Cape Peninsula
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The role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation in South Africa: a case of a university of technology

by

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DECLARATION

I, Amelia Vuyokazi Rorwana, declare that the contents of this dissertation represent my own unaided work, and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed **Date**

ABSTRACT

Universities have long been recognised as sources of knowledge creation, innovation and technological advancements. Interest in academic entrepreneurship and the establishment of university spin-off companies has grown in South Africa over the past 10 years. South Africa's national research and development strategy argues that economic growth and wealth generation are founded on innovation. The area of university entrepreneurial behaviour and technology commercialisation has attracted much research attention in recent years especially as more innovative solutions are sought for the world's ever growing socioeconomic challenges. In view of this, the South African government has made considerable and various efforts to promote the creation and commercialisation of research output in the university context.

Against the aforementioned, this study seeks to understand the position of the Cape Peninsula University of Technology (CPUT) as a university of technology in terms of commercialisation and technology creation since the 2005 merger. More specifically, the study seeks to understand the dynamics surrounding the creation and transfer of technology in South Africa, using CPUT as a case study.

A quantitative research approach was adopted for this study, and as such part of this approach, structured questionnaires were directly administered to the respondents to collect the data. Specifically, 52 electronic survey questionnaires were distributed. The sample was drawn from two databases compiled using CPUT internal research records. One database contained a list of those academics that have been active in terms of research as evidenced in their research outputs: technology creation and transfer. The other database (control group) contained a list of those academics that have not been active. From both groups, a purposive sample was drawn for the survey questionnaire.

This study revealed that 'pull factors' rather than 'push factors' tend to influence the entrepreneurial activities of academics at CPUT, and that academics are key players in the process of technology transfer. Thus, this study may assist the university senior management to develop strategies to improve academic entrepreneurship for all faculties. In line with this, it is expected that the primary function of CPUT should be to instil a greater entrepreneurial spirit among the relevant stakeholders. Furthermore, CPUT should strive to consider carefully local development needs and support the promotion of entrepreneurial education initiatives. This should not only be done at the tertiary level, but should be commenced as early as the primary school level.

KEY WORDS: academic entrepreneurship, commercialisation, entrepreneurship, technology spin-offs, technology transfer,

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DEDICATION

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

Abbreviations and Acronyms

CIPRO	Companies & Intellectual Property Registration Office
CIS4	Community Innovation Survey fourth year period
CPUT	Cape Peninsula University of Technology
DFES	Department for Education and Skills
DHET	Department of Higher Education and Training
DOE	Department of Education
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EU-27	European Union with 27 members
GDP	Gross Domestic Product
GEM	Global Entrepreneurship Monitor
GERD	Gross domestic Expenditure on Research And Development
HEIs	Higher Education Institutions
IP	Intellectual Property
IPR	Intellectual Property Rights
NIS	National Innovation System
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
SMEs	Small and Medium Enterprises
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
TEA	Total Early-Stage Entrepreneurial Activity
TIA	Technology Innovation Agency
TTO	Technology Transfer Office
TOT	Transfer of Technology
WEF	World Economic Forum

Clarification of basic terms and concepts

Entrepreneurship: This refers to the ability and inclination to organize, develop and manage a business in an attempt to make a profit while considering the associated risks. Observable examples of entrepreneurship include new business start-ups (Zimmerer & Scarborough, 2004:3). From an academic viewpoint, Meyer (2003:108) defines entrepreneurship as the act and art of being an entrepreneur, or one who undertakes innovations or introduces new things, finance and business acumen in an effort to transform innovations into economic goods. Academic entrepreneurs can therefore be seen as those who turn the knowledge created as an institution into innovation, form new firms, and make new products and services that change the world.

Academic entrepreneurship describes the relationship or partnership between university (or academic staff) and industry for the commercialisation of research output. During this partnership, industry is expected to acquire knowledge from a higher education institution and use the knowledge in the innovation process (Chiara & Francesco, 2006:3).

Balázs (1996:3) sees academic entrepreneurship as a behaviour that modifies the outcome of research and education to the extent that the activity becomes income generating. This involves a significant amount of resources and risks, though the positive spin-off for the university outweighs the risks.

Technology spin-off: This term is generally applied to university research programmes separated into commercial ventures. They are typically speculative and privately held by the founders, university, and venture capitalists, and thus neither desirable nor available to the typical passive investor (Lockett et al., 2003:186).

Commercialisation: According to Wood (2011:159), commercialisation is the final phase of the academic entrepreneurship process model that brings a new innovative product or service into the market.

Technology Transfer: This is also referred to as Transfer of Technology (TOT) or Technology Commercialisation. It refers to the process of transferring skills, knowledge, technologies and facilities between universities or governments and other institutions to promote public access to scientific and technological developments in the hope that this will lead to further developments.

CHAPTER 1
INTRODUCTION AND BACKGROUND

1.1 Introduction

A growing number of studies continue to highlight the importance of entrepreneurship, as it has been noted to be the engine of most economies (Harper, 2003:1). Entrepreneurship has been particularly extolled for its positive contribution to growth, employment and poverty reduction. Concomitant with the foregoing, public research organisations and principally universities are becoming progressively entrepreneurial, adopting a leading role in creation and commercial of research, and seeking newer organisational engagements aligned with scientific research and innovation (Rothaermel, Agung & Jiang, 2007: 692).

At a time when most global economies are contracting, promoting entrepreneurship becomes a prerogative for most developing economies, with South Africa being no exception. Growing a country's entrepreneurship base would require exploring beyond the traditional sources of business start-ups. It is customary for higher education institutions to provide entrepreneurial training, but numerous challenges have prompted proactive universities to be directly involved in new venture creation or indirectly through university–industry linkages (Co & Mitchell, 2006:348-359).

Higher Education Institutions (HEIs) are considered the engines of scientific discovery, and a source of knowledge creation and technological innovation. Thus, the thriving association between universities and industry, as well as the commercialisation of academic research, has been the subject matter of intense policy and research debate since the mid-1980s (Kutinlahti, 2005:13). It is worth noting that this pattern is still the case today, with a growing number of universities making concerted efforts to commercialise their research and to develop linkages with industry. South African institutions have gone through a huge transformation since the democratic government came into power in 1994. The Cape Peninsula University of Technology (CPUT) has also not been able to escape the impact of higher education transformation (Nicolaides, 2011:1045).

According to Djokovic and Souitaris (2008:225-247), university spin-offs are enterprises that emerge out of universities through the commercialisation of intellectual property (IP) and transfer of the technology produced by these institutions. This study evaluates the role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation in South Africa, with particular reference to the Cape Peninsula University of Technology.

1.2 Background to the research problem

Universities have long been recognised as sources of knowledge creation, innovation, and technological advancements. Interest in academic entrepreneurship and the establishment of university spin-off companies has grown in South Africa over the past ten years, in particular after publication of its national research and development strategy in August 2002, the new funding framework, and post-merger (2005).[1]

South Africa's national research and development strategy argues that economic growth and wealth generation are founded on innovation. Without the establishment of new technology missions aligned with quality of life goals and economic and industrial strategies, South Africa will not be able to make progress towards a knowledge economy (Department of Trade and Industry, 2002:23).

In 2008, the Department of Science and Technology published a ten-year innovation plan (Department of Science and Technology, 2008) that is supposed propel South Africa's transformation towards a knowledge-based economy. Four years down the line, CPUT launched the Research, Technology and Innovation Ten-Year Blue Print with the vision of "Unlocking the potential of staff, students and partners to excel in research, technology and innovation that offer solutions to the needs of society (CPUT, 2012:11).

Years after launching of its own version of the previously mentioned ten-year innovation plan, CPUT has not assessed its impact nor put in place assessment mechanisms. At present, it is unclear whether CPUT has been successful in unlocking the potential of its staff as far as academic entrepreneurship is concerned, given the low 'visibility' of academic staff in new venture creations and university–industry collaborations. Similar concerns have been shared with regard to the efficacy of such policies in the United Kingdom (Mowery & Sampat, 2004:125).

1.3 Statement of research problem

The area of university entrepreneurial behaviour and technology commercialisation has attracted much research attention in recent years, especially as more innovative solutions are being sought for the world's ever growing socio-economic challenges (Wright et al., 2004:235).

[1] In 2004 South Africa started reforming its higher education system, merging and incorporating small universities into larger institutions, and renaming all higher education institutions 'university'. The nomenclature of 'technikon' changed to 'university of technology'. The mergers came into effect in 2005. The Cape Technikon merged with Peninsula Technikon to form the Cape Peninsula University of Technology (CPUT).

Ideally, universities are perceived to be suitably positioned for innovation and economic competitiveness, and to be strategic assets as well as 'problem-solvers' for some of the socioeconomic issues affecting a country.

For universities to fully assert this position, they need the support of government, the private sector and civil society, given that they do not operate in a vacuum (Deiaco et al., 2012:525).

According to Klofsten and Jones-Evans (2000:301), a significant challenge that European economies face is the relatively constrained potential to transform scientific developments and technological achievements into industrial and commercial successes. Turning to African economies, one may see a close parallel between Africa and its European counterparts if not for the fact that the former faces relatively greater challenges.

Concurring with Ssebuwufu, Ludwick & Beland (2012:19), Derbew, Mungamuru & Asnake, (2015:73), assert that most universities of technology in Africa lack an enabling environment for recreating and aligning themselves towards a more entrepreneurial role. In spite of criticisms regarding the inadequate state of university–industry linkages in Africa, Derbew et al. (2015:73) believe that the condition of these industry linkages has improved.

Against the aforementioned, this research study seeks to understand the position of CPUT as a university of technology in terms of technology creation and commercialisation since the merger. More specifically, the study aimed to understand the dynamics surrounding technology creation and transfer in South Africa, using CPUT as a case study.

1.4 Research questions

1.4.1 Main question

The main question that this study seeks to address is:

- What is the role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation at CPUT?

1.4.2 Research sub-questions

To simplify the process of participants' responses to the main research question that governs this study, sub-questions were formulated as follows:

- Why do academics become involved in entrepreneurial activities?
- What role can academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT?
- What role do private companies play in the process of technology transfer and commercialisation?

- What role can spin-off companies play in the process of technology transfer and commercialisation?

1.5 Research objectives

Drawing on the research questions that this study seeks to answer, the following objectives were formulated to guide the study:

1.5.1 Main objective

The main aim of this research is to examine the role played by academics and spin-off companies in the process of technology transfer and commercialisation at CPUT.

1.5.2 Sub-research objectives

To accelerate the accomplishment of the core research objective, sub-objectives were formulated as follows:

- To ascertain the factors that motivates academics to become involved in entrepreneurial activities.
- To identify the role that academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT.
- To ascertain the role that private companies play in the process of university technology transfer and commercialisation.
- To investigate the role that spin-off companies play in the process of technology transfer and commercialisation.

1.6 Research methodology and design

The nature and type of research questions that a research study intends to answer influences its design. The research was designed to explore the role played by academics and spin-off companies in the process of technology creation and commercialisation at CPUT.

A quantitative research technique was adopted in this study to explore the role played by academics and spin-off companies in the process of technology creation and commercialisation at CPUT. Structured questionnaires were designed and directly administered to the respondents to collect data related to technology creation and commercialisation with special emphasis on the triggers and challenges that accompany the process. The argument for choosing a survey was two-fold.

Firstly, surveys deliver a quick, efficient and accurate means of evaluating information about the population. Secondly, surveys are more suitable in cases where there is a lack of

secondary data. The questionnaire adopted for this study came from the following sources: University of Minnesota, Harvard University (n.d.), University of Calgary (2013) and Holmes-Watts (2012).

1.6.1 Sampling strategy

The sample population comprised all CPUT researchers and research units, although emphasis was placed on those who had been very active since the merger. Aiming to employ both quantitative and qualitative research methods, the sampling strategy for this study involved selecting respondents who would complete the quantitative survey questionnaire.

Using internal (CPUT) research records, two databases were established. One database held a list of those academics active in terms of research as evident in their research outputs – technology creation and transfer. The other database (control group) held a list of inactive academics. A purposive sample was drawn from both groups for completion of the survey questionnaire.

1.6.2 Data analysis

The data in this study was gathered using quantitative instruments. Specifically, a questionnaire was utilised. The data collected by use of the quantitative survey instrument (the survey questionnaire) was analysed using the Statistical Package for the Social Sciences (SPSS). Focusing on the quantitative survey questionnaire as the primary data-collection tool, descriptive statistical techniques were applied. In particular, techniques such as frequencies and cross-tabulations were employed to describe as well as measure the relationship between the variables of concern. Hence, the results were presented in the form of graphs and tables.

1.6.3 Questionnaire

For the aim of this study, the researcher made use of a questionnaire that included both closed and open-ended questions. According to Leedy (1993), using a questionnaire for data collection is commendable in that it enables the researcher to contact people outside of his/her normal scope of physical interaction.

Questionnaires were preferred because they can reach many people within a short space of time and the collected data is easy to code and analyse. Besides, questionnaires offer great anonymity because there is no face-to-face interaction between the researcher and the respondent; hence they increase the dissemination of required information (Simsek & Veiga, 2000:93) The researcher adapted questionnaires from University of Minnesota, Harvard University (n.d.), University of Calgary (2013) and Holmes-Watts (2012).

1.6.4 Ethical considerations

Ethics is a vital aspect of all research, especially in the social sciences where human beings are involved. Ethical considerations refer to rules and regulations set by various responsible authorities to protect subjects under study from harm and abuse by researchers (Welman & Kruger, 2001:171).

For this study, the researcher assured the confidentiality of respondents' information. The respondents were asked to make an informed choice to participate in the study without the use of coercion or bribes. The objectives and benefits of the study were clearly explained to the respondents prior to their participation, anonymity was ensured as respondents were not required to record their names, and finally the researcher requested permission to carry out the research from the relevant authorities (including CPUT). Thus, the research instrument (questionnaire) was submitted to the Faculty of Business Research Ethics Committee. Specifically, the researcher aimed to accomplish the aforementioned as follows:

- **Informed permission:** An agreement between the researcher, the Technology Transfer Office, and the Director of the Research Directorate at CPUT was drawn up, focusing on confidentiality and protection against victimisation of the research participants.

- **The right to complete disclosure:** The researcher explained the full extent of the study to the participants and offered them the opportunity to decide whether to proceed or decline to participate.

- **Do no harm to data:** To present the data as it is.

- **Doing no harm to myself:** Preserve my integrity, and behave morally and professionally.

- **Do no harm to CPUT:** The research complied with the CPUT ethics policy.

1.7 Delineation of the research

This study was carried out at the Cape Peninsula University of Technology, and the researcher focused on research academics from all faculties with active university–industry linkages post-merger (a five-year period from 2008–2012). This study covered research contracts, since research grants do not have industry linkages as do contract research.

1.8 Significance of the research

The study was undertaken with the hope of proposing a model to create an enabling entrepreneurial culture at CPUT and other universities. Furthermore it was believed that the study might provide direction to other higher education stakeholders hoping to develop appropriate services, tools, and programmes that respond to the capacity gaps identified in the study, while building on the current strengths and capabilities of South African universities. Other benefits that may result from the study include the following:

- In view of the aforementioned, the study may provide a springboard for a nationwide study.

- The study may provide the heads of these institutions with the feedback necessary for improvement.

- For the government and policy makers, this research may provide the tools necessary for assessing and evaluating the role of academic entrepreneurs and spin-off companies at other universities and provide avenues for improvement of technology transfer offices and empowerment of research and development managers.

- One of the outcomes of this research may be a model that will encourage the development and sustainability of university–industry linkages.

1.9 Expected outcome

The purpose of this study was to contribute to the existing body of knowledge on academic entrepreneurship by addressing the following five questions:

- What is the role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation at CPUT?
- Why do academics become involved in entrepreneurial activities?
- What role can academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT?
- What role do private companies play in the process of technology transfer and commercialisation?
- What role can spin-off companies play in the process of technology transfer and commercialisation?

This researcher believes that the missing link is knowledge of whether CPUT academics have any desire to be entrepreneurs in the first place, and if so, what are the motivational factors that influence the decision to create spin-offs in an emerging knowledge economy such as South Africa. In line with the foregoing, it is further believed that the findings of this study may provide direction as to what CPUT needs to put in place to support its researchers towards creating spin-offs. Possibly CPUT can formulate programmes geared at promoting an entrepreneurial culture in postgraduate students and researchers.

1.10 Summary

This chapter examined the role that needs to be played by CPUT's academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation in South Africa. It outlined the background to the research, definition of key terms, and significance and objectives of the study. A quantitative research method was adopted in this study. Furthermore, the questionnaire as research instruments, population size, reliability and validity, ethical considerations and data presentation were outlined. The next chapter focuses on a review of the relevant literature in the hope that it will shed more light on the dynamics of the research problem and aid the researcher in investigating and resolving the problem.

1.11 Outline of the study

The layout of this dissertation is as follows:

Chapter 1: This provides the introduction to and background of the study. It begins with a definition of certain basic terms; a description of the research problem addressed by the study; research questions; research objectives; methodology and research design; delineation of the research; significance of the research; expected outcomes; and theoretical background to the study.

Chapter 2: It presents the literature study and a theoretical review that spans the concepts and constructs the relevance of the study. Firstly, the broad field of entrepreneurship and the factors that pull or push individuals to become entrepreneurs are discussed. This is followed by a discussion of university entrepreneurship, technology transfer, the concept and formulation of spin-offs, and academic entrepreneurship specifically within the South African context.

Chapter 3: This chapter describes the research design and methodology used to address the research objectives. This includes sampling, population, the data collection process and instruments, as well as the data analysis methods.

Chapter 4: The research results of the study are discussed in this chapter.

Chapter 5: The core findings, conclusions and recommendations, and areas for further research, are discussed in this chapter.

CHAPTER 2
LITERATURE STUDY

2.1 Introduction

According to Birley and Moreland (1998:80), the literature study is the key aspect of any research report. It is a critical analysis of the existing literature on the topic and a significant help during the process of clarifying and framing research questions. Polonsky and Waller (2011:106) assert that in most cases there is earlier written (scholarly) material that relates directly or indirectly to the researcher's area of study. The aim of literature study, as Tengeh (2011:31) notes, is partly to highlight the research issues or problems that the study intends to resolve, either because they are controversial or have not been fully addressed by previous research.

This literature chapter contextualises and aligns the research problem and methods of solving the problem to the existing body of knowledge. In accordance with these objectives, the following key concepts and themes are covered in this chapter: definition of entrepreneurship, importance of entrepreneurship, entrepreneurship education, the role of higher institutions of learning, academic entrepreneurship, entrepreneurial university, innovation, and technology transfer.

2.2 Definition of entrepreneurship

The approach to the concept and discipline of entrepreneurship by many scholars has been from different perspectives. To emphasise this point, Peneder (2009:77) labels entrepreneurship as one of the most fascinating concepts that is difficult to grasp its real meaning. Some authors have approached entrepreneurship from a general perspective (Kuratko, 2007), while others have focused on the process involved (Gantsho, 2006; Nicolaides, 2011). Others lean to an examination of the characters involved (Casson, 1982; Hébert & Link, 1989; Johnson, 2001).

According to Kuratko (2007:2), entrepreneurs bring about changes in the world of business, and they are individuals who see opportunities where others see nothing, chaos, contradiction or confusion. Kuratko (2007:2) further describes entrepreneurship as the passion and drive that move the world of business forward as entrepreneurs challenge the unknown and continually create the future.

From a process angle, for Gantsho (2006:23) the entrepreneurial process involves all the, activities, functions and actions associated with the identification of opportunities and the establishment of organisations to explore them. As such, Nicolaides (2011:1043) sees

entrepreneurship as a process of conceptualising, organising and launching, and through innovation, nurturing a business opportunity into a possibly high-growth venture. Others have a different view of entrepreneurship. Looking at entrepreneurship from a personal character perspective, Johnson (2001:139) describes an entrepreneur as a person who shows ingenuity; takes charge in making things happen; is innovative; assumes the associated risks; and has the ability to accomplish satisfactory results, even in the face of obstacles and difficulties.

Casson (1982:23) defines the entrepreneur as a person who has the ability to exercise good judgement as far the coordination of limited resources is concerned. Concurring with the previous writer, Hébert and Link (1989:47) assert that the entrepreneur is someone who makes decisions with regards to the location of a business, choice and type of resources to be utilised. Casson et al. (2006:510-530) concur that the sources, for instance, information is relatively diverse, localised, and reside with different people in different places. Attracting these resources require judgemental decisions which depend on the identity of the entrepreneur and are potentially unique.

Nonetheless, the prevalent thoughts on entrepreneurship are that the theoretical and empirical underpinnings of the discipline are either limited or unclear. Ahmad and Seymour (2008:5) laments about the considerable misconception that exists with regards to the use of the term ‘entrepreneurship’. In like manner, Shane and Venkataraman (2000:217) note that the term ‘entrepreneurship’ has become a "one size fits" all for researcher. Peneder (2009:78) also acknowledges noticeable misunderstandings and widespread frustration surrounding the definition and usage of the term ‘entrepreneurship’.

