and academic values.
- IP ownership policies, the roles of researchers in interactions with industry, and other ground rules should be set up before the program begins because conflicts of interest, both real and perceived, are inevitable
- There university should and the technology transfer offices should have a clear and well articulated communication and marketing strategy internal broader university community and the industry
- Resource allocation decisions must also be driven by strategic choices the university makes regarding various modes of technology transfer.

A technology transfer office can create many benefits for the university, industry, and the surrounding community, but it requires carefully planned and consistent long-term financial and administrative support. And above all, it requires technology transfer officers that are able and willing to take risks and university top management that support them.

#### **7.4 Recommendation to future research**

Although the finding of the research project gives us a picture of what key determinants are for driving successful commercialisation of university innovations by technology transfer offices, this was limited to the opinion given from the technology directors side. The following areas are potential for further research on technology transfer topic

- The involvement of university top management in technology transfer support at the universities
- A similar study but focusing on, publicly research institutes like, agricultural research Council (ARC), Centre for Scientific and Industrial Research (CSIR) etc.
- Awareness of university technology transfer offices activities by a broader university community e.g. Researchers, Faculty members, administrators etc

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## APPENDICES

### Appendix 1. List of Technology Transfer Directors Interviewed

Respondent	University Name	TTOs names
Dr Duncan Raftesath. CEO Wits Enterprise	University of Witwatersrand	Wits Enterprise
Prof Aart Boessenkool, Director, Commercilisation	University of Johannesburg	Commercilisation office
Dr Rudi van der Walt Director, Innovation	North West University	Innovation (TTO)
Dr Ayanda Noma, Manager TTO	Tshwane University of Technology	Innovation (TTO)
Mrs Refiole Ngoato Manager, Innovation support and Technology Transfer	University of Pretoria	Innovation Support (TTO)
Mr Piet Barnard Director, RCIP	University of Cape Town	Research Contracts and intellectual property services
Dr Andrew Bailey, Intellectual Property services	University of Cape Town	Research Contracts and intellectual property services

## Appendix 2. Informed Consent letter before the interview

*Dear Participant*

*As part of my MBA studies with GIBS, I am conducting a research on determining the key drivers that stimulates commercialisation of potential university innovation outputs through technology transfer offices. More specifically I would be looking at those factors within the university technology transfer offices that drive the commersilisation of university innovations.*

*Our interview is expected to last an hour, and your participation in this interview will help us understand how South African university technology transfer offices commercialise university innovations. Your participation is voluntary and you can withdraw at any time without penalty. Please note that all data will be kept confidential. By completing this survey, you indicate that you voluntarily participate in this research. If you have any concerns, please contact me or my research supervisor using the details provided below.*

Researcher Name	Researcher	Supervisor
Name		
Phineas Thosago	Leon Staphorst	
Email: <a href="mailto:Phineas.thosago@tia.org.za">Phineas.thosago@tia.org.za</a>	Email:	
<a href="mailto:leon.staphorst@gmail.com">leon.staphorst@gmail.com</a>		
Phone: 076 016 2008	Phone: 082 857 1135	

Signature \_\_\_\_\_ of \_\_\_\_\_ Participant:

Date: \_\_\_\_\_

Signature

of

Researcher:

\_\_\_\_\_  
Date: \_\_\_\_\_