Venkataraman (1997:120) claims that entrepreneurship as an academic discipline attempts to understand how opportunities that lead to the creation of products and services are found, produced, by whom, and with what ramifications. Shane and Eckhardt (2003:165) describe entrepreneurial opportunities as conditions under which raw materials, new goods, services, and organising methods are introduced to the markets. Shane and Eckhardt (2003:165) describe entrepreneurial opportunities as conditions under which raw materials, new goods, services, and organising methods are introduced to the markets.

Notwithstanding the definitional inconsistencies found in the literature, there are certain themes that run through most definitions and are not limited to process, activity and behaviour. Having noted a number of definitions of entrepreneurship, the researcher concurs with Kuratko (2007:1), who sees entrepreneurs as individuals who can recognise opportunities where others see chaos, contradictions or confusion. Comparing entrepreneurs to Olympic athletes, Kuratko notes that they both strive to break new grounds and hence act

as catalysts for change in the world of business. Seemingly, all of these tend to fit in the context of academic entrepreneurship.

2.3 Importance of entrepreneurship

Small and medium enterprises (SMEs) play a very important role in regional economic growth and fighting unemployment through job creation. Thus, a number of policies have been put in place to improve the state of entrepreneurship by making it easier to create SMEs (Staber & Bögenhold, 1993:128; Ács & Audretsch, 2003:27).

Considerable attempts have been made in the past decades to link knowledge and growth on the one hand, and entrepreneurship on the other. One such attempt came from Braunerhjelm (2010:44) who concludes that a society's capacity to improve its wealth and welfare over time seriously depends on its potential to develop, exploit and disseminate knowledge, thereby influencing growth. Today, many would agree that new and emerging firms play a vital role in the innovations that lead to technological change and productivity growth in any society.

A significant source of economic vitality has always been the need to utilised entrepreneurship to achieve economic growth, upward mobility and equal opportunity. According to Kuratko (2007:5), entrepreneurship provides the essential platform that enables a significant number of people to enter the economy and social mainstream of our global society. As Kuratko (2007:5) concedes, this is particularly true for the marginalised, especially women, minorities and immigrants. Furthermore, entrepreneurial ventures play an essential role in bringing together both high-tech and traditional business activities (Kuratko, 2007:3).

Several initiatives have attempted to measure the impact of entrepreneurial ventures on the economy. One such initiative is the Global Entrepreneurship Monitor (GEM) that monitors entrepreneurial activities across over 40 countries worldwide. The most recent GEM report (Herrington et al., 2015:22) on South Africa noted a significant decline at all levels of early-stage entrepreneurship activity compared with 2013. The Total Early-Stage Entrepreneurial Activity (TEA) has decreased by 34% from 10.6% in 2013, to 7.0% in 2014, and the gap between South Africa and countries in sub-Saharan Africa (SSA) has widened. It looks like entrepreneurship in South Africa is regressing when compared with its counterparts in the rest of Africa.

The youth (18–24 year olds) represent the highest proportion of the total population in South Africa. The percentage of 18–24 year olds in South Africa involved in early-stage entrepreneurial activity is also significantly lower than the average for sub-Saharan Africa

and it is a concern for South Africa (Herrington et al., 2015:28). Amongst others, Co and Mitchell (2006:348) believe that the South African entrepreneurial problem can be linked to South African educational structures. Both South Africa's formal and informal education structures do not prepare the youth to be skilled entrepreneurs, but have created a culture in which young South Africans dream of becoming employees rather than employers.

As a result of the aforementioned, there is growing pressure on Higher Education Institutions (HEIs) to champion and contributed significantly to the international competitiveness of economies, particularly through the commercialisation of research. In fact there are persistent demands for the sector to contribute more substantially to local economic and social development. Thus, universities are urged to take centre stage in regional development strategies (Gibb & Hannon, 2005:4).

2.4 Entrepreneurship education and the role of higher institutions of learning

Highlighting the place of education in the world, and particularly in respect of economic growth, Ilie (2010:64) notes that education is vital, given that it is impossible to sustain progress unless people are educated. Ilie (2010:65) laments the poor quality of education prevalent in the world today and emphasises the need for urgent action and organised efforts to improve educational systems worldwide. In view of the foregoing, one may argue that infusing entrepreneurship and innovation in the educational process may ensure that skills such as creativity, leadership, critical thinking and so forth are passed on to students, creating a significant impact on their personal and societal growth.

Entrepreneurship has never been as important as it is today when the world is confronted with massive challenges that extend beyond economy (World Economic Forum, 2009:7). Entrepreneurship is a substantial force that can have a great impact on recovery, growth, and social progress by stimulating innovation, employment generation and social empowerment. While it is clear that the world needs more entrepreneurial communities that can provide solutions to seemingly difficult, interrelated and ever changing problems, attention should be given to the role that education can play in developing the next generation of innovators and entrepreneurs can create jobs and inspire others to success (Tshikovhi & Shambare, 2015:152).

According to Fatoki (2010:88), South African graduates have little entrepreneurial interest, because of the educational culture from primary school to university; they dream of being employed instead of being employers. South Africa has a high rate of youth unemployment because South Africans have always depended on government and industry to create jobs (Tshikovhi & Mvula, 2014:77).

Many scholars have concurred on the importance of entrepreneurial education programmes as one of the ways to fight unemployment (World Economic Forum, 2009:7; Bezuidenhout & Nenungwi, 2012:11658). In an attempt to provide entrepreneurial skills to all, the South African government made significant changes to school curricula some years ago. In fact, South African entrepreneurship school curricula have been implemented in schools since 2005, starting from Grade 1, to promote an entrepreneurial culture from a young age (North, 2002:25). However, nine years later, entrepreneurship education in South Africa is still in its developmental stage (Tshikovhi & Mvula, 2014:80).

Teaching and learning of entrepreneurship at HEIs need to be changed; the subject needs to be more practical, instead of lecturers setting students formal examinations for entrepreneurship that only test theoretical knowledge. South African graduates are expected to create new businesses and fight unemployment using theoretical knowledge. They are being set up for failure. Before university students graduate, the university should assist them to create a start-up venture within the university, provide business mentors and prepare them for the business world (Tshikovhi & Mvula, 2014:79).

Many scholars argue that business schools should empower their graduates with the requisite business skills to recognise business opportunities, to deal with business risks and social network skills for entrepreneurship, and how to generate capital funds. Each student should venture into various communities and identify business opportunities by examining the needs of these communities (Tshikovhi & Shambare, 2015:153). Many graduates are discouraged from starting up their own ventures because of a fear of failure and a lack of resources (Fatoki, 2010:89).

Further buttressing the importance of entrepreneurship, the World Economic Forum (2009:18) sees entrepreneurship education as an undeniable societal change agent and emphasises that everyone does not need to become an entrepreneur to benefit from entrepreneurship education. However it is essential that all members of society become entrepreneurial.

2.5 Academic entrepreneurship

Universities are seen as ‘enterprises’ and university academics as ‘entrepreneurs’ (Grundling & Steynberg, 2008:9). According to Nicolaides (2011:1043), entrepreneurship is a process of conceptualising, organising, launching, and through innovation, nurturing a business opportunity into a potentially high-growth venture in a complex, unstable environment. It is the entrepreneurs who create and give birth to new technologies, products and services. They also create new markets and jobs along the way. Entrepreneurs are savvy risk takers,

implementers and innovators. They transform the socio-economic landscape by creating and exploiting new opportunities.

Academic entrepreneurship is a business venture established by a university student, technician or professor and it is a well-organised university–industry technology transfer mechanism (Doutriaux, 1987:285). Starting a new business can be financially risky, and Doutriaux (1987:296) suggests that the academic entrepreneur (professor or technician) should remain on the university payroll to reduce the financial risks to himself/herself, and should remain a part-time academic and part-time businessperson. This may provide easy access to university facilities, including student labour, and increased industry contact for the benefit of the students and researcher (Doutriaux, 1987:296).

Generally, the literature on entrepreneurship notes a distinction between opportunity identification and opportunity exploitation and the importance of entrepreneurship (Mitchell, 2011:616). Hence, the literature on academic entrepreneurship focuses increasingly on these two notions, recognising them as being distinct and crucial to the study of entrepreneurship (Wright, Birley & Mosey, 2004:236; Park, 2005:740). This notwithstanding, there is not much information on the factors that contribute to the development of entrepreneurial skills among academic scientists and particularly the skills necessary for opportunity identification and opportunity exploitation.

Grundling and Steynberg (2008:9) note that academic entrepreneurship is essentially the modified behaviour of research and education in the sense that it should be considered an ‘income oriented’ activity which could be seen as ‘risk-taking’, technology- and knowledge-based and causing greater stability for the university through its involvement in business activities. This debate centres primarily on the ‘commercialisation’ aspect of higher education and the utility value thereof to achieve a country’s economic goals (Imenda, 2006:257). Progressive universities have endeavoured to be at the forefront of knowledge and innovation, unlike in the past where universities have been custodians of old knowledge and traditions. Universities have evolved side by side with new theoretical understandings and trends of practice. Some universities have become the main drivers of regional community and industry relevance as well as entrepreneurism.

Van Staden (2006:41-51) cautions against equating entrepreneurialism in universities with commercialisation and proposes that a more holistic perspective is required when analysing an entrepreneurial university in which academic criteria dominate financial matters, that is, finance should follow academic matters and not vice versa.

Academic entrepreneurship is never a single event. It is an umbrella term that refers to push-and-pull activities that universities and industry initiate to commercialise research results to generate income for the university (Wood, 2011:153).

According to Wood (2011:154), academic entrepreneurship is a process with different stages, but it starts with the researcher or student at the faculty level or in the laboratory.

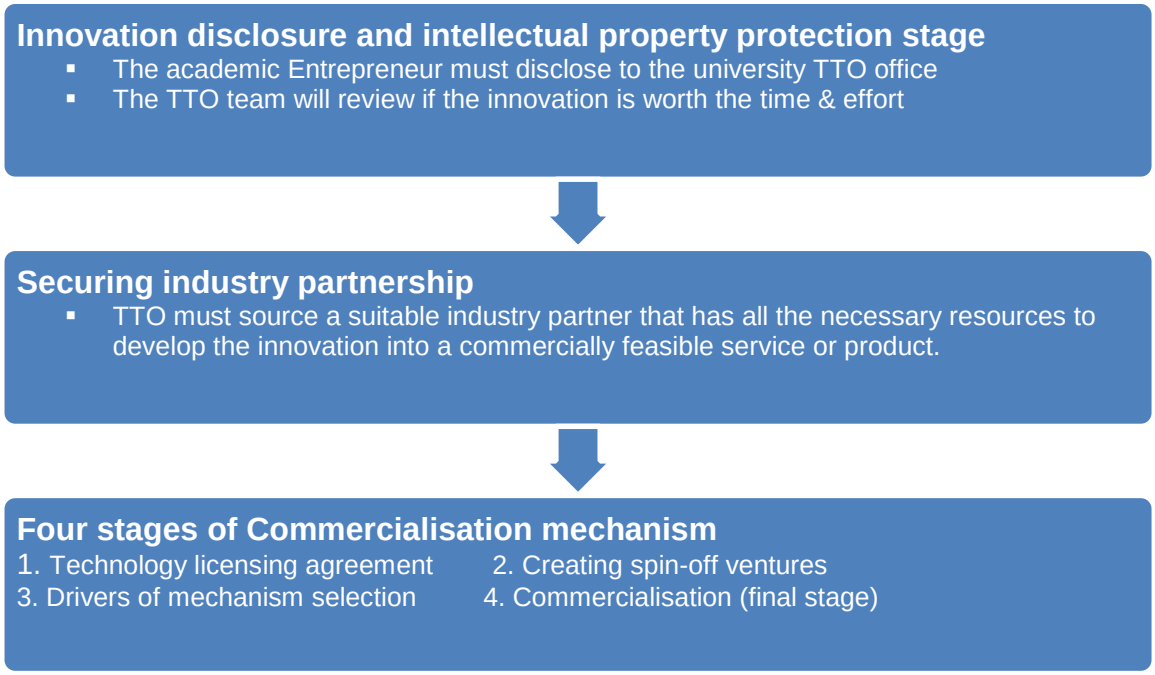

Figure 2.1: Process model of academic entrepreneurship developed by Wood (2011:159)

Wood (2011:160) argues that a process model for academic entrepreneurship is beneficial to both the university and industry as it clarifies all the activities, possible options, role players for each stage, and responsibilities of each stakeholder during the process.

According to Wood (2011:160), there is much financial gain that can be provided by academic entrepreneurship; however other scholars seem to disagree (Åstebro et al., 2013:306).

The literature on academic entrepreneurship in general and university–industry technology transfer in particular identifies an academic entrepreneur as a university scientist who engages in the commercialisation the results of research, by obtaining a patent and/or setting up a business. In relation to academic entrepreneurship, the process of identifying a commercial opportunity is often associated with an invention disclosure to university technology transfer offices and with academic patenting (Giacomin, Guyot, Janssen & Lohest, 2007:2).

According to Åstebro et al. (2013:281), for the past three decades universities have amended policies and changed the university culture to encourage university spin-offs. Åstebro et al. (2013:306) do not encourage academics to become full-time entrepreneurs because there is not much to gain in remaining a university employee and becoming an entrepreneur.

Lacetera (2009:461) argues that academic entrepreneurship does not mean only starting a new venture; it can take different forms, namely, industry–university collaborations, university-based incubator firms, start-ups by academics, etc.

Academic entrepreneurship has brought changes in universities' management and governance. Entrepreneurship is about managing a business, managing income and risk, and thinking and behaving entrepreneurially. The university governance has to ensure that its academic reputation is protected at all times. It is even more crucial in an entrepreneurial university to employ risk management (Kwiek, 2008:761).

2.6 The entrepreneurial university

Universities are organisations that perform a key role within modern societies by educating significant proportions of the society and generating knowledge (Perkmann et al., 2013:423). Universities are increasingly called upon today to contribute to economic development and competitiveness. As Kutinlahti (2005:13) notes, the growing relationship between universities and industry as evident in the quest to commercialise academic research, can be traced to the mid-1980s and this has generated significant interest in policy and research to date. Universities have thus become more active in their attempt to commercialise their research and establish linkages with industry.

According to Kutinlahti (2005:13) and Mowery and Sampat (2005:209), a variety of policy schemes and programmes have been launched to support university–industry collaboration and commercialisation of results. Notably, policy-makers have implemented laws that provide commercialisation incentives to universities by granting them ownership of intellectual property arising from their research (D'Este & Perkmann, 2010:6). Examples of such commercialisation legislation include the 1980 Bayh-Dole Act in the US and similar legislation in other countries (Mowery & Sampat, 2004:116). D'Este and Perkmann (2010:6) note that other policies encourage universities and firms to engage in partnerships and personnel exchange, for instance via university–industry centres or science parks. Furthermore, another type of initiative seeks to build universities' knowledge transfer capabilities by supporting recruitment and training of technology transfer staff (Woolgar, 2007:1272; Kirby, 2006:602).

The aforementioned developments have given rise to the entrepreneurial university (D'Este & Perkmann, 2010:3). The discussion of the entrepreneurial university has heightened

concerns about what inspires academics to engage with industry. In a UK study, D'Este and Perkmann (2010:3) revealed that most academics engage with industry to further their research as opposed to commercialising their knowledge.

Undoubtedly, the growth of entrepreneurial activity in universities has multiple causes. On the one hand, some scholars in the field of science and technology studies have feared that greater involvement with industry and the commercialisation of research may corrupt academic research, undermining the commitment to teaching and research as well as the openness of academic research (Feller, 1990:335).

D'Este and Perkmann (2010:3) conclude that the vision of the entrepreneurial university fails to capture the complex nature of academic researchers' interactions with industry. For instance, notwithstanding the perceived relationship between universities and industry in the process of technology transfer, D'Este and Perkmann (2010:3) note that most academic researchers strive to retain their autonomy. This may imply that for universities, the benefits of university–industry collaboration are best accomplished by cross-fertilisation, instead of pushing academics to become entrepreneurs.

2.7 Innovation

As noted earlier, innovation is one of the themes that regularly appear in most attempts to define entrepreneurship. Johnson (2001:135) notes that innovation is any change in the product or service range an organisation takes to the market. This is the most clearly understood form of innovation and involves the creation of new products and services, usually via the R&D department. Supporting Johnson's (2001:135) position, Blankley and Moses (2009:15) suggest that innovation has to do with the introduction of new or improved goods or services to the market or the use of new or improved processes for producing goods. Furthermore, innovative enterprises are those that are changing to meet the demands and expectations of clients.

The policy makers view small and medium enterprises as main developers of innovation and contend that commercialisation of intervention is innovation (Massa & Testa, 2008:393).

In 2007, Eurostat published a number of results from the Fourth Community Innovation Survey (CIS4) for EU-27 countries as well as for Iceland and Norway. The South African innovation survey of 2005 was aligned with CIS4, which makes it easier to conduct a comparison study of the South African results with those in the European countries (Blankley & Moses, 2009:15). These international comparisons provide a rich source of reference for understanding and interpreting South Africa's innovation survey results. The final results of the South African innovation survey, including international comparisons, were compiled as a detailed report to the Department of Science and Technology (Blankley & Moses, 2009:15).

According to Blankley and Moses, 2009:16), most European nations' industrial enterprises are more innovative than service enterprises, while in certain states like Luxembourg, Estonia, Portugal, Greece, and Latvia, the rates of invention in the services sector are higher than those in industry. The rate of enterprises engaged in cutting-edge activities ranged as follows: from 72.8% in German industry to 12.7% in Bulgarian services. On the contrary, in South Africa, 54.8% of industrial enterprises were innovative, compared with 49.3% of service enterprises (Blankley & Moses, 2009:15).

The rate of cutting-edge enterprises in South Africa is higher than the EU-27 averages of 41.5% for industry and 37.0% for services. South Africa had the sixth highest rate of innovation in industrial enterprises and the fifth highest rate of innovation in service enterprises (Blankley & Moses, 2009:16). It is becoming more imperative for both industrial and service enterprises to be inventive, as services play an increasingly significant role in the transfer of technology and promotion of business in both developed and growing economies (Blankley & Moses, 2009:15).

The innovation landscape has changed. In the past, many industries used to operate in closed innovation spaces. Large private companies used to operate and produce innovative products, equipment, etc., using their own Research & Development (R&D) laboratories behind closed doors; this was called closed innovation. Enterprises cannot afford to operate/innovate on their own (Van de Vrande et al., 2009:424). The policy makers have changed things by encouraging collaboration between universities, industries, SMEs, etc. (Etzkowitz & Leydesdorff, 1995:14).

2.8 Universities and technology transfer

This section focuses on the relationship between the university, technology transfer and the spin-off company.

2.8.1 Technology transfer

Bozeman (2000) defines technology as the science or study of practical industrial arts used in science, technical terminology and applied science. Technology transfer focuses on technology entity, not a study and not applied science. Bozeman (2000:628) views technology as a tool and describes it as the movement of know-how and technical knowledge.

Technology transfer has been used to describe and analyse a wide range of institutional and organisational interactions involving technology-related exchange. Sources of technology have not been limited to private firms, non-profit research organisations, universities,

government laboratories, and government agencies. Users have included small businesses, legislatures, schools, states, cities, and nations (Bozeman, 2000:629).

Lin (2003:327) suggests that technology comprises the theoretical and practical knowledge, skills, and artefacts that can be used to develop products and services as well as their production and delivery systems. Technology is embodied in people, materials, cognitive and physical processes, facilities, machines and tools.

Technology transfer entails that technology 'changes hands'. According to Lockett, Wright and

Franklin (2003:186), the most important strategy when developing spin-off companies concerns the role of the entrepreneur. The academic as technology inventor automatically takes on the role of entrepreneur. The academic may run the spin-off company in parallel with his/her academic duties because the involvement of the inventor may add positive value and knowledge to the technology.

It is very important for universities to pay greater attention to the study of entrepreneurship in technology transfer; they need to be able to identify how wealth can be created from the spin-off companies (Wright et al., 2004:235). Furthermore, Wright et al. (2004:236) also argue that the university's internal entrepreneurial culture, processes, resources, and scientific disciplines should encourage the creation and development of spin-off ventures. Academics need to be trained and mentored in how to recognise opportunities and their research ideas need to be shaped to meet the market.

The roles of all parties (academics, university and commercial organisations) during the transfer process need to be clear. The university and scientists should first agree that spin-out is the most viable option for technology commercialisation and should negotiate a spin-out deal. This may include discussions regarding equity split, royalties, academic secondment, identification and transfer of intellectual property, and the use of university resources in the start-up phase. It is important to understand these spin-out companies and the entrepreneurial processes behind them (Shane, 2004:151).

Encouraging technology transfer by incentivising university researchers to form spin-off companies requires a potentially costly trade-off that is rarely contemplated in policy discussions (Czarnitzki et al., 2013:1). Unlike start-ups created by people already working in the private sector, university researchers tend to make employment transition out of the not-for-profit research sector. Furthermore, as these academic entrepreneurs pursue commercialisation, less time and reasoning effort is directed to university research and their contribution to knowledge accumulation and disclosure decreases (Czarnitzki et al., 2013:1). According to Toole and Czarnitzki (2010:1599), when academic researchers indulge in

commercialisation using for-profit firms, there is a likely costly trade-off in that their time and effort are partly diverted away from the production of knowledge. One may argue that this promotes brain drain in the not-for-profit research sector with a potential reduction in the production of academic research, university performance and long-run economic growth.

To enhance the technology transfer process, universities have established Technology Transfer Offices (TTOs). According to Wilson (2007), institutional technology transfer offices (TTOs) are relatively new developments in South African universities and there is no comprehensive benchmarking of the performance of these TTOs till date

2.8.1.1 Technology transfer in the UK

The Industrial Liaison Offices and Teaching Company Schemes of the 1980s were gradually transformed or enhanced during the last decade of the 21st century by the growth of formal knowledge and technology transfer units. An initial science park concept was enhanced to embrace technology parks, innovation centres and incubators (virtual and real) of all shapes and sizes (Gibb & Hannon, 2005:8). This transition was propelled and supported EU and the UK government. It must be noted that a significant proportion of just mentioned these developments involved partnerships between universities, industry and local and regional government.

In the past decade, the UK government has made concerted efforts to improve the technology transfer in the HE sector through the DTI's Office of Science and Technology and the Department for Education and Skills (DFES). Furthermore, by making use of a number of funding schemes not limited to the University Challenge Funds, Science and Enterprise Challenge Funds and currently Higher Education Innovation Funds, the UK government made it possible for the stimulation enterprises and the exploration of opportunities generated university research (DFES, 2003; DTI, 1999, cited by Gibb & Hannon, 2005: 9).

2.8.1.2 Technology transfer in South Africa

There were attempts made to encourage technology transfer activities as early as the 1980s. A new democratic government has been in place since 1994, and policy developments in South Africa have been numerous. More care has been paid to supporting innovation in acknowledgment of its vital functions in advancing growth, enhancing competitiveness and improving quality of livelihood. The 1996 White Paper on Science and Technology, Department of Arts Culture Science and Technology (DACST, 1996) established the concept of a National Innovation System (NIS). The White Paper created the framework for many key enabling policies and strategies to inform the strategic evolution of science and technology in South Africa.

According to Kloppers et al. (2006:1), technology transfer remains a problematic topic for many universities in developing countries, including South Africa. Universities in developing countries are expected to champion the creation of technology that will help drive African countries towards becoming knowledge-based economies, globally competitive and ensure wealth creation and economic upliftment through new spin-offs. Thus, it is imperative that African universities become active in the area of technology creation and commercialisation.

As stated by Kloppers et al. (2006:2), when the South African government introduced the Intellectual Property Rights (IPR) policy framework in 2003, the goal was to move South Africa from being a resource-based economy to being a knowledge-based economy.

In 2008 the South African Department of Science and Technology (DST), launched a ten-year innovation plan for South Africa for 2008–2018: *Innovation Towards a Knowledge-Based Economy* (DST, 2008). The aim of the ten-year innovation plan is to thrust South Africa's transformation towards a knowledge-based economy in which the production and utilisation of knowledge leads to economic benefits and enriches all fields of human endeavour (DST, 2008:1).

As clearly expressed by Kloppers et al. (2006:2), researchers from developing countries need to make a distinction between commercial technology transfer and social technology transfer. The traditional model of technology transfer has to do with owning, protecting and exploiting IP, while the social development model is concerned with giving the commercial advantage to others through the dissemination of the Intellectual Property (IP).

Table 2.1: Key differences between the two modes of technology transfer in developing countries as explained by Kloppers et al., 2006:4

	Commercial Mode	**Social Mode**
Motivation for participation	Realise value of IP through commercial exploitation	Creating real, positive social change through IP dissemination
Technology transfer paid for by	Entity receiving the IP	Government and/or development aid organisation
Technology transfer facilitated by	Technology transfer	Academic staff
Key outcome	Financial gain for parties involved	Changed behaviour in society
Underlying principle	Make yourself valuable through protecting your IP	Make yourself redundant through teaching others your IP

In conclusion, considering the availability of corporations and advances in information technology, universities do not have monopoly main sources of intellectual property. To retain their status will require partnerships with other stakeholders in society. Nor can they expect to be insulated from the demands of society by the public purse.

2.9 Business model for technology transfer

Human capital refers to the stock of productive skills and technical knowledge embodied in labour. Human capital is one of the most vital resources of any organisation because human capital underlies any organisational capability in the sense that organisations do not make decisions or allocate resources; people do (Zakaria & Yusoff, 2011:48).

Human capital is an important input to most forms of economic activity. Marimuthu et al. (2009:266) state that human capital is an important input for organisations, especially for employees' continuous improvement in the areas of knowledge, skills, and abilities. Thus, it needs to be maintained and developed via on-going investment.

Such evolution of capability leverages human capital, while also leaving a larger dimension of the value created and appropriated by the governing body. In this context, the way in which an organisation's business model facilitates this development eases the integration of the various systems and of the physical and human capital (Zakaria & Yusoff: 2011:48).The term 'business model' became popular in the business world during the 1990s. Academic researchers have been slower to adopt the concept, but are now giving more attention to it (Dottore et al., 2000:4).

The importance of university research in contributing to economic growth is today widely acknowledged in Western Europe (Organisation for Economic Co-operation and Development, 2003a, cited in Gabrielsson et al., 2012:214). This, among other things, contributed to the fact that universities today are not simply envisioned to operate as suppliers of human capital, but also as developmental agents that promote regional and internal economies (Rasmussen et al., 2006:518).

Barbaroux (2012:232) argues that it is important for collaborators to work together and nurture the invention and commercialisation of their new technology/product. Many scholars also concur that it is critical to support the invention and commercialisation of the new innovation, especially in its early stages (Hindle & Yencken, 2004:793).

University professors are among the numerous actors involved in the transfer of knowledge and research output from university to industry. Beyond having professional knowledge in their particular scientific disciplines and a network of contacts, Van Rijnsoever et al., (2008:1257), argue that their academic hierarchy place them in a position to expand their

influence beyond campus activities like research and teaching (Baldwin & Blackburn, 1981:609).

Universities are regarded as promising patrons of innovation, business creation and technological change through university–industry collaborations and through their backing of new knowledge-intensive start-ups (Etzkowitz & Leyesdorff, 2000:109; Etzkowitz, 2003a:294). As a consequence of changes and growing pressures on universities to contribute to economic development, universities are increasingly considering technology transfer and commercialisation of research results to be a component of their explicit mission.

In summary, university-developed knowledge is not instantly transmitted into the commercial area. Faculty members are the principal bearers of this knowledge, especially in the very early phases of research commercialisation, owing to their direct participation in its creation. As Hindle and Yencken (2004:800) confirm that, the high level of tacit knowledge involved in stimulating ideas that result in research-established businesses often necessitate that such distinctive insights initially are individually conceived and developed by those concerned. As such, Gabrielsson et al., (2012:217) conclude that university professors as academics are in a better position to generate commercially viable enterprise ideas that can be developed in viable businesses. New firms resulting from research activities tend to have a high growth expectation, even if this is not always realised. Growth involves risk and sometimes giving out equity to obtain the necessary financial resources.

2.10 Spin-off companies

According to Steffensen et al. (1999:93) a spin-off company is a new venture that is established from a parent organisation. If academic employees leave the university (parent organisation), they take along technology that serves as the ticket for the spin-off in a high-technology industry. Similarly, Smilor et al. (1990:63) looks at university spin-off companies from two angles: (a) one of the founding members is active or retired academic (b) the spin-off company was developed from a technology or technology-based idea developed in a university.

The relationship between a university-based parent organisation and its spin-off can be beneficial to both parties. This is realised when a spin-off can provide support for the parent organisation such as for a technology licensing fee and a role model to encourage more transfer technology of from research universities. Such transfer via spin-offs contributes to the university's role in its region's economic development.

University spin-offs can be and often are created by entrepreneurs who come from outside the academic institution to lead the effort to exploit university technologies to create new firms. Similarly, investors who bring together external entrepreneurs and university technologies to establish new companies are another category of lead founders of university spin-offs (Shane, 2004:6). An example of a country that continuously promotes and encourages the formation of university spin-off firms is Britain. During the period 1996 to 2001, 31% spin-offs were created in the United Kingdom (Clarysse & Moray, 2004:57; Wright et al., 2004:246).

2.10.1 The importance of university spin-offs

A number of national governments and public research organisations have enacted policies to encourage the formation of university spin-off companies, indicating a shift in the culture and missionary work of public research organisations towards an entrepreneurial paradigm (Mustar & Wright, 2010:42).

University spin-offs are valuable in at least five ways: they enhance local economic development; they are useful for commercialising university technologies; they help universities with their major missions of research and teaching; they are disproportionately high performing companies; and they generate more income for universities than licensing to established companies. The following may affect/influence the creation of spin-off companies:

- **Exclusive licence policy***:* One policy that influences the rate of spin-off activity of universities is exclusive licencing. Permitting exclusive licences encourages spin-off activity for several reasons. Shane (2004:69) argues that entrepreneurs are unwilling to start new companies and bear the risks of developing new technology, while investors are unwilling to finance them because they need assurance that they will have exclusive rights to that technology once it has been developed. The non-exclusive licencing allows possible competitors to gain access to the technology that makes it even harder for the spin-offs to have appropriate returns on the developed technology. Non-exclusive licencing discourages the ability to create university spin-offs because it reduces the amount of capital that is invested in the development of the companies.

- **Equity policy:** In many institutions, licensing offices capitalise on royalties and fees and take equity in the spin-off company rather than demanding payment in cash.

- **Leave policy:** The university leave policy that leads some universities to have more spin-off activity than other universities is the institution's policy toward leave of absence and outside work.

- **Use of university resources policy:** Universities that have fewer rules about the use of university resources to encourage spin-off company development have more spin-off activity (Shane, 2004:73).

- **Division of royalties' policy:** Universities generate income in the form of royalties on the gross sales of service or products that use technology. When universities split those revenues with the investors in their faculty, it influences the university spin-off rate (Shane, 2004:74).

- **Pre-seed stage capital policy:** "Pre-seed stage capital is money that is used for further technological development to bring the technology to a stage where it can be financed by the private sector. The universities that have high rates of spin-offs have funds reserved for pre-seed stage capital" (Shane, 2004:76).

Lambert (2003:83) argues that there is a huge difference between the creation of a spin-off and the creation of a spin-off that will generate wealth. It is relatively convenient for technology transfer offices (TTOs) to generate a legal entity that contains the intellectual property (IP) related to new technology than it is to develop the technology into a viable business.

Becoming an entrepreneurial university active in technology transfer requires the participation and commitment of all faculties. The entire technology transfer process is predicated on individual faculty members revealing their inventions to the university's technology transfer office (Owen-Smith & Powell, 2001:99).

2.11 Higher education and technology in South Africa: A post reflection

Different policies have been designed to encourage the establishment of spin-offs from universities by academics, such as the Bayh–Dole Act in the United States and the Law on University Patenting in Denmark (Åstebro et al., 2013). Although South Africa has been behind in technology transfer, it is taking compelling steps in that direction. South Africa has gone through political transformation in the past two decades and as Mpako-Ntusi (2003:129) asserts, higher education has not been able to escape its impact.

The Green Paper on Higher Education Transformation produced by the Department of Education in 1996 (DOE, 1996) was its first policy document anticipating change. This was followed by the White Paper on Higher Education published in 1997 (DOE, 1997). It contends that research is the essential tool for generating new knowledge, while disseminating the knowledge through teaching and collaboration in research tasks is central to developing academic and research staff (Mpako-Ntusi, 2003:130). The DOE, (1997:12) add that the foregoing is reliant on ongoing technological advancement and innovation,

propelled by a well-organised, excellent research and development system which incorporates the research and training potential of higher education with the requirements of industry and of social reconstruction.

The National Plan for Higher Education was published in 2001 (South Africa. Ministry of Education, 2001). According to this plan, “Research, in all its forms and functions, is perhaps the most powerful vehicle … It contributes to the global accumulation of knowledge and places South Africa among those nations who have active programmes of knowledge generation” (South Africa. Ministry of Education, 2001:67).

The New Funding Framework 2004 (South Africa. Ministry of Education, 2004) indicates three major transformational shifts: (a) institutional excellence will be measured by the quality and quantity of outputs, (b) research subsidies will be based on research outputs, and (c) no research output equals no research publications’ subsidy.

2.11.1 Policy and procedures for measurement of research output

According to the South African Ministry of Education (2004:3), the purpose of a research output policy is to stimulate the production of more and greater quality research by academics in higher education institutions.

The Department of Science and Technology (DST) in 2008 published an innovative ten-year plan towards a knowledge-based economy (DST, 2008). This plan is motivated by four elements: human capital development; knowledge creation and application; knowledge infrastructure – enablers to tackle the ‘innovation chasm’ between research results; and socio-economic outcomes. The resulting from the fore going policy was the creation of technology transfer offices (TTOs).

Institutional technology transfer offices (TTOs) are relatively new initiatives in South African universities and research organisations and fewer research institutions have endorsed them as of date. While considerable efforts have been made to promote technology transfer since the 1980s, it was not until 1990 that most universities and research organisations started to set up TTOs (Wilson, 2007).

2.12 Characteristics of a university licensing office

A university’s rate of spin-off development is influenced by the quality of the university’s technology licensing office. Licensing office resources are very important; the universities that are successful in spin-offs are the ones that have invested resources in licensing activities (Wilson, 2007). Most universities lack sufficient staff devoted to technology

licencing, with the result that they have lower rates of spin-off companies (Wright et al., 2003:187).

Reasons for certain universities generating greater spin-offs:

- Greater expertise on how to establish a technology company (Wright et al., 2003:186).
- Technology licensing officers with linkages to a network of investors, managers and advisors that can provide the necessary resources to start new spin-off companies (Shane, 2004:78).
- The availability of entrepreneurs among faculties or university community (Hsu & Bernstein, 1997).
- University technology offices influence how the spin-off stakeholders and inventors perceive the university technology licensing office (Shane, 2004:76).
- Faculty academic entrepreneurs influence at faculty level by providing an 'informal curriculum' to postgraduate students and other researchers, which provides information on how to start spin-offs and how to find venture capital.
- A university with a good reputation makes it easier for academic entrepreneurs to persuade investors to supply the resources that are needed for new ventures (Shane, 2004:84).

2.13 University–industry linkages

The goal of supporting university–industry linkages is to promote the relevance and contribution of universities to socioeconomic development. Within the National Innovation System (NIS) framework, innovation is viewed as a collective process; companies do not innovate in isolation but within a larger system involving other companies, universities, research centres, government agencies, and other actors (Ssebuwufu et al., 2012:5). The NIS model considers all aspects of the economic and institutional structure of a country that influences the development, diffusion and use of innovations (Edquist, 2010:18).

According to Etzkowitz (2003a:293), innovation is based upon a triple helix of the university–industry–government interaction. The importance of knowledge and the role of the university in nurturing technology-based firms place it in a position to influence entrepreneurial activities in the economy. The entrepreneurial university takes a proactive role in putting knowledge to use and broadening the input into creation of academic knowledge. As organisation improve their technological capacity, they tend to adapt an academic model as they engage in higher levels of training and sharing of knowledge. Government acts as a public entrepreneur and venture capitalist in addition to its traditional regular role in setting the rules of the game.

Universities, for example, may even look to industry to recruit entrepreneurial researchers to work in their faculties and act as role models. University–industry linkages can either be formal or informal. As a means to support a more institutional approach to promoting linkages, many universities set up industry liaison offices, technology transfer offices, technology and business incubators, and in some cases establish science parks on or near campuses to facilitate such interaction.

For research to contribute to addressing major social, environmental and technical problems, collaboration across disciplines and between research and practitioners are increasingly being seen as essential (Bammer, 2008:875). According to Ssebuwufu et al. (2012:5), the perceived benefits of university–industry collaboration include: providing alternative funding channels in an era of constrained financing; access to/acquisition of state-of-the-art equipment; improved curricula and training in technology-oriented programmes and problem solving; enhanced employment prospects for students; supplemental income for academic staff; and clearer contribution of universities to the economy.

Although strengthening university–industry linkages offers many potential benefits, enthusiasm should be tempered with realism and recognition of the trade-offs inherent in promoting such linkages. While some universities have prospered significantly through large research contracts and the commercialisation of marketable technology, many others have not necessarily accrued substantial revenue through activities directed towards the productive sector, though they have still benefitted in other ways (Ssebuwufu et al., 2012:5).Collaboration between industry and universities faces significant challenges, including the fact that these organisations are driven by different incentive systems (Salter et al., 2010: 858).

The increasing engagement of universities in technology transfer and commercialisation questions their nature and mission (McKelvey & Holmén, 2009 cited in D'Este & Perkmann, 2010:7). The proponents of the 'triple helix' theory maintain that universities have welcomed economic and social development as a new mission, in addition to their conventional missions of teaching and research (Etzkowitz, 1998, cited in D'Este & Perkmann, 2010:7).

2.13.1 The state of university–industry linkages in Africa

Many countries in Africa lack an enabling environment for re-orienting and aligning universities and other higher education institutions (HEIs) towards a more entrepreneurial role (Ssebuwufu et al., 2012:7). Apart from perhaps the Maghreb region and South Africa, most of sub-Saharan Africa lacks high-tech industries and a true technology culture (Barry & Sawyer, 2008:10). Many of Africa's industries are small- to medium-scale companies producing for local markets, while the relatively larger ones are subsidiaries of transnational

companies which draw upon the in-house R&D capabilities of the parent company (Munyoki et al., 2011:164).

Ssebuwufu et al. (2012:7) argue that many African universities are not in a strong position to conduct research and technology development. Long years of neglect in financing higher education and university research in Africa have left many universities with weak research infrastructure and reliant on donor funding for research (Mouton, 2008:6). Under the just mentioned conditions, research activities tend to take a backseat to teaching activities in most African universities (Mohamedbhai, 2008:8).

Furthermore, low investment in science and technology and lack of national strategies in these areas further compound the difficulties (Mouton, 2008, cited in Ssebuwufu et al., 2012:5). Thus, insufficient funding and the lack of relevant university policies for collaboration with industry is a constraint to university–industry interaction.

2.14 Entrepreneurship theories

Given that entrepreneurship as scholarly endeavour is still in its infancy stage, many theories abound. These theories are based on different, often conflicting assumptions borrowed from a range of disciplines (Ardchvili et al., 2003:106). Scholars have propounded a number of theories in the field of entrepreneurship, inter alia:

2.14.1 Push and pull theory

In order to understand the factors that influence individuals to engage in entrepreneurial activities, the push and pull theory has been adopted. According to this theory, there must be push and pull factors for academics to be involved in entrepreneurial activities. From a push perspective, Smilor et al. (1990:63) argue that universities are pulled to spin-offs by factors such as recognition of a market opportunity, the drive to try something new, and the desire to put theory into practice. From a pull angle, there are various university environmental push factors that influence start-up companies. Nonetheless, it shows that universities have started to take a more proactive role in spin-off company formation and development.

Universities have not been able to escape push or pull factors: because of these factors universities have been pushed to expand their missions. In the past, university focus was on teaching and doing research, but that has changed over the years. Universities have been pushed to create start-up companies in order to spread knowledge. According to Etzkowitz and Zhou (2007:1), entrepreneurial universities play different roles in triple helix models: university-pushed, government-pulled and industry-led innovation. In other triple helix models, entrepreneurial universities are the leaders in regional innovation. In a university-

pushed environment, government-pulled model, they collaborate with industry to create innovative products to meet the market needs and to establish new companies.

According to Giacomin et al. (2007:2), Oxenfeldt (1943)[2] and Johnson and Darnell (1976) developed and tested a framework of analysis of push-pull factors (Harrison & Hart, 1983:1395). Johnson and Darnell's (1976) starting point is that the creation of new businesses changes the lives of unemployed and employed people to that of self-employed (Giacomin et al., 2007:3).

According to Slaughter and Leslie, research has become less curiosity driven and more market driven. As universities are forced by diminishing public funds to raise tuition fees, faculties likewise are pushed by diminishing support from their universities to seek outside funding. This has pushed academics to think like entrepreneurs to form spin-offs (Slaughter & Leslie, 1997:89).

It is clear that individuals are involved in venture creation not by accident (Schjoedt & Shaver, 2007). Johnson and Darnell (1976) argue that individuals become entrepreneurs because of two factors: push and pull. One's push factor can be another's pull factor. According to Giacomin et al. (2007:3), there are reasons behind the push and pull factors: the need for achievement, nascent entrepreneurship, market opportunities, etc.

2.14.2 Maslow's hierarchy theory or need for achievement theory

According to Maslow's hierarchy, human beings have four basic needs (physiological, safety and security, social/belonging, and self-esteem) that need to be satisfied before their experiencing a self-actualisation need. This theory classifies human needs in an ascending order. Therefore Maslow's' theory suggests that humans strive to satisfy their basic needs first before developing a desire to satisfy higher-level needs (Gambrel & Cianci, 2003:143). This theory can be applied to individuals (entrepreneurs) and universities that happen to be some of the key participants in the process of the creation and commercialisation of research output.

In applying this theory, one would note that entrepreneurs establish ventures to satisfy their individual needs – these needs may differ from one entrepreneur to the other. Hence, some entrepreneurs establish businesses to satisfy their basic needs: to buy food and pay rent. Others get into business because it is good for their self-esteem and to advance to the highest level of needs in the hierarchy (Carland et al., 1995:55).

[2] Oxenfeldt, A.R. 1943. *New firms and free enterprise: pre-war and post-war aspects*. Washington, DC: American Council on Public Affairs.

In line with the theory, one may argue that universities become involved in spin-off creations because there is a need to raise third-stream income. They are also driven by the need to meet government expectations, to create jobs, and to introduce new technologies to the market. Academics are motivated (pushed) by the university to be involved in entrepreneurship because humans have a need to succeed or to achieve (Simpeh, 2011:3).

2.14.3 Opportunity-based entrepreneurship theory

One such theory is that of opportunity based; the proponents of this theory believe that entrepreneurs' personality traits, social networks and prior knowledge are antecedents of entrepreneurial alertness to business opportunities (Ardchvili et al., 2003:106). Entrepreneurial |awareness in turn is an essential condition for success in opportunity |recognition}, identification, development and evaluation (Ardchvili et al., 2003:106). The |major factors that have |impact on the process of opportunity recognition and development leading to business formation include:

1. Entrepreneurial alertness
2. Information asymmetry and prior knowledge
3. Social networks
4. Personality traits, including optimism
5. Type of opportunity itself

There is a link between opportunity-based theory and the need for achievement, since an entrepreneur must have a need for achievement to be able to identify and take advantage of market opportunities; further, entrepreneurs are individuals who recognise opportunities where others see chaos (Kuratko, 2007:2).

Entrepreneurs are always looking for market opportunities by being innovative and looking at possible ways of changing the environment by taking risks (Simpeh, 2011:4).

2.14.4 Resource-based entrepreneurship theories

According to Alvares and Busenitz, 2001:756), most entrepreneurs start a new venture with their unique resources. This theory also links with the previous two theories (the need for achievement and opportunity-based theory), because the entrepreneur makes use of his resources once the market opportunity has been identified because of the need to achieve. The resource can be human, financial, or social capital. Davidsson and Honig (2003:305) and Kim et al. (2006:6) argue that human capital is a better resource than financial and social capital, since individuals' human capital abilities provide them with compelling intellectual and leadership abilities to become successful entrepreneurs.

2.14.5 Financial capital/liquidity theory

Starting a new venture without capital can be very challenging, according to Simpeh (2011:5). It's easier to have access to capital for a new venture if the entrepreneur has his or her own start-up capital. This theory supports the resource theory. Various scholars are in agreement that the possession of significant personal financial resources when starting a new venture will result in a greater chance of success (Holtz-Eakin, et al., 1994:73).

According to Markman and Baron (2003:282), entrepreneurship takes many forms and finance is just one of the resources. This does not dismiss the probability of starting a new venture without capital (Hurst & Lusardi, 2004, cited by Simpeh, 2011:5). This theory argues that having one's own financial capital or specific resources to start a new business makes it easy to identify market opportunities (Alvarez & Busenitz, 2001:756).

2.14.6 Social capital or social network theory

To network means to exchange valuable information in order to become a more competent entrepreneur (OECD, 2004:52). According to Simpeh (2011:5), entrepreneurship social networks make it easier for a nascent entrepreneur to identify and convert a business idea into a new business venture. Aldrich and Cliff (2003:589) and Kim et al. (2006:10) affirm that these networks enable entrepreneurs to forge collaborations with other entrepreneurs.

Policy makers must foster the network of associations and encourage co-operation and partnerships among national and international networks and facilitate entrepreneurial endeavours in the economy.

The following scholars (Aldrich & Cliff, 2003:589; Kim et al., 2006:10) argue parents (that are entrepreneurs) are more likely to have children that become entrepreneurs; these individuals usually build on their parents' social networks to become successful entrepreneurs. Cooper et al. (1994:377) furthermore agree that entrepreneurs are more likely to be successful because of their early exposure to business environments.

2.15 Summary

Entrepreneurship thrives in ecosystems in which multiple and diverse stakeholders play central roles. In particular, education should be better linked with practice to ensure that future skills match future jobs. Academia should be encouraged to reach out to the business community and integrate businesses into the learning process. Entrepreneurship is a powerful tool for business and achievement. Entrepreneurs' sense of opportunity, their drive to innovate, and their capacity for accomplishment, have become the standard by which free enterprises are now measured. The world has witnessed a significant revolution as far as entrepreneurship is concerned in the 21th century. Entrepreneurs will continue to be

significant contributors to economic growth through their management, competitiveness, research, innovation, leadership, research and development, effectiveness, job creation, productivity, and formation of new industries (Kuratko, 2007:3).

This chapter addressed both the literature study and theoretical review of the study that span the concepts and construct the applicability of the study. It succeeded in identifying the similarities and differences of opinion between each author (Birley & Moreland, 1998:95). Universities have also dramatically changed their policies, behaviour and cultures during the past 30 years to promote the creation of more university spin-offs. But we still do not know whether it is privately beneficial for academics to start new businesses.

The next chapter describes the research design and methodology used in the study to address the research objectives. This includes sampling, population, and data collection processes and instruments, as well as data analysis methods.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In the previous chapter an overview of the relevant literature was presented and discussed in an attempt to identify the research gap. This chapter focuses on the design of the research and the methodology used to collect and analyse the data. According to Maxwell (2005:2), the research design and methodology is the blueprint of scientific study and is a framework that is used to seek answers to the research questions (Maxwell, 2005:2).

Chapter 3 describes the research objectives, research questions, population, research technique, data collection tools, ethical considerations, delineation of the research, and significance of this study.

3.2 Research Design

This study is designed to explore the role played by academics and spin-off companies in the process of technology creation and commercialisation at CPUT. According to Welman and Kruger (2001:45), research design is a systematic plan to study a research problem. In educational research the terms ‘research design’ and ‘research methodology’ are commonly used interchangeably (Harwell, 2011:148). According to Creswell (2003:4), during the research design process there are four issues that a researcher needs to consider:

- Epistemology: This constitutes the theory of knowledge embedded in the theoretical perspective and it informs the research, for example, objectivism or subjectivism.
- Theoretical perspective: This is the philosophical theory underpinning the methodology in question, for example, positivism, post-positivism, interpretivism, critical theory, etc.
- Methodology: This includes the strategy or plan of action that links methods for outcomes, and also governs the choice and use of methods, for example, ethnography, survey research, experimental research, etc.
- Methods, procedures and techniques: These are linked to the methodology plan of action on the use of questionnaires, focus groups, interviews, etc.

3.3 Research methods

The study's research design is important because it communicates information about key features of the study that can differ for qualitative, quantitative and mixed methods (Birley & Moreland, 1998: 28-30).

The quantitative research technique was adopted in this study to explore the role played by academics and spin-off companies in the process of technology creation and commercialisation at CPUT. Quantitative research methods attempt to maximise objectivity, generalizability of findings, and are particularly pertinent to prediction (Harwell, 2011:148-151).

The researcher has chosen the case study methodology as advocated by Baxter and Jack (2008:544). It provides tools for researchers to study complex phenomena within their contexts using a variety of data sources. This ensures that the issue is not explored through one lens.

According to Yin (2003:1), a case study approach should be considered when the focus of the study is to answer 'how' and 'why' questions. A further advantage of this approach is that the researcher cannot manipulate the behaviour of respondents.

For this study the researcher selected a single case study approach since it was an appropriate means of obtaining maximum insight into the case.

3.4 Research objectives

The following objectives were formulated to guide the study:

3.4.1 Main research objective

- ***To examine the roles played by academics and spin-off companies in the process of technology transfer and commercialisation at CPUT.***

3.4.2 Sub-research objectives

To accelerate the accomplishment of the core research objectives, sub-objectives were formulated as follows:

- To identify the factors that motivate academics to become involved in entrepreneurial activities.
- To investigate the role that academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT.

- To ascertain the role that private companies play in the process of university technology transfer and commercialisation.
- To identify the role that spin-off companies play in the process of technology transfer and commercialisation.

3.5 Research questions

3.5.1 Main research question

The main question that this study sought to address was:

- What is the role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation at CPUT?

3.5.2 Research-sub questions

To simplify the processing of responses to the main research question that governs this study, sub-questions were formulated as follows:

- Why do academics become involved in entrepreneurial activities?
- What role can academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT?
- What role do private companies play in the process of technology transfer and commercialisation?
- What role can spin-off companies play in the process of technology transfer and commercialisation?

3.6 Population and sampling

According to Welman and Kruger (2001:46), a research population refers to the group or individuals on which the study is based. Goddard and Melville (2001) define a population as any group that is the subject of research interest. It is not practicable or possible to study an entire population; for this study it was not possible to send questionnaires to the entire CPUT academic body. It was necessary to create a sub-set of the population, known as sampling.

The population for this study comprised all active researchers from the Cape Peninsula University of Technology. Purposive sampling was conducted to select those researchers with university–industry projects. This was necessary for sampling, since not all CPUT academics have university–industry partnerships or have in the past been involved in a university–industry partnership.

As evident from this database, some academics have been active or non-active in terms of research, as evident in their research outputs–technology creation and transfer. A sample of 52 academics was drawn from the CPUT research database; of the 52 academics, 16 were active, 20 less active, and a further 16 did not respond.

The sample was captured in a Microsoft Excel spreadsheet containing the following fields: faculty, independent (not linked to faculty) research unit, title, surname, initials, name of industry partner, amount awarded by industry partner, and email address.

3.7 Data collection

According to Birley and Moreland (1998:40), data collection provides evidence that real research has occurred. Data collection is not just a process of collecting information; it is also a unique way of collecting information that is relevant to the research study. In the same vein, Goddard and Melville (2001:41) contend that for any research method to produce relevant data, that research method has to be able to measure data. Many scholars support two basic principles of data collection: researchers are advised to ensure that the data collection instrument is valid and reliable (Birley & Moreland, 1998, cited in Graham & Thomas, 2008:118).

'Valid' means the research must be cogent, well grounded, justifiable, and logically correct. For the data collection instrument to be reliable, the instrument used must be consistent and easy to measure (Goddard & Melville, 2001:41).

Electronic survey questionnaires were distributed by email to 52 academics for completion and 36 were returned fully completed. The researcher had to remind the respondents to complete the questionnaires. This delayed the completion of this study and a low response rate was obtained.

The researcher found the questionnaires user friendly. It was relatively easy to record all responses on Microsoft Excel spreadsheets. The questionnaire comprised five sections: Socio-Demographic Information; Employment and Work Situation; Self-efficacy; Beliefs and Opinions; Views and Experiences of Institutional Context; Information of Past; and lastly, Current Research Engagement & Behaviour.

Prior to data collection the questionnaire was tested on 10 CPUT academics with similar characteristics to the study sample (pilot study). Their feedback was used to make improvements to the questionnaire.

3.8 Ethical considerations

According to Goddard and Melville (2001:49), collecting data from people raises concerns. The researcher should avoid harming people, and should having due regard for their privacy, respecting them as individuals and not subjecting them to unnecessary research.

This study was approved by the Cape Peninsula University of Technology Higher Degrees Committee (HDC) and permission to access the CPUT research database to obtain possible participants for the research was granted. The CPUT Faculty of Business Research Ethics Committee approved the methodology and ethics. The research questionnaires were distributed only after all CPUT ethics approval had been granted and the research proposal had been ratified by the HDC (a committee of Senate). No harm to or victimisation of CPUT researchers occurred. Participation in this study was voluntary and participants were given the choice whether or not to participate. The purpose of the study was clearly articulated in the consent forms. All participants participated in this study willingly and were free to withdraw from the study at any time. The researcher treated the participants professionally and with confidentiality.

3.12 Delineation of the research

The study was carried out at the Cape Peninsula University of Technology and it focused on research academics from all faculties and research units with active university–research linkages from 2008 to 2012.

3.13 Significance of the research

The purpose of this study was to examine the role played by academics and spin-off companies in the process of technology transfer and commercialisation at CPUT. The significance of this study was to contribute to the emerging body of research in academic entrepreneurship.

3.14 Summary

This chapter outlined the research design and methodology used during the study to address the research objectives. These included sampling, population, the data collection process and instruments, as well as the data analysis methods. The next chapter focuses on data analysis and interpretation.

CHAPTER 4
PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Introduction

According to Birley and Moreland (1998:58), data analysis and interpretation is the real essence of research. The researcher used descriptive statistics to analyse the data, presented in this chapter by pie charts, tables and graphs.

This chapter focuses on the interpretation and analysis of data collected for this study. The purpose of this study was to explore the role played by academics and spin-offs companies in the process of technology creation and commercialisation at CPUT. A qualitative research technique was used to collect data for this study and survey questionnaires were used. The researcher adapted questionnaires from University of Minnesota, Harvard University (n.d.), the University of Calgary (2013) and Holmes-Watts (2012).

4.2 Research objectives:

Drawing on the research questions that this study sought to answer, the following objectives were formulated to guide the study:

4.2.1 Primary objective

The primary objective of this study was to examine the role played by academics and spin-off companies in the process of technology transfer and commercialisation at CPUT.

4.2.2 Secondary objectives

To accelerate the accomplishment of the core research objective, sub-objectives were formulated as follows:

- To identify the factors which motivate academics to become involved in entrepreneurial activities.
- To identify the role that academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT.
- To identify the role that private companies play in the process of university technology transfer and commercialisation.

- To identify the role that spin-off companies play in the process of technology transfer and commercialisation.

4.3 Sampling strategy

Internal research records from 2008 to 2013 were utilised to establish a database for the study. The database contains the names of academics that had university–industry research projects from 2008–2013. The established database comprised academics that had been active and those that were non-active in terms of research as evident in their research outputs and technology creation and transfer. A total of 52 academics were drawn from the database. Of the 52 academics, 16 had been active and 20 less active; the remaining 16 were non-responsive.

A guide on how to complete the questionnaire was provided. Electronic survey questionnaires were distributed to all 52 academics for completion and 36 were returned fully completed. The researcher had to remind the respondents to complete the questionnaires; this delayed the completion of this study and a low response rate was obtained.

Table 4.1: Response rate

Sample	Total	Percentage (%)
Non-responsive	16	30
Final sample	36	70
Original sample	52	100

The SPSS version 22 program was used to analyse the data. SPSS is software for performing statistical procedures in the social sciences. Validity tests and reliability tests were performed and are presented below.

4.4 Sections of the questionnaire

The questionnaire was divided into five sections:

- Section One: Socio-Demographic Information
- Section Two: Employment and Work Situation
- Section Three: Self-efficacy, Beliefs and Opinions
- Section Four: Views on and Experiences of Academic Entrepreneurship at CPUT

- Section Five: Information on Past and Current Research Engagement & Behaviour

4.4.1 Section One: Demographic Statistics:

This section provided an overview of the demographic profile of the respondents. This information was very important, as the researcher could draw a profile of respondents' individual characteristics.

4.4.1.1 Nationality of the respondents

The following figure indicates that 78% of respondents are South African and 22% are non-South African.

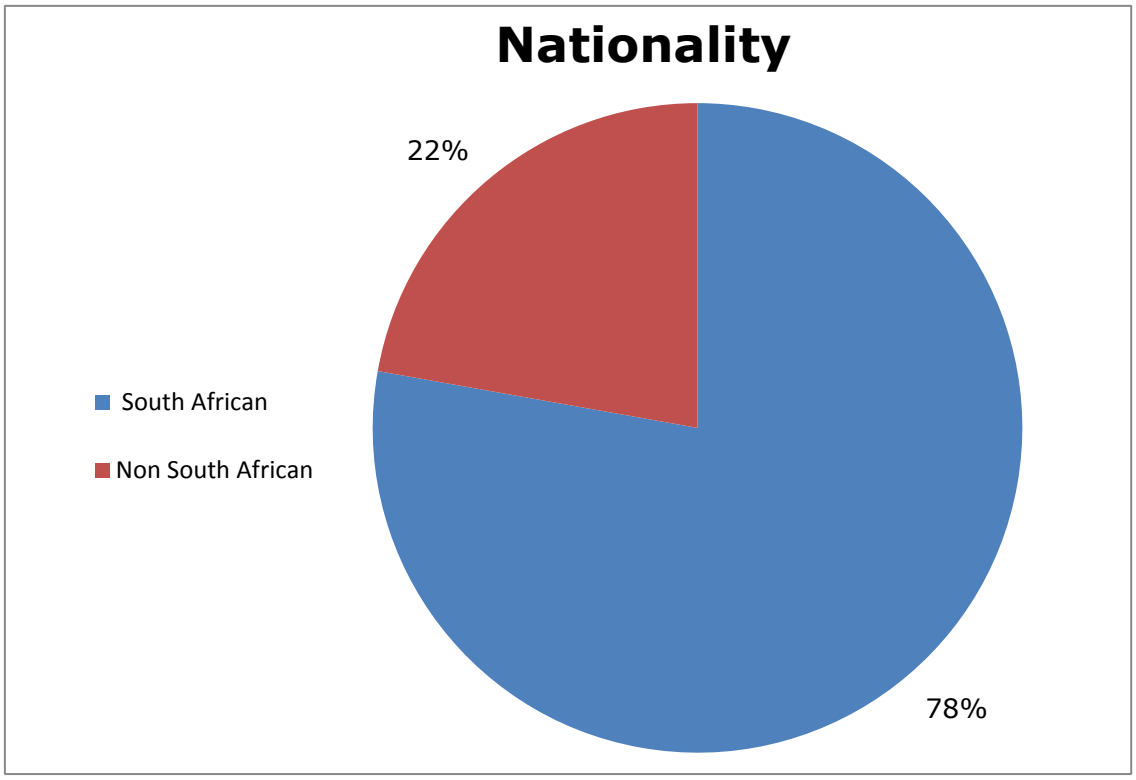

Figure 4.1: Nationality distribution of sample

4.4.2 Country of origin

The following table (Table 4.2) outlines the nationalities of non-South Africans who participated in the study. It is interesting to note that the majority (67%) of the non-South African respondents are Nigerians. This is closely followed by Cameroonians (2.8%) and Zimbabweans (2.8%). It is worth noting that these results do not portray the whole picture, given that 83% of the respondents did not indicate their nationalities.

Table 4.2: Frequency distribution of respondents' country of origin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cameroon	1	2.8	16.7	16.7
	Nigeria	4	11.1	66.7	83.3
	Zimbabwe	1	2.8	16.7	100.0
	Total	6	16.7	100.0	
Missing		30	83.3		
Total		**36**	**100.0**		

4.4.3 Gender

Figure 4.2 indicates there were 39% female respondents and 61% male respondents. In total 36 people responded. As the figure clearly shows, there is an imbalance between female and male respondents. Men are by far in the majority (61%).

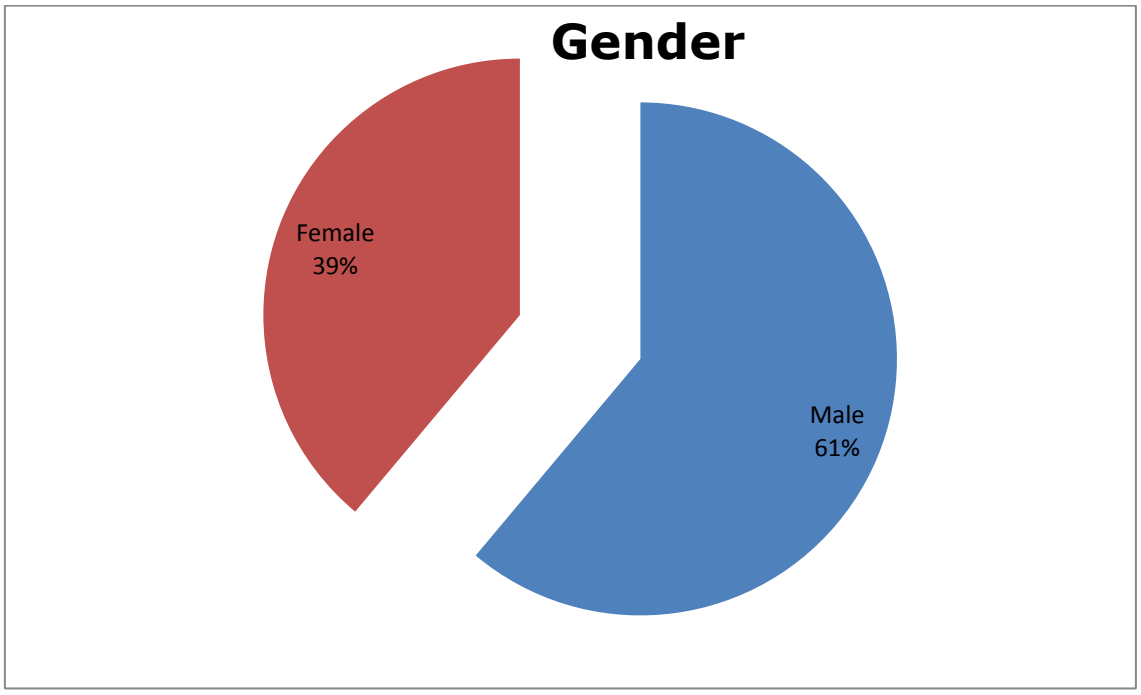

Figure 4.2: Gender presentation of respondents

4.4.4 Ethnicity of respondents

It is customary for studies to include an element to measure the ethnicity of the participants and this is particularly true for South African studies. Table 4.3 indicates that 41.7% of the respondents were white; 38.9% were black; 8.3% were coloured; and 8.3% were Indian – 2.8% preferred not to answer this question.

Table 4.3: Frequency distribution of respondents' ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	African	14	38.9	38.9	38.9
	Coloured	3	8.3	8.3	47.2
	Indian	3	8.3	8.3	55.6
	White	15	41.7	41.7	97.2
	Prefer not to answer	1	2.8	2.8	100.0
	Total	**36**	**100.0**	**100.0**	

4.5 Section Two: Employment and Work Situation:

This section reported on the respondents' current employment situation and personal professional work history. It is believed that such information may provide vital insights into the respondents' research and entrepreneurial inclinations. The 36 participants drawn for the study came from six faculties and one non-categorised unit made of assorted academic and non-academic departments grouped as 'other'.

4.5.1 Faculty of employment

As noted in Table 4.4, the most represented faculties were Applied Sciences (25%); Engineering (25%); Business (16, 7%) and the non-faculty group (13.9%). At first glance this may be an indication of the research activity levels of these faculties.

Table 4.4: Frequency distribution of respondents' faculty employment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Applied Sciences	9	25.0	25.0	25.0
	Business and Management Sciences	6	16.7	16.7	86.1
	Education	3	8.3	8.3	33.3
	Engineering	9	25.0	25.0	58.3
	Health & Wellness Sciences	2	5.6	5.6	63.9
	Informatics & Design	2	5.6	5.6	69.4
	Other	5	13.9	13.9	100.0
	Total	**36**	**100.0**	**100.0**	

4.5.2 Current professional rank

In an attempt to understand the relationship between rank and research/entrepreneurial activity, Table 4.5 reports on the professional rank of the respondents. The results (Table 4.5) indicate that a considerable proportion of the sample comprised associate professors (25%), followed by senior lecturers (19.4%), lecturers (19.4%), full professors (13.9%), and junior lecturers (2.8%).

Table 4.5: Frequency distribution of respondents' professional rank

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Junior lecturer	1	2.8	2.8	2.8
	Lecturer	7	19.4	19.4	22.2
	Sen. Lecturer	7	19.4	19.4	41.7
	Ass professor	9	25.0	25.0	66.7
	Full professor	5	13.9	13.9	80.6
	Other	7	19.4	19.4	100.0
	Total	**36**	**100.0**	**100.0**	

4.5.3 Employment status

With the understanding that the employment status of an academic may impact on his or her research and entrepreneurial activities, Table 4.6 reports on the employment status of the sample. The results indicate that the majority (80.6%) of the staff members were full-time employees, while 19.4% were on contract.

Table 4.6: Frequency distribution of respondents' employment status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Full time	29	80.6	80.6	80.6
	Contract	7	19.4	19.4	100.0
	Total	**36**	**100.0**	**100.0**	

4.5.4 Work responsibilities

In terms of the work responsibilities of the respondents, 77.8% (see Table 4.7) of respondents have both research and teaching responsibilities at CPUT.

Table 4.7: Frequency distribution of respondents' work responsibility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Only research	8	22.2	22.2	22.2
	Both teaching and research	28	77.8	77.8	100.0
	Total	36	100.0	100.0	

In summary, Section Two indicated very interesting results. Associate professors constitute the largest group, while the majority of respondents are from the faculties of Engineering (25%) and Applied Sciences (25%). The number of respondents from units not affiliated to faculties is higher than for faculties, and 81% of the respondents are full-time employees of CPUT. Units independent of faculties have more active researchers than faculties. In respect of work responsibilities, 77.8% of respondents have both research and teaching responsibilities at CPUT.

4.6 Section Three: Self-Efficacy, Beliefs and Opinions:

In this section, the researcher attempted to elicit information on how the respondents see themselves and how they perceive research activity. This information is very important, as insight is gained from the individual instructional staff responses.

4.6.1 Interest in academic entrepreneurship

Respondents were asked to rate their interest in academic entrepreneurship. The results displayed in Figure 4.3 indicate that 91% were highly interested while 9% were not interested.

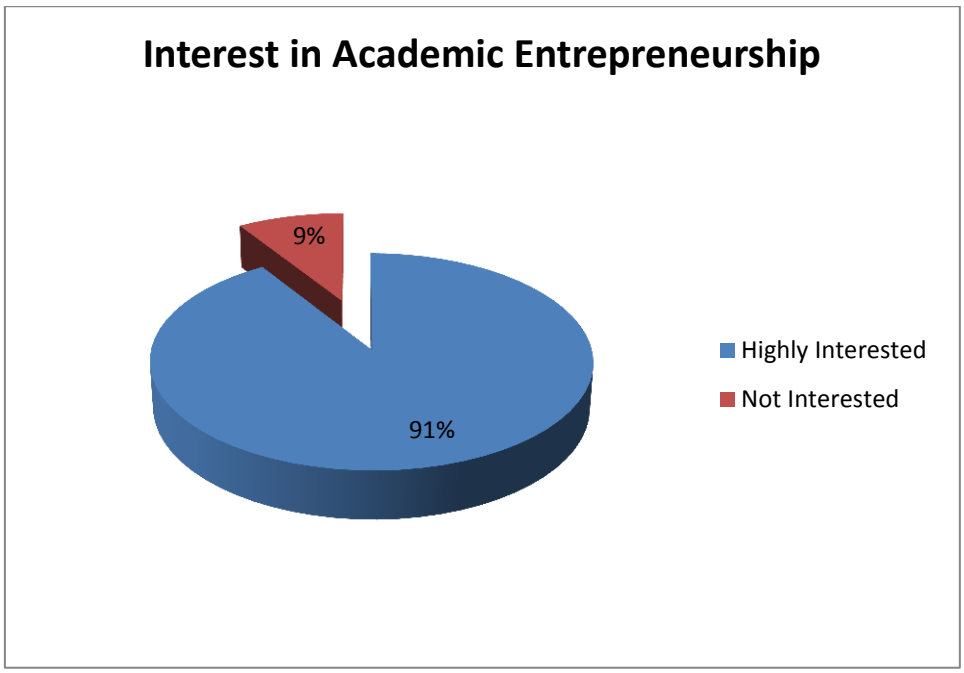

Figure 4.3: Interest in Academic Entrepreneurship

4.6.2 University–industry linkages

The aim of this question was to gauge involvement in university–industry linkages. In Figure 4.4, 78% of the respondents indicated that they were involved in university–industry linkages and only 22% of the respondents had never been involved in any university–industry linkages.

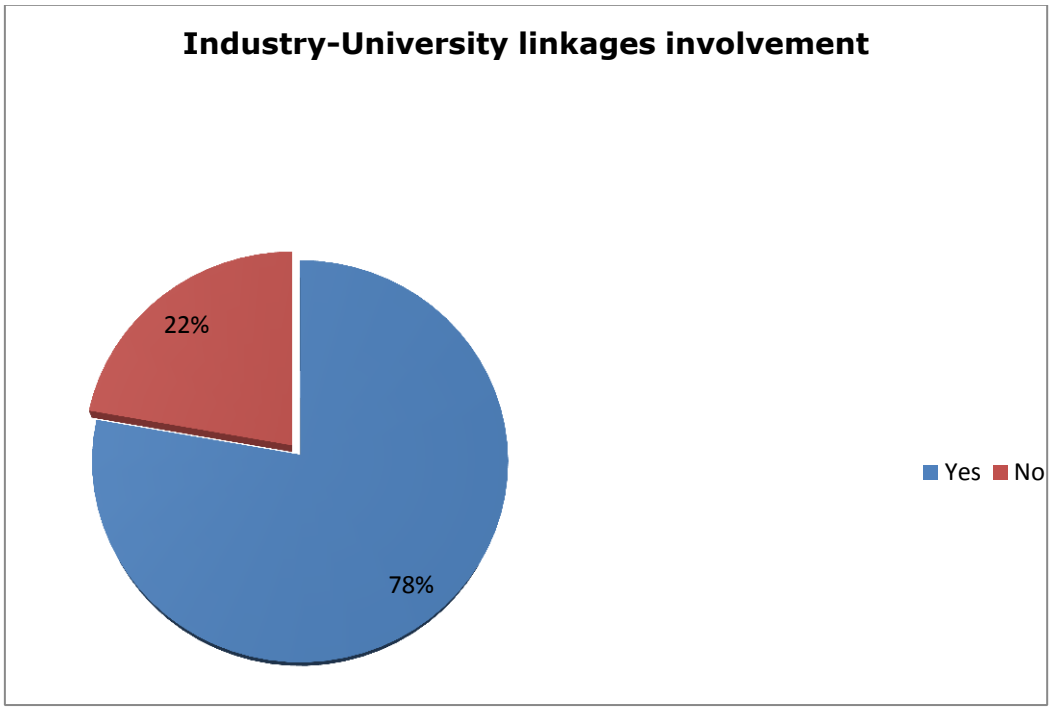

Figure 4.4: University –Industry linkage involvement

These results, together with the following, tend to align with the literature that suggests that academics become involved in technology transfer to further their research, rather than for commercialisation (D'Este & Perkmann, 2010:3). In the context of CPUT this is particularly relevant, given that research happens to be one of the three highly promoted core mandates of the university (that is, research, teaching and learning, and community engagement).

4.6.3 University–industry partnerships

The participants were asked to rate the importance of university–industry partnerships. The results (Table 4.8) indicate that 91.7% of the respondents indicated industry–university partnerships to be highly important. Approximately 3% of the respondents did not see the importance of university–industry partnerships, while 5.6% of the respondents rated industry–university partnerships as moderately important. These results concur with the research findings of Bammer (2008:875) as they support the need for collaboration between relevant stakeholders.

Table 4.8: Frequency distribution of respondent on importance of university-industry partnerships

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	2.8	2.8	2.8
	3	2	5.6	5.6	8.3
	High importance	33	91.7	91.7	100.0
	Total	**36**	**100.0**	**100.0**	

4.6.4 Technology transfer skills

This question was asked to gauge the participants' technology transfer skills. The results displayed in Table 4.9 indicate that 80.6% of respondents considered themselves skilled enough to excel in technology transfer, while 16.6% of respondents considered themselves insufficiently skilled; 2.8% did not respond.

Table 4.9: Frequency distribution of respondent's technology transfer skills

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not skilled enough	3	8.3	8.3	8.3
	2	3	8.3	8.3	16.7
	3	10	27.8	27.8	44.4
	Skilled enough	19	52.8	52.8	97.2
	22	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

4.6.5 Academic entrepreneurial culture

The respondents were asked to state the academic entrepreneurial culture in their faculties. According to the results reflected in Table 4.10 below, 11% of respondents indicated that their faculties had a high academic entrepreneurship culture, 50% of respondents stated that their faculties had a semi- or moderate academic entrepreneurship culture, and approximately 39% of respondents indicated that their faculties had a weak academic entrepreneurial culture. On the basis of these results combined (61%), one may suggest that there is a positive attitude towards entrepreneurship.

Table 4.10: Respondents' academic entrepreneurial culture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Weak culture	7	19.4	19.4	19.4
	2	7	19.4	19.4	38.9
	3	18	50.0	50.0	88.9
	High culture	4	11.1	11.1	100.0
	Total	36	100.0	100.0	

4.6.6 Innovative products produced

In this section the respondents were asked to disclose if they had produced any innovative products. As noted in Table 4.11 below, approximately 47% of respondents indicated that they had produced innovative products, while 53% indicated that they had never produced any innovative products.

Table 4.11: Production of innovative products

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	47.2	47.2	47.2
	No	19	52.8	52.8	100.0
	Total	36	100.0	100.0	

4.6.7 Influences on producing an innovative product

The respondents were asked to state the factors that had influenced them to produce innovative products. According to the results displayed in Table 4.12, the majority of the respondents (47.2%) indicated that they were not that much influenced by the availability of funding to produce an innovative product, while 27.8% of respondents indicated that they had been highly influenced by the availability of funding in the past five years, and approximately 16.7% of respondents indicated that availability of funding had very little influence.

Table 4.12: Availability of funding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	4	11.1	12.1	12.1
	2	2	5.6	6.1	18.2
	3	17	47.2	51.5	69.7
	High influence	10	27.8	30.3	100.0
	Total	33	91.7	100.0	
Missing	System	3	8.3		
Total		36	100.0		

4.6.8 Private company

The respondents were asked to indicate how private companies had influenced them to produce innovative products. According to the results displayed in Table 4.13, the highest number of respondents (52.8%) indicated that they had been highly influenced by private companies during the past five years to produce an innovative product, while 38.9% of

respondents indicated that private companies had had a low influence on them in the past five years.

Table 4.13: Private company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	11	30.6	33.3	33.3
	2	3	8.3	9.1	42.4
	3	15	41.7	45.5	87.9
	High influence	4	11.1	12.1	100.0
	Total	33	91.7	100.0	
Missing	System	3	8.3		
Total		36	100.0		

4.6.9 Technology Transfer office (TTO)

The respondents were asked to indicate how the university TTO had influenced them to produce innovative products. According to the results displayed in Table 4.14, 33.4% of respondents indicated that they had been highly influenced by the university TTO during the past five years to produce an innovative product, while 33.3% of respondents indicated that private companies had had a low influence on them in the past five years. These are very interesting results because there is only a 0.1 difference between those respondents that were influenced by the TTO compared with those who were not influenced by the TTO.

Table 4.14: Technology Transfer Office

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	9	25.0	37.5	37.5
	2	3	8.3	12.5	50.0
	3	2	5.6	8.3	58.3
	High influence	10	27.8	41.7	100.0
	Total	24	66.7	100.0	
Missing	System	12	33.3		
Total		36	100.0		

4.6.10 Personal passion for innovation

The respondents were asked to indicate whether personal passion had influenced them to produce innovative products. According to the results displayed in Table 4.15, a notable proportion (61.1%) of the respondents indicated that they were highly influenced by personal passion to produce an innovative product, while 13.9% respondents indicated that personal passion had had a low influence on them in the past five years.

Table 4.15: Personal passion for innovation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	5	13.9	18.5	18.5
	3	4	11.1	14.8	33.3
	High influence	18	50.0	66.7	100.0
	Total	27	75.0	100.0	
Missing	System	9	25.0		
Total		36	100.0		

4.6.11 Faculty commercialisation culture

In this section the participants were asked to indicate the influence of a faculty commercialisation culture. The results in Figure 4.5 show that 66% of respondents indicated a low faculty commercialisation culture, and 15% of respondents indicated a high faculty commercialisation culture, while 19% of respondents indicated that their production of innovative products was semi- or moderately influenced by the faculty commercialisation culture.

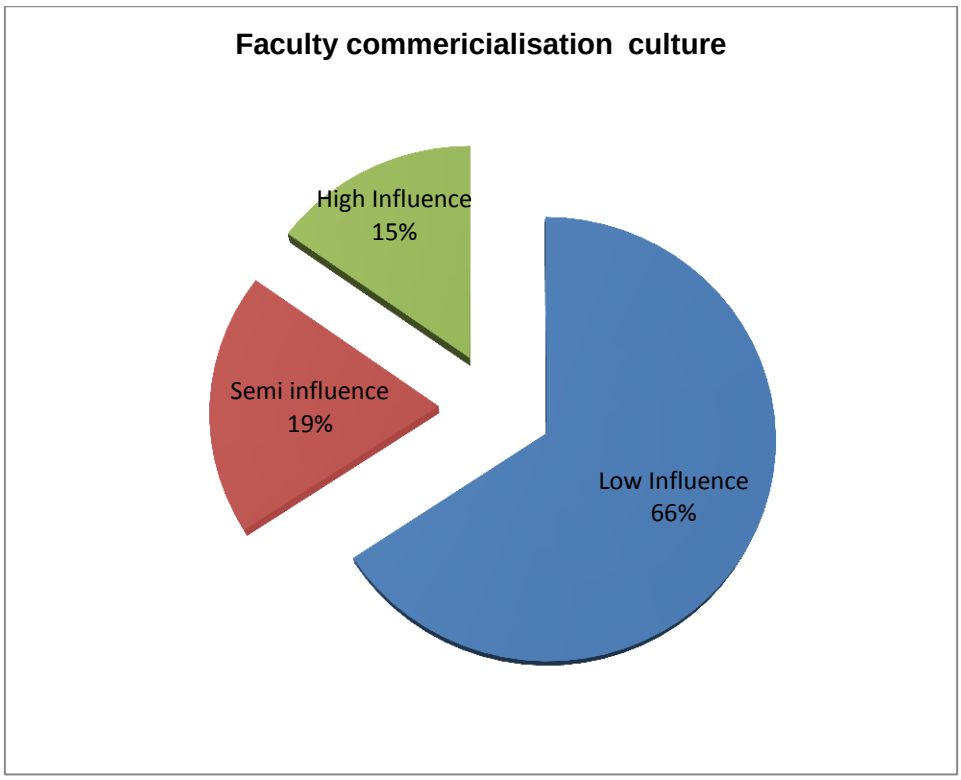

Figure 4.5: Faculty commercialisation culture

4.6.12 Entrepreneurial culture's influence on production of innovative product

Respondents were requested to respond to a question probing how their faculty entrepreneurial culture influenced their production of an innovative product. The results are displayed in Table 4.16. Only 19.4% reported a strong faculty entrepreneurial culture; the other 19.4% indicated a semi-strong faculty entrepreneurial culture, while 8.3% of respondents reported a very low faculty entrepreneurial culture. Combining these results (38.8%), one would suggest that the entrepreneurial culture at CPUT is not a very positive one.

Table 4.16: The influence of faculty entrepreneurial culture on respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	3	8.3	13.6	13.6
	2	5	13.9	22.7	36.4
	3	7	19.4	31.8	68.2
	High influence	7	19.4	31.8	100.0
	Total	22	61.1	100.0	
Missing	System	14	38.9		
Total		36	100.0		

4.7 Section Four: Views on and experiences of academic entrepreneurship at CPUT

This section of the results focuses on respondents' views on and experiences of academic entrepreneurship at CPUT.

4.7.1 Faculty academic entrepreneurship

In this section the respondents were asked questions within the CPUT context on the importance of faculty academic entrepreneurship. Results as reflected in Table 4.17 indicated that approximately 53% of respondents agreed that a strong record of successful academic entrepreneurship activity was important in faculty evaluation at CPUT; approximately 33% of respondents disagreed, while approximately 14% respondents were unsure.

Table 4.17: Faculty academic entrepreneurship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	7	19.4	19.4	19.4
	Agree	12	33.3	33.3	52.8
	Neutral	5	13.9	13.9	66.7
	Disagree	11	30.6	30.6	97.2
	Strongly Disagree	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

4.7.2 Commercialisation training opportunities

This question wanted to test whether CPUT has commercialisation training. The results displayed in Figure 4.6 show that 41.7% of respondents indicated that CPUT hardly ever offered commercialisation training opportunities; 33.3% indicated that CPUT sometimes offered commercialisation training; a small percentage of 5.6% of respondents indicated that CPUT constantly offered this kind of training; while 16.7% of respondents indicated that CPUT did not offer commercialisation training. A low percentage (2.8%) could not answer this question.

Figure 4.6: Commercialisation training opportunities

4.7.3 Academic entrepreneurship training opportunities

The respondents were asked to state the academic entrepreneurship training opportunities at CPUT. Results are displayed in Figure 4.7, indicated that 47% of respondents felt that CPUT hardly ever offered academic entrepreneurship training, 22% indicated that CPUT never offered training 22.2% indicated sometimes, 2.8% responded that CPUT seldom offered training for academic entrepreneurship, while 5.6% of the respondents indicated that CPUT constantly provided academic entrepreneurship training.

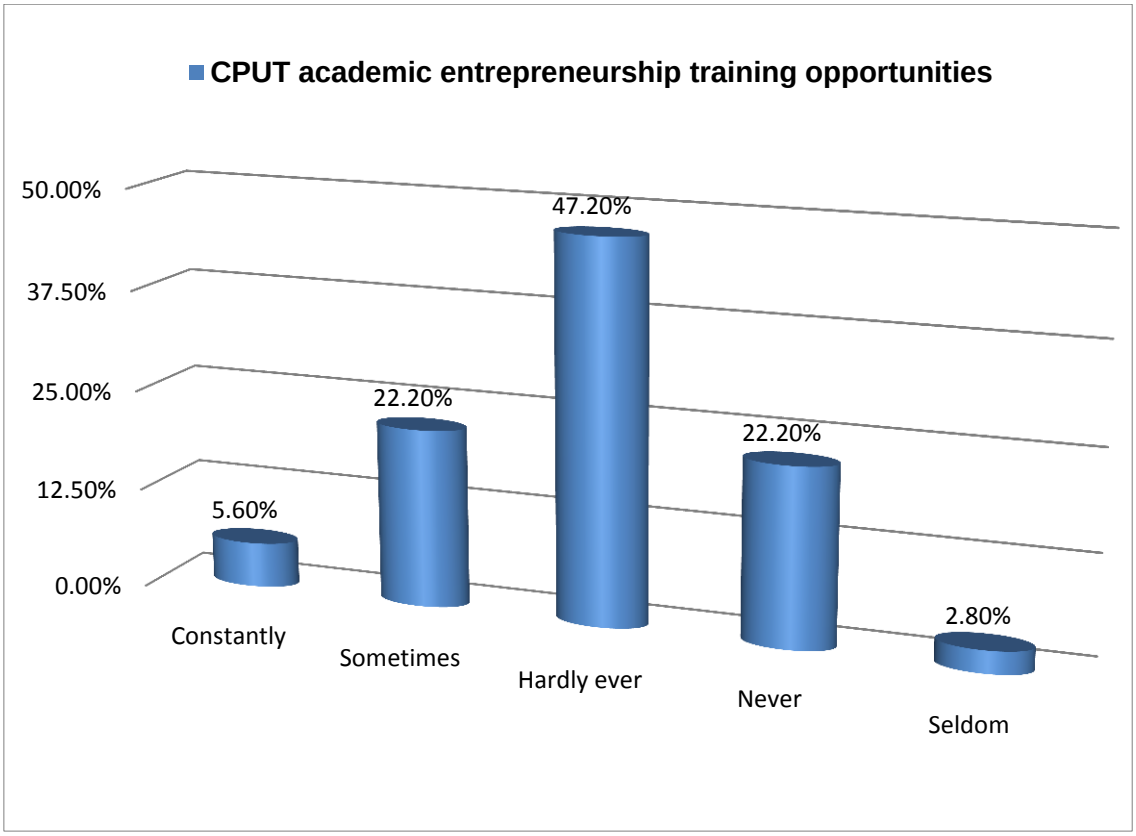

Figure 4.7: CPUT academic entrepreneurship training opportunities

4.7.4 Financial support to participate in commercialisation

In this section the respondents were asked to state if they knew about CPUT financial support for commercialisation. According to Table 4.18, 47.2% of respondents acknowledged that CPUT provided financial support to participate in commercialisation, while 50% did not know if CPUT provided financial support to participate in commercialisation.

Table 4.18: Financial support to participate in commercialisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	47.2	48.6	48.6
	No	3	8.3	8.6	57.1
	Don't know	15	41.7	42.9	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		**36**	**100.0**		

4.7.5 Funding opportunities for university-industry research projects

The respondents were asked to state whether CPUT offered funding support for university–industry research projects. Results as reflected in Table 4.19, indicate that 66.7% of respondents confirmed that CPUT did provide opportunities for CPUT staff to participate in university–industry linkages, while approximately 22.2% did not know, 8.3% disagreed and 2.8% did not answer the question.

Table 4.19: University–industry funding opportunities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	66.7	68.6	68.6
	No	3	8.3	8.6	77.1
	Don't know	8	22.2	22.9	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		**36**	**100.0**		

4.8 Section Five: Information on Past and Current Research Engagements & Behaviour:

In an attempt to understand whether there is a correlation between previous activity and current research engagement and behaviour, questions were posed on whether respondents had received research grants and the source of such grants in the last five years.

The results presented below (Table 4.20) indicate that while an overwhelming majority (94.4%) were grant recipients with grants carried over from their previous employment, a less significant proportion (5.6%) indicated the contrary.

Table 4.20: Grant recipients and previous employment (university)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	94.4	94.4	94.4
	No	2	5.6	5.6	100.0
	Total	**36**	**100.0**	**100.0**	

The researcher being cognisant that government grants are instrumental in promoting research activities and subsequent commercialisation, respondents were asked if they had been recipients of government grants currently or in the past. To some extent, this gives a broad impression of how supportive the South African government is towards research and its commercialisation. While a slight majority (58.3%) noted that they were recipients of government grants, the remainder (41.7%) indicated otherwise (see Table 4.21).

Table 4.21: Funding from government entities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	58.3	58.3	58.3
	No	15	41.7	41.7	100.0
	Total	**36**	**100.0**	**100.0**	

Since businesses have an interest in university research and commercialisation in different forms (not limited to providing funds), the research sought to investigate whether the recipients had been beneficiaries of such benevolence. The results (Table 4.22) indicate that an overwhelming majority (75%) of the respondents had not received any funding from business at the time of the interview. The results however acknowledge the fact that 25% of the respondents had received funding from business.

Table 4.22: Funding from business firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	25.0	25.0	25.0
	No	27	75.0	75.0	100.0
	Total	**36**	**100.0**	**100.0**	

In an attempt to investigate the extent to which private foundations promoted research and commercialisation at CPUT, respondents were requested to indicate whether they were recipients of such support. The results in Table 4.23 indicate that the majority (83.3%) of the respondents had not received any funding from private foundations in the last five years. Only 16.7% acknowledged receiving funding from private foundations.

Table 4.23: Funding from private foundations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	16.7	16.7	16.7
	No	30	83.3	83.3	100.0
	Total	36	100.0	100.0	

The results presented in Table 4.24 indicate that 63.9% of respondents had not received international research grants in the past five years. Only 36.1% of respondents had research engagements or received international research grants during the past five years.

Table 4.24: International organisations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	36.1	36.1	36.1
	No	23	63.9	63.9	100.0
	Total	**36**	**100.0**	**100.0**	

As shown in Table 4.25, the respondents were asked if they had any professional linkages with industry. The majority (75%) of respondents confirmed that they did have such linkages, while the minority (25%) had not had any professional linkages in the past five years. University–industry linkages are very important for research, innovation, spin-offs, etc.

Table 4.25: Professional contacts with private companies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	27	75.0	75.0	75.0
	No	9	25.0	25.0	100.0
	Total	**36**	**100.0**	**100.0**	

According to Thune (2007:158), in recent R&D and innovation policies, most industrialised countries like South Africa put strong emphasis on interaction between universities and industry. This is seen as a strategy to strengthen innovation throughout the economy by increasing the flow of knowledge across sectors and stimulating industrial R&D investments.

4.9 Conclusion

This chapter presented the research findings. The primary objectives and sub-objectives were revisited. The data obtained from questionnaires was analysed, the methods used to analyse the data were explained, and conclusions were drawn. The aim of this empirical research was to examine the role played by academics and spin-off companies through the process of technology transfer and commercialisation at CPUT. The next chapter discusses the conclusions, limitations of the research, and recommendations.

CHAPTER 5
KEY FINDINGS, RECOMMENDATIONS AND LIMITATIONS

5.1 Introduction

In Chapter 4, the results were presented and discussed. This chapter begins with a recapitulation of the research questions and the presentation of key results. This is followed by the presentation of limitations, conclusions and recommendations of the empirical research.

5.2 Research questions:

The following questions provided a focus for this research study:

5.2.1 Main question:

The main question that this study sought to address was:

- What is the role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation at CPUT?

5.2.2 Research sub-questions:

- Why do academics become involved in entrepreneurial activities?
- What role can academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT?
- What role do private companies play in the process of technology transfer and commercialisation?
- What role can spin-off companies play in the process of technology transfer and commercialisation?

5.3 Key findings:

The findings were analysed in accordance with the above research questions, to identify the role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation at CPUT.

5.3.1 The factors that motivate academics to become involved in entrepreneurial activities:

It has become important for universities to pay greater attention to identifying ways of creating wealth (Wright et al., 2004:235). In the past ten years, interest in academic entrepreneurship and the establishment of university spin-off companies has grown in South Africa.

While noting in the literature on academic entrepreneurship that there are factors that push or pull academics (Smilor et al., 1990:63) into entrepreneurial activities, the researcher designed questions to capture these factors in the context of CPUT. Combinations of questions were thus geared towards accomplishing this task. The results noted that pull factors tend to influence the entrepreneurial activities of academics at CPUT more than push factors. For instance, it was noted that:

- Approximately 91% (Figure 4.3) of the respondents were highly interested in academic entrepreneurship while only 9% were not.
- The culture of entrepreneurship within faculties (see Table 4.10) also influenced others in engaging with entrepreneurial activities. Faculties with a higher culture of entrepreneurship saw more academics engaging with entrepreneurial activities. It is worth noting that the entrepreneurship culture at CPUT is weak. As Kirby (2006:599) notes, most academics view their roles as teachers and researchers, and not as entrepreneurs.
- University support for entrepreneurial activities was also instrumental in shaping and influencing entrepreneurial intentions. Funding, for instance, the availability of funding (see Table 4.12) was noted to exert a positive impact on entrepreneurial intentions.
- Passion for research (see Table 4.15).

5.3.2 The role that academic entrepreneurs play in the process of technology transfer and commercialisation at CPUT:

According to Wood (2011:160), academic entrepreneurship involves the contribution, interaction, participation and collaboration of a number of parties not limited to academics. In fact, it involves a number of stakeholders and different activities that involve the TTO, faculty stakeholders, funding agency, industry, and other university stakeholders.

The study revealed that academics are the key players in the process of technology transfer, given that they initiate the process by turning ideas into innovative products that can be marketed. Passion (see Table 4.15) and faculty entrepreneurial role models (see Figure 4.5, Table 4.9, 4.10 and Table 4.16) are important determinants and drivers of this process.

Faculty academic entrepreneurs are very influential at faculty level because they provide postgraduate students and other researchers with information on how to start spin-offs and how to find venture capital.

Furthermore, academics initiate and maintain collaborations with private companies involved in the commercialisation activities. Academics also become immersed in the process of technology transfer and commercialisation through spin-off companies.

These results are further corroborated by the literature. For instance, Owen-Smith and Powell (2001:99-114) note that becoming an entrepreneurial university requires the participation and commitment of all faculties, with the entire technology transfer process predicated on individual faculty members revealing their inventions to the university. According to Lockett et al. (2003:186), the academic may run the spin-off company parallel with his/her academic duties because the involvement of the inventor may add positive value and knowledge to the technology. Furthermore, university professors can be considered as key persons in the transfer of technology and research-based know-how from the university setting to private enterprise.

5.3.3 The role that private companies play in the process of university technology transfer and commercialisation:

- It was noted that most active researchers and innovators were involved in one form of university–industry collaboration or another (see Table 4.8).
- It was noted that the private companies have a vital role to play as far as the process of technology and commercialisation is concerned. An overwhelming majority of the participants (91.7%) reiterated the importance of university–industry partnerships in the transfer and commercialisation of inventions. Furthermore, respondents were asked to indicate how private companies had influenced them to produce innovative products in the past five years. Further highlighting the importance of private companies, the results (Table 4.13) indicated that 52.8% respondents were highly influenced by private companies during the past five years to produce an innovative product.

Ssebuwufu at al. (2012:5) noted that the perceived benefits of university–industry collaboration include: providing alternative funding channels in an era of constrained financing; access to/acquisition of state-of-the-art equipment; improved curricula and training in technology-oriented programmes and problem solving; enhanced employment prospects for students; supplemental income for academic staff; and clearer contribution of universities to the economy.

5.3.4 The role that spin-off companies play in the process of technology transfer and commercialisation:

The study participants were asked to indicate the influence of faculty commercialisation culture. The results in Figure 4.5 show that 66% of respondents indicated that their production of innovative products was influenced by a low faculty commercialisation culture, while 15% respondents indicated the high influence of a commercialisation faculty culture.

Drawing on these findings, it was noted that CPUT has a low culture and lack of training in one of the contributing factors. According to the results reflected in Figure 4.6, a significant proportion of the respondents (41.7%) indicated that CPUT seldom offers training opportunities for commercialisation. This was followed by 16.7% that noted CPUT never organises training opportunities. These results support the views of Gabrielsson et al. (2012:214) that there is a high expectation of universities to support commercialisation. Marimuthu et al. (2009:266) emphasise that the need to continuously develop people cannot be overstated, especially when it comes to the improvement of employees' knowledge, skills, and abilities.

5.4 Recommendations

Entrepreneurship education for all programmes should increase the entrepreneurship culture at all levels and should assist in improving the entrepreneurship culture in all faculties. CPUT should thus play an active role by instilling a greater entrepreneurial spirit among its students. CPUT should also strive to consider carefully local developmental needs and support the promotion of entrepreneurial education initiatives. This should occur at the tertiary level but could also be inculcated at the primary school level. According to Nicolaides (2011:1045-1046), the South African government should encourage such initiatives, promote a holistic education at all levels, and help to establish entrepreneurial ventures.

The cultural mind-set with regards to entrepreneurship in any region needs to be taken into consideration and the conditions that impact on entrepreneurship as a career choice should be cautiously analysed. In this regard, the "spatial and cultural proximity" between those that create knowledge and those who utilise it is particularly salient (Koschatzky, 2001,cited in Nicolaides, 2011:1046).

CPUT has to encourage academics to establish start-ups, and the university should provide incentives. According to the survey results, 33% of respondents disagree that faculty academic entrepreneurship is important, while 14% did not respond. It is clear that faculty education on the importance of academic entrepreneurship is needed. The respondents were asked also to state the commercialisation training opportunities at CPUT; 41.7% of respondents indicated that there is seldom any training.

According to Ilie (2010:63-72), education is the key factor because if people are not educated, it will be impossible to sustain progress. There should be greater emphasis on the importance of entrepreneurship, commercialisation, university–industry partnerships, spin-off creations, and technology transfer.

5.5 Limitations of the research:

The first challenge had to do with the perceived low entrepreneurship culture at CPUT, which made the potential participants reluctant to participate in the study given their views of academic entrepreneurship as unimportant.

The second challenge was that of the time frame, as CPUT academics have very busy work schedules. The researcher had to send reminders regularly and the deadline for the survey had to be extended. Notwithstanding this constraint, the researcher achieved a 70% response rate.

The last challenge had to do with private companies that have partnerships with CPUT researchers, as their contact details were not made available to the researcher. Thus, the researcher was unable to interview or survey the industry partners. However information about industry–university partnerships was elicited from CPUT researchers themselves.

5.6 Suggestions for further research areas:

This study has revealed areas that need further research in the field of academic entrepreneurship:

- An evaluation of the faculty entrepreneurship culture at CPUT.
- A further comparative study of all CPUT faculties' culture: academic entrepreneurship, commercialisation, technology transfer, and creation of spin-offs.
- Training in academic entrepreneurship, commercialisation, technology transfer, and spin-off creation.
- An assessment of the benefits of offering entrepreneurship as a compulsory module for all university programmes, as supported by Nicolaides (2011:1048):

> Entrepreneurship gives students a new way of looking at the world, irrespective of whether or not they opt to develop their own enterprises. New business start-up activity is probably one of the most important social activities for countries around the world.

- An investigation into whether academic entrepreneurship is profitable.

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Appendices

Appendix A: Ethics clearance

P.O. Box 1906 • Bellville 7535 South Africa •Tel: +27 21 4603239 • Email: zouityf@cput.ac.za
Symphony Road Bellville 7535

Office of the Chairperson Research Ethics Committee	**Faculty:** **BUSINESS**

At a meeting of the Research Ethics Committee on 18 September 2013**, Ethics Approval was granted to** RORWANA, Amelia Vuyokazi (193038994) **for research activities Related to the MTech/DTech:** MTech: Business Administration **at the**
Cape Peninsula University of Technology.

Title of dissertation/thesis:	**The role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation in South Africa: A case of a university of technology** **Supervisor: Dr R Tengeh, Dr C Steyn**

Comments:

Decision: APPROVED

18 September 2013
Signed: Chairperson: Research Ethics Committee Date

Signed: Chairperson: Faculty Research Committee	Date

Clearance Certificate No | 2013FBREC116

Appendix B: Survey Questionnaire

SURVEY QUESTIONNAIRE

The role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation in South Africa: a case of a university of technology

COVER LETTER

Dear Respondent

This questionnaire is designed to provide relevant data for the following study: The role of academic entrepreneurs and spin-off companies in the process of technology transfer and commercialisation in South Africa: a case of a university of technology.

The administration of the questionnaire and the subsequent analysis of its contents constitute (in part) a survey research project in which you are asked to participate.

The result of the survey will inform policy makers and advocates of institutional entrepreneurial transformation and facilitate improved management of academic entrepreneurship and spin-off companies at higher education establishments in general.

Your voice is therefore critical to expand our empirical and theoretical understanding of this matter.
You were selected as a potential participant in this study, because you are currently a full-time instructional staff member at the Cape Peninsula University of Technology. Potential participants in this study were selected through the application of a matching technique using the last five years' research reports provided by Cape Peninsula University of Technology.

EXPLANATORY NOTES

We would appreciate it if you could spare a few minutes to complete our survey questionnaire. In answering this questionnaire, it is **most important** that your responses are as complete and candid as possible. In addition to facts, many questions ask for your opinions and perceptions. Thus, the value of this work relies heavily upon how you complete each question.

Concerning the **confidentiality** of your replies, **all** responses will be kept in strict confidence. Also, in subsequent analysis of data and presentation of results, no responses from individuals will be identified in the dissertation or other publications.

Feedback about results: results will be communicated to interested participants. **Instructions** are given under "General" at the beginning of the survey and also **just before each question is asked**. Please read them carefully before replying.

If you have any questions relating to this survey, please contact Amelia Rorwana: (021) 460 4283, 082 590 2188, email rorwanaa@cput.ac.za.

Thank you for your help.

GENERAL INSTRUCTIONS FOR COMPLETING THE SURVEY QUESTIONNAIRE

- ➢ Please read each question carefully and provide the response that best represents your answer by choosing the relevant option for the associated category.
- ➢ For most questions you need only to tick a SINGLE box, while a few require that you write (type) in your answer.
- ➢ Answer all the questions as well and honestly as you can.

Please sign below if you agree and are willing to answer the attached questionnaire.

By signing this form, I agree that:

1. The study was explained to me and all my questions were answered.
2. I have the right to participate and the right to stop at any time.
3. I have been told that my personal information will be kept confidential.

I hereby consent to participate in this study:

Name of participant.....

Signature..... Date

….....

Section One: Socio-Demographic Information

In this section we seek personal information about you and your background. This information is very important to draw a profile of respondents' individual characteristics.

1. Are you a South African citizen? Yes ☐ No ☐

   1.1. If " NO" was selected at **Question 1**, please indicate your country of birth:

   ……

2. What is your date of birth (YY/MM/DD – Year/Month/Day)? …….

3. What is your sex? Male ☐ Female ☐

4. Within the South African context, in what population group do you fall?

African ☐ Coloured ☐ Indian ☐ White ☐

Other, please specify ……. Would prefer not to answer ☐

Section Two: Employment and Work Situation

In this section we are looking for information on your current employment situation and your personal professional work history. This information will assist us to understand your employment background and current employment context.

5. How long have you been employed at the Cape Peninsula University of Technology (in years – including this current year)? ……

6. In which faculty are you employed? (Please tick the appropriate box)

Applied Sciences ☐ Business ☐ Education ☐ Engineering ☐ Health & Wellness Sciences

Informatics & Design ☐ Other ☐, please specify ……..……

7. What is your current professional rank?

Jun. Lecturer ☐ Lecturer ☐ Sen. Lecturer ☐ Ass. Professor ☐

Full Professor ☐ Other ☐ please specify ……..……

8. How long (in years) have you occupied the above-mentioned professional rank at CPUT? ……

9. What is your current employment status?

Full-time permanent ☐ Contract ☐ Other, please specify ……

10. Which category below describes your **current** work role best?

Only have **teaching** responsibilities ☐
Only have **research** responsibilities ☐
Have **both teaching and research** responsibilities ☐

Other (please specify) ……..……

10.1 Do you enjoy your current work role?

Yes ☐ No ☐

10.2 Please explain your answer to 10.1

……
……
……
……

Section Three: Self-Efficacy, Beliefs and Opinions

In this section, we would like to gather information about how you see yourself and about how you perceive research activity. This information is very important to gain insight from the individual instructional staff members themselves.

11.1 Do you consider yourself an academic entrepreneur? Yes ☐ No ☐

11.2 Please explain your answer to 11.1

……
……
……

12. How would you rate your interest in academic entrepreneurship?

Low interest				High interest
1	2	3	4	5
☐	☐	☐	☐	☐

13. Have you ever been involved in industry–university linkages? Yes ☐ No ☐

14. How much importance do you think there is in industry–university partnership?

Low importance			High importance	
1	2	3	4	5
☐	☐	☐	☐	☐

15. Do you consider yourself as being skilled enough to excel in technology transfer?

Not skilled enough			Skilled enough	
1	2	3	4	5
☐	☐	☐	☐	☐

16. What is the state of academic entrepreneurial culture in your faculty?

Weak culture Strong culture

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

17. If you have indicated anything between 3 and 5 above, please provide a short summary of your understanding.

……

……

……

18. Have you ever produced an innovative product? Yes ☐ No ☐

19. What influenced your production of this product?

	Low influence 1	2	3	4	High influence 5
Availability of funding	☐	☐	☐	☐	☐
Private company	☐	☐	☐	☐	☐
Technology Transfer Office	☐	☐	☐	☐	☐
Personal passion for innovation	☐	☐	☐	☐	☐
Commercialisation faculty culture	☐	☐	☐	☐	☐
Entrepreneurial culture	☐	☐	☐	☐	☐

20. What in your view are the most important factors that **promote (help/encourage)** academic entrepreneurship at CPUT?

……

……

……

21. What in your view are the most important factors that **constrain (hinder/limit)** entrepreneurial culture at CPUT?

……

……

……

22. Please indicate your level of agreement:

22.1 All academics MUST think like entrepreneurs

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

22.2 Good academic entrepreneurs are BORN, not MADE (trained)

Strongly Agree Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

22.3 Good academic entrepreneurs are MADE (trained), not BORN

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

22.4 It would be a good idea if some academics were to focus on teaching, while others were to focus on research, and others on entrepreneurship

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

22.5 Research informs and complements teaching

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

22.6 Teaching has nothing to do with research and vice versa

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

Section Four: Views on and Experiences of Academic Entrepreneurship at CPUT

This section seeks information about your views on and experiences of Academic Entrepreneurship at CPUT.

23. Please indicate your level of agreement:

23.1 A strong record of successful academic entrepreneurship activity is important in faculty evaluation at CPUT.

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

24. To your knowledge, to what extent does CPUT provide **commercialisation training** opportunities?

Constantly ☐ Sometimes ☐ Hardly ever ☐ Never ☐

25. To your knowledge, to what extent does CPUT provide academic entrepreneurship **training** opportunities?

Constantly ☐ Sometimes ☐ Hardly ever ☐ Never ☐

26. Does CPUT provide opportunities for you to apply for financial support to participate in commercialisation? No ☐ Yes ☐ Don't know ☐

27. To your knowledge, does CPUT provide opportunities for you to apply for university–industry funding of your research projects? Yes ☐ No ☐ Don't know ☐

28. Are you familiar with the work of any the following departments?

Please tick the appropriate box(es)

Division of Research Directorate ☐

Technology Transfer Office ☐

29. Please indicate your level of agreement:

29.1 I have grown as an academic researcher since I started working at this institution

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

Section Five: Information on Past and Current Research Engagements & Behaviour

30. During the past *five* years, have you ever received a research grant from:

The university where you are employed	Yes ☐	No ☐
Government entities	Yes ☐	No ☐
Business firms	Yes ☐	No ☐
Private foundations	Yes ☐	No ☐
International organisations	Yes ☐	No ☐

Other, please specify ……

31. Do you have professional work contacts with colleagues employed at any private companies? Yes ☐ No ☐

32. Do you have professional work contacts with any private companies?

Yes ☐ No ☐

33 Are you willing to participate in further research on this project? Please indicate:

- ❖ Are you willing to participate in a 20-minute face-to-face interview? Yes ☐ No ☐
- ❖ Are you willing to provide a copy of your curriculum vitae? Yes ☐ No ☐

Once you have completed all the questions in the survey, please submit to

Amelia Rorwana, rorwanaa@cput.ac.za, (021) 460-3128

Thank you very much for your participation; it is greatly appreciated.

Appendix C: SPSS Data Analysis

Frequencies

Frequency Table

Are you a South African citizen?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	77.8	77.8	77.8
	No	8	22.2	22.2	100.0
	Total	36	100.0	100.0	

Country, if not South African

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cameroon	1	2.8	16.7	16.7
	Nigeria	4	11.1	66.7	83.3
	Zimbabwe	1	2.8	16.7	100.0
	Total	6	16.7	100.0	
Missing		30	83.3		
Total		36	100.0		

Date of Birth

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	36/09/09	1	2.8	3.1	3.1
	39/05/16	1	2.8	3.1	6.3
	52/05/14	1	2.8	3.1	9.4
	53/05/03	1	2.8	3.1	12.5
	56/05/13	1	2.8	3.1	15.6
	56/11/22	1	2.8	3.1	18.8
	58/04/30	1	2.8	3.1	21.9
	59/02/05	1	2.8	3.1	25.0
	59/11/22	1	2.8	3.1	28.1
	60/12/21	1	2.8	3.1	31.3
	63/01/01	1	2.8	3.1	34.4
	63/05/19	1	2.8	3.1	37.5
	66/01/13	1	2.8	3.1	40.6
	66/05/10	1	2.8	3.1	43.8
	66/11/20	1	2.8	3.1	46.9
	67/05/02	1	2.8	3.1	50.0
	67/08/04	1	2.8	3.1	53.1
	70/03/01	1	2.8	3.1	56.3
	70/06/24	1	2.8	3.1	59.4
	70/08/12	1	2.8	3.1	62.5
	71/08/10	1	2.8	3.1	65.6
	72/02/05	1	2.8	3.1	68.8
	72/07/15	1	2.8	3.1	71.9
	72/09/19	1	2.8	3.1	75.0
	74/07/14	1	2.8	3.1	78.1
	75/02/18	1	2.8	3.1	81.3
	76/06/14	1	2.8	3.1	84.4
	76/12/03	1	2.8	3.1	87.5
	77/06/26	1	2.8	3.1	90.6
	78/02/15	1	2.8	3.1	93.8

	80/06/17	1	2.8	3.1	96.9
	81/10/30	1	2.8	3.1	100.0
	Total	32	88.9	100.0	
Missing	System	4	11.1		
Total		36	100.0		

Age of respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	32	1	2.8	3.1	3.1
	34	1	2.8	3.1	6.3
	36	2	5.6	6.3	12.5
	37	1	2.8	3.1	15.6
	38	1	2.8	3.1	18.8
	39	2	5.6	6.3	25.0
	41	2	5.6	6.3	31.3
	42	2	5.6	6.3	37.5
	43	2	5.6	6.3	43.8
	44	1	2.8	3.1	46.9
	46	1	2.8	3.1	50.0
	47	2	5.6	6.3	56.3
	48	2	5.6	6.3	62.5
	51	2	5.6	6.3	68.8
	53	1	2.8	3.1	71.9
	54	1	2.8	3.1	75.0
	55	1	2.8	3.1	78.1
	56	1	2.8	3.1	81.3
	57	1	2.8	3.1	84.4
	58	1	2.8	3.1	87.5
	61	1	2.8	3.1	90.6
	62	1	2.8	3.1	93.8
	75	1	2.8	3.1	96.9
	77	1	2.8	3.1	100.0

	Total	32	88.9	100.0	
Missing	System	4	11.1		
Total		36	100.0		

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	22	61.1	61.1	61.1
	Female	14	38.9	38.9	100.0
	Total	36	100.0	100.0	

Ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	African	14	38.9	38.9	38.9
	Coloured	3	8.3	8.3	47.2
	Indian	3	8.3	8.3	55.6
	White	15	41.7	41.7	97.2
	Would prefer not to answer	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

Other Ethnic group

		Frequency	Percent
Missing		36	100.0

Employed at the Cape Peninsula University of Technology in years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.8	2.8	2.8
	3	2	5.6	5.6	8.3
	4	2	5.6	5.6	13.9
	5	6	16.7	16.7	30.6
	6	4	11.1	11.1	41.7
	7	3	8.3	8.3	50.0
	8	1	2.8	2.8	52.8
	9	1	2.8	2.8	55.6
	10	3	8.3	8.3	63.9
	11	2	5.6	5.6	69.4
	12	3	8.3	8.3	77.8
	13	3	8.3	8.3	86.1
	14	1	2.8	2.8	88.9
	16	1	2.8	2.8	91.7
	18	1	2.8	2.8	94.4
	26	1	2.8	2.8	97.2
	30	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

Faculty of employment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Applied Sciences	9	25.0	25.0	25.0
	Business & Management Sciences	6	16.7	16.7	89.1
	Education	3	8.3	8.3	33.3
	Engineering	9	25.0	25.0	58.3
	Health & Wellness Sciences	2	5.6	5.6	63.9
	Informatics & Design	2	5.6	5.6	69.4
	Other	5	13.9	13.9	100.0
	Total	36	100.0	100.0	

Other specification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bio-Catalysis and Technical Biology Research Group	1	2.8	20.0	20.0
	Bio-Catalysis and Technical Biology Research Group, not affiliated to a faculty	1	2.8	20.0	40.0
	BTB (under DVC for RTIP)	1	2.8	20.0	60.0
	Fundani CHED	1	2.8	20.0	80.0
	Research, Innovation, Technology Transfer	1	2.8	20.0	100.0
	Total	5	13.9	100.0	
Missing		31	86.1		
Total		36	100.0		

Department Other

		Frequency	Percent
Missing		36	100.0

Current professional rank

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Junior lecturer	1	2.8	2.8	2.8
	Lecturer	7	19.4	19.4	22.2
	Sen lecturer	7	19.4	19.4	41.7
	Ass Professor	9	25.0	25.0	66.7
	Full professor	5	13.9	13.9	80.6
	Other	7	19.4	19.4	100.0
	Total	36	100.0	100.0	

Other professional rank

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Adjunct Professor	1	2.8	14.3	14.3
	HOD	1	2.8	14.3	28.6
	Research and Management	1	2.8	14.3	42.9
	Research Officer	2	5.6	28.6	71.4
	Researcher	1	2.8	14.3	85.7
	Researcher Officer	1	2.8	14.3	100.0
	Total	7	19.4	100.0	
Missing		29	80.6		
Total		36	100.0		

How long (in years) have you occupied the above-mentioned professional rank at CPUT?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	5.6	5.6	5.6
	2	1	2.8	2.8	8.3
	3	11	30.6	30.6	38.9
	4	7	19.4	19.4	58.3
	5	3	8.3	8.3	66.7
	6	6	16.7	16.7	83.3
	7	1	2.8	2.8	86.1
	9	1	2.8	2.8	88.9
	10	1	2.8	2.8	91.7
	13	1	2.8	2.8	94.4
	14	1	2.8	2.8	97.2
	18	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

Employment Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Full time	29	80.6	80.6	80.6
	Contract	7	19.4	19.4	100.0
	Total	36	100.0	100.0	

Employment Status Other

		Frequency	Percent
Missing		36	100.0

Work Responsibilities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Only research	8	22.2	22.2	22.2
	Both teaching and research	28	77.8	77.8	100.0
	Total	36	100.0	100.0	

Work Responsibilities Other

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Additional: Head of programme, administrative duties	1	2.8	14.3	14.3
	Both research and management	1	2.8	14.3	28.6
	HOD administrative duties	1	2.8	14.3	42.9
	I prefer Research at this stage at my career	1	2.8	14.3	57.1
	IT Coordinator	1	2.8	14.3	71.4
	Makes the research responsibilities of my work impossible	1	2.8	14.3	85.7
	Student project research supervision, mostly postgraduate students. No lecturing	1	2.8	14.3	100.0

	Total	7	19.4	100.0	
Missing		29	80.6		
Total		36	100.0		

Enjoy Work Role

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	33	91.7	91.7	91.7
	No	3	8.3	8.3	100.0
	Total	36	100.0	100.0	

Enjoy Work Role Explain

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1. Love interacting with students and being able to assist them in improving themselves, 2. Love finding out and testing new ideas (research).	1	2.8	2.9	2.9

	Being able to focus solely on research, has allowed me to explore various aspects of my research and to become more involved in university research activities (e.g. ethics, workshops, innovation). I do not have the added burden of having to prepare and give lectures, prepare exam and test papers, and mark them. In 2011, I lectured for one semester (Biotechnology programme, Faculty of Applied Sciences). This made me realise how much time actually goes into lecturing and how fortunate I am to be employed in a research position. Being able to focus on research only has also allowed me to interact more with my staff and students (informal meetings, idea exchange, etc.) – time which would've been spent on teaching-related activities should I have been employed to do research and lecturing.	1	2.8	2.9	5.7
	Diversity of responsibilities, covering all aspects of the industrialisation value chain of academic, research, innovation and commercialisation. Multidisciplinary of space technology and the internationalisation aspects of the F'SATI programme.	1	2.8	2.9	8.6
	During my research studies the past 18 years I have identified a number of possible innovation solutions for certain health issues, but have never had the time nor human capacity to develop them further, as my emphasis thus far has been on the growth and development of postgraduates at CPUT and other academic matters.	1	2.8	2.9	11.4

	Fulfilling; challenging.	1	2.8	2.9	14.3
	I have been doing research for more than 50 years and it is like a hobby to me. Since 1993 I have been supervising Btech students and postgraduates (MSc and PhD), which was an exciting challenge for me. Until now I have supervised 19 masters and 6 doctoral students.	1	2.8	2.9	17.1
	I am passionate about research and the field in which I am working. Working with a small group of similarly minded individuals who are all hard working and dedicated, makes coming to work a pleasure. Enjoy assisting students to better themselves through education.	1	2.8	2.9	20.0
	I enjoy both teaching students, as well as the opportunities for research. Also, postgraduate students assist with your research while you supervise them.	1	2.8	2.9	22.9
	I enjoy doing research, writing my research findings and certainly enjoy it when they are published. I have a great passion for postgraduate supervision and I delight in assisting my students. I equally enjoy teaching.	1	2.8	2.9	25.7
	I enjoy research, publishing and working with PG students.	1	2.8	2.9	28.6
	I enjoy teaching and relating to students as well as carrying out research activities that give me the opportunity to learn new things in my field, also contributing to research outputs.	1	2.8	2.9	31.4

	I enjoy teaching as well as research.	1	2.8	2.9	34.3
	I enjoy the balanced role of educator, researcher and manager.	1	2.8	2.9	37.1
	I have a passion for what I do. I wouldn't see myself doing any other thing.	1	2.8	2.9	40.0
	I have the freedom to do research in my areas of expertise (as long as I can find sufficient funding, of course). I would enjoy increasing the amount of teaching I do but there haven't been opportunities to do this. More teaching would also decrease time available for research and therefore outputs would drop, making funding harder to come by.	1	2.8	2.9	42.9
	I like doing research and transferring my knowledge and experience to the postgraduate students.	1	2.8	2.9	45.7
	I like integrating my research activities with teaching because students get better value from that and they help a lot in gathering essential data.	1	2.8	2.9	48.6

	I was appointed in the capacity of lecturer for the drama subjects in the faculty. I have since developed interest in other more teaching-oriented areas, such as professional practice and academic development, but I was told in no uncertain terms that I would remain responsible for all the drama subjects until I've completed my PhD. I have since done so, due to a supportive leader in my teaching. However, it is clear to me that when I return from my sabbatical I will have to return to my normal workload of 31 lectures a week (most of which would be drama) with little chance of implementing my research in any way.	1	2.8	2.9	51.4
	I would not do it if it wasn't fun, and if I didn't feel I could contribute something to the University and its students.	1	2.8	2.9	54.3
	In so far as my work role involves imparting technical skills on the one hand, and exploring new technology on the other, I find it absolutely enjoyable. The trebling and quadrupling of class sizes in the last few years has squeezed out the time available to do research or any other activities.	1	2.8	2.9	57.1
	It is in my field of specialisation (Mathematics Education).	1	2.8	2.9	60.0
	Love doing research.	1	2.8	2.9	62.9
	Making a difference to the lives of young people. Being an innovator and producer of new knowledge in the field.	1	2.8	2.9	65.7

	Most times I enjoy my work but there are many problems which arise: 1. In our faculty people are promoted and employed who do not research/publish and do not understand the research process and who hinder my research process. 2. For example, I sent an ethics clearance form to the Ethics Review Committee and only had a response 7 months later!! The chair of this committee does not do research and is clear that this process is not managed adequately. The postgraduate students talk to each other about how incompetent this lecturer is and yet she is protected. 3. The administration process of doing some research is terrible. Too many incompetent people to deal with. For example, it took me about 5 months to purchase a laptop for my doctoral student ... I had to get two quotes because the process took so long and the previous one became outdated. However, at the same time there are a few extremely competent and friendly people who are excellent at their jobs. 4. Policies are not always firmly implemented – for example some exclusionary items are ignored in URF applications for some lecturers. Why are some people protected? 5. When new curricula are introduced to the faculty, people who do not publish, and who neither attend national nor international conferences, nor have PhDs, lead these processes – how can one respect these processes? 6. There is too much focus on the marks and processes and yet we never discuss	1	2.8	2.9	68.6

	current teaching pedagogies – this is a huge gap in our campus. This is leading to very poorly trained teachers – this point is being recognised by many people in the education field. We are graduating incompetent teachers. 7. The university is employing staff to fill the equity quotas rather than focusing on employing quality staff regardless of colour.*.I did not enjoy it when a colleague stole my exam papers before they went to the examination department for printing.				
	My current job allows me to expand my managerial and administrative skills. I am also enjoying the ability to interact with both students and staff.	1	2.8	2.9	71.4
	My postgraduate students are very successful. My research output is also very good and the area of my research is interesting and it has an impact on the community	1	2.8	2.9	74.3
	My role is varied as a lecturer and researcher. There are no dull moments. The excitement peaks when the students succeed and one's work gets read around the world. That gives a sense of fulfilment and accomplishment. The joy is about touching lives.	1	2.8	2.9	77.1
	No issues – Sometimes quite busy, but coping.	1	2.8	2.9	80.0
	Overwhelmed by administration and solving problems related to operational inefficiencies. Contribution to research and innovation is under-realised.	1	2.8	2.9	82.9

	Teaching and research are passions of mine and I really also enjoy the planning and coordination that administrative work affords me.	1	2.8	2.9	85.7
	Teaching gives me joy. I am always glad to see my students succeed. It gives me courage and hope for another day knowing that I make a difference in people's lives.	1	2.8	2.9	88.6
	The balance between research and teaching is lacking, making very difficult for me to carry out effective research.	1	2.8	2.9	91.4
	The research I am involved in does not have an entrepreneurial angle.	1	2.8	2.9	94.3
	Yes and no. I enjoy the research; the workload is too much especially lack of supervisory capacity	1	2.8	2.9	97.1
	Yes, As I continually formulate new and innovative projects that are both community and industry based.	1	2.8	2.9	100.0
	Total	35	97.2	100.0	
Missing		1	2.8		
Total		36	100.0		

Do you consider yourself an academic entrepreneur?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	66.7	68.6	68.6
	No	11	30.6	31.4	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		36	100.0		

Please explain your answer to 10.1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Although there may be economically viable spin-offs from my work, money is not the primary driver of my ambition. If it was, I would not be working as a researcher at CPUT.	1	2.8	3.1	3.1
	Busy, with some progress.	1	2.8	3.1	6.3
	Development of RDI centres, programmes and projects which provide the university with a competitive advantage in terms of attracting industrial contracts, innovation partnerships and good calibre students.	1	2.8	3.1	9.4
	During my research studies the past 18 years I have identified a number of possible innovation solutions for certain health issues, but have never had the time nor human capacity to develop them further, as my emphasis thus far has been on the growth and development of postgraduates at CPUT and other academic matters.	1	2.8	3.1	12.5
	Even though I have not yet, in my current position, set up a production system, my research tends to focus on the economic feasibility of applying cutting-edge technology to the South Africa environment, with a view to make the technology available for local entrepreneurs.	1	2.8	3.1	15.6
	Have taken IDEA over 5 years through whole process.	1	2.8	3.1	18.8

	I am always on the lookout for opportunities to commercialise my research as I work	1	2.8	3.1	21.9
	I am more [of an] entrepreneur in organisation of the activities, assuring funding, creation of good working conditions for the staff and postgraduates in the research centre, building a research culture and self-requirements for [a] high level of quality in the research work in the group, creating interest in and joy from the achievements. At the moment I feel that I am more manager than researcher. But maybe only in this way I can give to others my understanding and experience of the existing conditions at CPUT	1	2.8	3.1	25.0
	I am not familiar with the term. Also, there is very little commercial benefit from my research area, i.e., conservation and marine biology. I have, however, produced environmental impact assessment reports privately in the past.	1	2.8	3.1	28.1
	I believe in using education not as a means to live but as a means of life. As academics we need to be dynamic in thoughts and action to promote the growth and development of our country by contributing to the alleviation of poverty.	1	2.8	3.1	31.3

	I believe one of my responsibilities is to produce students that will be able to solve some of the problems our environment is facing and improve some of our day-to-day products and amenities. On the other hand, my research activities are also to contribute to the development of light-emitting diodes in order to solve the current energy problem the country is facing. In addition, an integral part of my research is to find a cure for some of the terminal diseases.	1	2.8	3.1	34.4
	I continuously find new ways of doing what I do. I will want to be remunerated too.	1	2.8	3.1	37.5
	I don't have the skills to convert academic results into a viable company nor do I have access to the necessary resources.	1	2.8	3.1	40.6
	1. I have a history of doing innovative research with my students, which I publish. 2. I have been invited to be part of international research projects. 3. I volunteer and do international teaching – I have been to Mauritius, Zambia, Bangladesh and Sri Lanka. This is done for the International Reading Association.	1	2.8	3.1	43.8
	I have leveraged a multi-phased, multi-faceted approach to industry-driven research and innovation to establish a programme in space technology that has national and regional impact.	1	2.8	3.1	46.9
	I have never been involved in a project that led to commercialisation and I do not own or sell anything coming from my academic activities.	1	2.8	3.1	50.0

	I have not invented, patented or sold any concepts, ideas or material.	2	5.6	6.3	56.3
	I have not yet completed my PhD (I am in the early stage). I've been asked to write a chapter in a book on the topic of my PhD, but I don't know when I would be able to do that given my teaching load. I am very worried that I am going to complete my PhD studies and return to my role as drama teacher at CPUT and that my PhD would have no impact What so ever on my or others' practices.	1	2.8	3.1	59.4
	I have to find new ways of doing research, involving industry and students on an ongoing basis.	1	2.8	3.1	62.5
	I see research as a means to solving human problems. My research is in value addition to solving food security. In addition to being a problem-solving tool, it should consequently add value to the economy by making money both for the entrepreneur and the state, hence I desire that my research efforts should end with commercialised products and if possible, a spin-off.	1	2.8	3.1	65.6
	I use my skills in doing review work and chairing panels for the NRF. But this is part of my academic contribution. I also work with community organisations and NGOs on social issues. But do not get paid for this.	1	2.8	3.1	68.8

	I was the first chemist in South Africa to separate radio scopes from the target material and other radioisotopes by column ion exchange chromatographic methods. I also invented and developed a method to isolate and purify Mo-99 and I-131 fission material and also invented and developed two radionuclide generators for medical use. NTP has been using these methods to produce Mo-99 and I-131 for the world market. When iThemba LABS needed money to balance the annual budget, I took the initiative to market and sell radioisotopes to DuPont Radiopharmaceuticals Co. and to the Department of Energy (DOE) of the USA. When DuPont Radiopharmaceuticals Co. discontinued the production of Na-22 position sources I started to produce the sources at iThemba LABS, which is still the sole supplier of these position sources. In 2003 I applied for NRF funds from the Innovation Fund to investigate the production of F-18 and other PET radionuclides and an amount of 15million was granted for research and I was appointed as project leader. Today iThemba LABS is one of three producers of F-18 and [F-18] FDG and it is also producing Ge-68 and Sr-82 for MDS Nordion.	1	2.8	3.1	71.9

	In many ways, as researcher and manager and decision maker, one has to be entrepreneurial in one's approach, e.g. with funding sourcing and with curriculum development. The job also entails a close contact with industry and sourcing of new contacts, for research partnerships as well as with positions etc.	1	2.8	3.1	75.0
	It is not my field of study.	1	2.8	3.1	78.1
	My research is applied but no immediate commercial venture at this stage and in the foreseeable future.	1	2.8	3.1	81.3
	Produce new knowledge to be used by practitioners.	1	2.8	3.1	84.4
	Research and results are used directly by industry for implementation into their programmes.	1	2.8	3.1	87.5
	The research that I focus on is driven by the South African bio-economy and PUT's RI Blueprint. As such, the focus is towards generating products or technologies that can potentially be used for alleviation of problems faced by communities in the Western Cape Province, South Africa, as well as globally. Our research should therefore be innovative and geared towards solving real-world problems, but could also have potential for commercialisation.	1	2.8	3.1	90.6
	Thinking of innovative ways of teaching, research consultancy.	1	2.8	3.1	93.8
	To an extent I am able to bring in contract research and develop innovative partnerships. .	1	2.8	3.1	96.9

	Yes, As I continually formulate new and innovative projects – those are both community and industry based.	1	2.8	3.1	100.0
	Total	32	88.9	100.0	
Missing		4	11.1		
Total		36	100.0		

How would you rate your interest in academic entrepreneurship?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low interest	1	2.8	2.8	2.8
	2	2	5.6	5.6	8.3
	3	11	30.6	30.6	38.9
	High interest	22	61.1	61.1	100.0
	Total	36	100.0	100.0	

Have you ever been involved in industry–university linkages?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	77.8	77.8	77.8
	No	8	22.2	22.2	100.0
	Total	36	100.0	100.0	

How much importance do you think there is in industry–university partnerships?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	2.8	2.8	2.8
	3	2	5.6	5.6	8.3
	High importance	33	91.7	91.7	100.0
	Total	36	100.0	100.0	

Do you consider yourself as being skilled enough to excel in technology transfer?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not skilled enough	3	8.3	8.3	8.3
	2	3	8.3	8.3	16.7
	3	10	27.8	27.8	44.4
	Skilled enough	19	52.8	52.8	97.2
	22	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

What is the state of academic entrepreneurial culture in your faculty?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Weak culture	7	19.4	19.4	19.4
	2	7	19.4	19.4	38.9
	3	18	50.0	50.0	88.9
	High culture	4	11.1	11.1	100.0
	Total	36	100.0	100.0	

Please provide a short summary of your understanding of entrepreneurial culture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A number of programmes in the faculty are being considered for the creation of spin-off companies.	1	2.8	5.6	5.6

	Academic entrepreneurship is an exciting prospect but a challenge at the same time since one needs to combine the basic attributes of traditional scientist (research capability) and those of traditional entrepreneurs who are on the lookout for business opportunities and ways to satisfy customer requirements of profitability.	1	2.8	5.6	11.1
	All engineering and technology studies in the current economic system should be recognised as motivated by a goal to create products for industrial or retail consumption, and therefore by profit.	1	2.8	5.6	16.7
	Aware of some academics but not the depth of it.	1	2.8	5.6	22.2
	Being part of the engineering faculty, the traditional link between the faculty and the industry is always present although I am not involved directly. The advice given to students for internship purposes draws most lecturers in the faculty closer to the industry.	1	2.8	5.6	27.8
	Cannot talk about faculty but from a department perspective, there is constant communication between the industry and academic to better the industry through science/technology and research.	1	2.8	5.6	33.3
	Every researcher in the faculty is aware of the role of technology transfer in research.	1	2.8	5.6	38.9
	I can't speak for the whole faculty, but I know of several departments that have entrepreneurial-type projects.	1	2.8	5.6	44.4

	I have a keen interest in entrepreneurship, am working closely with the food and beverage industry already and through the number of postgraduates and consultancy done to the food and beverage industry proven to have skill to excel in tech transfer, but the major factor hampering taking this to the next level is the time available to me to pursue this, as I am occupied full time with other academic matters important to CPUT.	1	2.8	5.6	50.0
	I think there are processes of academic entrepreneurship, headed by a few individuals.	1	2.8	5.6	55.6
	Industry is typically driven by the needs of government as well as the consumer. This places them in a unique position to be able to identify potential gaps in products, technologies, services, etc. Linking with an industry partner therefore allows for research that becomes geared towards meeting the needs of the country. Even though I have experience in working with industry partners, I would not see myself as being highly skilled in technology transfer and would still defer to the Technology Transfer Office (TTO) for advice and guidance on any industry–university partnerships.	1	2.8	5.6	61.1
	It is encouraged, but not supported in a way that makes it easy to execute in full.	1	2.8	5.6	66.7
	It is promoted quite extensively and new products/innovation are quite visible.	1	2.8	5.6	72.2

	The faculty has a mix of innovative and predominantly mediocre staff. However, a number of R&D and technology transfer centres have been developed in recent years, allowing the faculty to establish a reasonable culture of innovation and entrepreneurship. This is also due to pressure from industry for the faculty, being the only technical university in the region, to provide the RDI support necessary.	1	2.8	5.6	77.8
	The NRF and CPUT should support researchers to a greater extent to enhance the interest in academic entrepreneurship and in industry–university partnership.	1	2.8	5.6	83.3
	This refers especially to the industry relationships and partnerships we need to build, as we do vocational training (it is thus essential), but it also includes research partnering (co-supervision, cross-teaching, etc., as well as the production at products/patents.	1	2.8	5.6	88.9
	We choose to do research with industrial relevance so that there would be entrepreneurial opportunities after successful research projects. We do not consider our job to be making marketable products though we see that as a spin-off function. Academics do research while some students will take that research further and start companies.	1	2.8	5.6	94.4

	Within my research group, some individuals are performing work on the development of industrial biocatalysts which always has the potential for patenting, etc.	1	2.8	5.6	100.0
	Total	18	50.0	100.0	
Missing		18	50.0		
Total		36	100.0		

Have you ever produced an innovative product?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	47.2	47.2	47.2
	No	19	52.8	52.8	100.0
	Total	36	100.0	100.0	

Availability of funding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	4	11.1	12.1	12.1
	2	2	5.6	6.1	18.2
	3	17	47.2	51.5	69.7
	High influence	10	27.8	30.3	100.0
	Total	33	91.7	100.0	
Missing	System	3	8.3		
Total		36	100.0		

Private company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	11	30.6	33.3	33.3
	2	3	8.3	9.1	42.4
	3	15	41.7	45.5	87.9
	High influence	4	11.1	12.1	100.0
	Total	33	91.7	100.0	
Missing	System	3	8.3		
Total		36	100.0		

Technology Transfer Office

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	9	25.0	37.5	37.5
	2	3	8.3	12.5	50.0
	3	2	5.6	8.3	58.3
	High influence	10	27.8	41.7	100.0
	Total	24	66.7	100.0	
Missing	System	12	33.3		
Total		36	100.0		

Personal passion for innovation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	5	13.9	18.5	18.5
	3	4	11.1	14.8	33.3
	High influence	18	50.0	66.7	100.0
	Total	27	75.0	100.0	
Missing	System	9	25.0		
Total		36	100.0		

Commercialisation faculty culture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	8	22.2	30.8	30.8
	2	9	25.0	34.6	65.4
	3	5	13.9	19.2	84.6
	High influence	4	11.1	15.4	100.0
	Total	26	72.2	100.0	
Missing	System	10	27.8		
Total		36	100.0		

Entrepreneurial culture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low influence	3	8.3	13.6	13.6
	2	5	13.9	22.7	36.4
	3	7	19.4	31.8	68.2
	High influence	7	19.4	31.8	100.0
	Total	22	61.1	100.0	
Missing	System	14	38.9		
Total		36	100.0		

Most important factors that promote academic entrepreneurship at CPUT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1. Time available, 2. Human capacity, 3. Funding	1	2.8	3.1	3.1
	1. Visibility of entrepreneurial successes, e.g. media coverage of the Nicki Drive vehicle, 2. Funding support from the CPUT Innovation Board, 3. Promotion of innovation among students (this can in turn encourage academics to explore their own ideas, 4. Workshops held by TTO to assist in identifying innovation and how this can be taken to the next step – commercialisation, spin-off companies, etc.	1	2.8	3.1	6.3
	Academic freedom, industry linkage.	1	2.8	3.1	9.4
	Access to funding and information.	1	2.8	3.1	12.5
	Availability of funding and the right culture.	1	2.8	3.1	15.6
	Combining skills between departments and faculties. For example: If you want to build, develop, or produce some new, often need assistance from engineers, designers, etc.	1	2.8	3.1	18.8

	Continuously keeping abreast with the latest developments and capability to think logically and not in a standard way; inside moving force always to do something new and better; availability of funds, especially in engineering and science; fully supportive finance and research systems; not such heavy teaching or research loads; enough technical staff that can help; removing the HR, finance, administration and other nonspecific duties from the researchers.	1	2.8	3.1	21.9
	Currently I have not witnessed the drive to promote entrepreneurship filtering to the departments and through to the classroom.	1	2.8	3.1	25.0
	Currently, innovation funding promotes this but it needs to go further into skills development and co-ordinating partnerships between researchers and people skilled in business and marketing.	1	2.8	3.1	28.1
	Dedicated academic staff.	1	2.8	3.1	31.3
	DVC Research plus TTO quite vigorously promote entrepreneurship.	1	2.8	3.1	34.4
	Enabling environment; recognition and remuneration of entrepreneurial efforts.	1	2.8	3.1	37.5
	Enabling environment: effective support structures (finance, HR, procurement), promoting innovative thinking, equitable rewards, awareness, and training programmes.	1	2.8	3.1	40.6
	Enough knowledge of the issue – incentive for progress	1	2.8	3.1	43.8

	Good leadership (and knowledgeable, connected leaders). Motivated staff with knowledge of the industry; a common vision between academia and industry; highly skilled researchers; research niche areas (teamwork).	1	2.8	3.1	46.9
	Having had experience of being an entrepreneur – and good contact with one.	1	2.8	3.1	50.0
	I cannot really comment since I am still very new.	1	2.8	3.1	53.1
	I do not know.	1	2.8	3.1	56.3
	I think the teaching load – especially with heavily underprepared students – discourages academic entrepreneurship. Too much time is spent explaining basic things and procedures (which should have been done at pre-university level) to students and struggling to improve throughputs than would be ideal for serious academic entrepreneurship.	1	2.8	3.1	59.4

	I was the recipient of a Thuthuka Grant in 2013 that was extended in 2014. At the time I also applied for an NRF Sabbatical Funding Grant. Fortunately, or unfortunately, I received both. While I am very humbled by the fact that I received both, I feel that my institution should have provided better guidance. I was "forced" to re-apply for the Thuthuka Grant (even though I was on sabbatical and could not utilise the funds). I have not had any previous exposure to the process of budgeting and when I contacted the person whom I was told could support me in this respect ... she asked me "do you want me to read the manual for you?" Furthermore, I've been constantly informed by various parties in HR that education lecturers never know how systems work ... clearly there is serious miscommunication between the Education Faculty and HR and research. Academic entrepreneurship would work if there were clear, transparent and reasonable procedures and informed advice from the research office available. Obviously there need to be links to the industry as well, but surely the miscommunication within the institution should be addressed before we attempt to involve industry?	1	2.8	3.1	62.5
	Industry linkages. Where academics may have [an] opportunity to go to the industry and bring back the skills necessary to prepare students for the future.	1	2.8	3.1	65.6
		1	2.8	3.1	68.8
		1	2.8	3.1	71.9

	Personal passion and drive and supportive faculty environment.	1	2.8	3.1	75.0
	Personal passion for innovation coupled with entrepreneurial culture.	1	2.8	3.1	78.1
	Self-motivation, personal development and academic promotion and recognition.	1	2.8	3.1	81.3
	Support from the TTO for patenting and advice. However, the strong focus on IP can sometimes hinder other research.	1	2.8	3.1	84.4
	The old tradition of the formal technikons with industry. This relationship needs to be maintained and improved in the context of the new technical universities in the country, CPUT included.	1	2.8	3.1	87.5
	The technology transfer unit assists colleagues with patents, etc. The university encourages research that has an impact on society and hence colleagues are supported to be entrepreneurial.	1	2.8	3.1	90.6
	There is a need to fund more basic research ideas with [the] ultimate aim of converting the results into commercial and beneficial products.	1	2.8	3.1	93.8
	URF and Technology Transfer Office.	1	2.8	3.1	96.9
	Visionary leadership. Specialist R&D centres with state-of-the art facilities. High-calibre postgraduate students.	1	2.8	3.1	100.0
	Total	32	88.9	100.0	
Missing		4	11.1		
Total		36	100.0		

Most important factors that constrain entrepreneurial culture at CPUT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1. Current workloads, 2.Funding for proof of concept (before innovation funding kicks in), 3. Human capacity.	1	2.8	2.9	2.9
	Access to information.	1	2.8	2.9	5.9
	All systems (financial, HR, etc., are not yet in place).	1	2.8	2.9	8.8
	At least part of the constraint in my department is overload of academic work, which crowds out the possibility of engaging in any other extracurricular activities.	1	2.8	2.9	11.8
	High teaching loads and lack of resources for research.	1	2.8	2.9	14.7
	I am not sure.	1	2.8	2.9	17.6
	I do not know.	1	2.8	2.9	20.6
	I think the teaching load – especially with heavily underprepared students discourages academic entrepreneurship. Too much time is spent explaining basic things and procedures (which should have been done at pre-university level) to students and struggling to improve throughputs than would be ideal for serious academic entrepreneurship.	1	2.8	2.9	23.5
	Lack of adequate support, lack of interest.	1	2.8	2.9	26.5

	Lack of administrative and operational efficiency in support services; low levels of professionalism among staff – both administrative and academic; weak qualifications (lack of engineering PhDs); lack of industrial experience among staff; low remuneration levels for engineering personnel; lack of motivation among technical support staff; lack of strong institutional leadership to drive RDI initiatives.	1	2.8	2.9	29.4
	Lack of communication from research office about the availability of funding opportunities in good time.	1	2.8	2.9	32.4
	Lack of funding, no incentive.	1	2.8	2.9	35.3
	Lack of Interest by potential researchers in research.	1	2.8	2.9	38.2
	Lack of support and personal remuneration for research affect interest.	1	2.8	2.9	41.2
	Lack of support for salaries for qualified researchers. Lack of understanding of the scientific process by those driving innovation funding.	1	2.8	2.9	44.1
	Lack of 'talk' between faculties.	1	2.8	2.9	47.1
	Lack of time due to all the other activities academic staff need to be involved in, besides lecturing!	1	2.8	2.9	50.0
	Lecturers are overloaded with teaching tasks and should have more time for research. A lack of funding of research is probably the biggest constraint.	1	2.8	2.9	52.9

	Management who do not publish or understand processes; finances; lack of leave; jealousy; greed for promotion without the necessary skills; incompetence that is ignored; protected staff.	1	2.8	2.9	55.9
	Non-innovative research problems and research projects; more emphasis on academic activities such as publications and presentations.	1	2.8	2.9	58.8
	Opposite of the above.	1	2.8	2.9	61.8
	Overloaded with academic issues – no procedures in place for academics; we repeat the same thing 100s of times – not being able to show anything.	1	2.8	2.9	64.7
	Research that maybe does not lend itself to innovation, and funding.	1	2.8	2.9	67.6
	Researchers are risk averse since they are working with limited funds that usually must be accounted for under very specific expenditure items.	1	2.8	2.9	70.6
	Scarcity of coordination to liaise with the industry. Student guest lecturers from corporate environment would assist them to be acquainted with what is happening in the business world.	1	2.8	2.9	73.5
	See previous comments.	1	2.8	2.9	76.5

	Since CPUT is still working towards increasing its standing in the area of research, there is a continuous pressure on all researchers to publish. The pressure to have a certain number of outputs and the incentive of seeing a guaranteed return on the papers published (DHET approved units and funds received for these units) will constrain many researchers.	1	2.8	2.9	79.4
	The absence of the above. Currently, the financial and procurements systems are most constraining as these are not designed to support innovation and commercialisation.	1	2.8	2.9	82.4
	The technikon culture; the slow work of admin and finance systems; too many levels of approval at every step; large teaching and research organisation load; too many students to supervise; desire always to do the minimum; lack of interest and knowledge; heavy university structure and the feeling that it depends on you; too many sacrifices are needed.	1	2.8	2.9	85.3
	Thinking that one person can do everything well (or would want to). Many academics do good research but don't have the desire or skill to be entrepreneurs. Instead of trying to change people, rather link them up with other people with complementary skills and passions.	1	2.8	2.9	88.2
	Time not flexible enough; no financial reward; lack of research institutes to foster commercial activities.	1	2.8	2.9	91.2

	Too few entrepreneurs to act as mentors or give guidance.	1	2.8	2.9	94.1
	Too much teaching.	1	2.8	2.9	97.1
	Workloads!!! Unmotivated staff and weak, uninterested leaders; cancelling of NFR niche areas; lack of planning and vision.	1	2.8	2.9	100.0
	Total	34	94.4	100.0	
Missing		2	5.6		
Total		36	100.0		

All academics MUST think like entrepreneurs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	5	13.9	13.9	13.9
	Agree	11	30.6	30.6	44.4
	Neutral	6	16.7	16.7	61.1
	Disagree	11	30.6	30.6	91.7
	Strongly Disagree	3	8.3	8.3	100.0
	Total	36	100.0	100.0	

Good academic entrepreneurs are BORN, not MADE (trained)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	1	2.8	2.8	2.8
	Agree	12	33.3	33.3	36.1
	Neutral	8	22.2	22.2	58.3
	Disagree	11	30.6	30.6	88.9
	Strongly Disagree	4	11.1	11.1	100.0
	Total	36	100.0	100.0	

Good academic entrepreneurs are MADE (trained), not BORN

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	4	11.1	11.1	11.1
	Agree	10	27.8	27.8	38.9
	Neutral	10	27.8	27.8	66.7
	Disagree	8	22.2	22.2	88.9
	Strongly Disagree	4	11.1	11.1	100.0
	Total	36	100.0	100.0	

It would be a good idea if some academics were to focus on teaching, while others were to focus on research, others on entrepreneurship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	7	19.4	19.4	19.4
	Agree	12	33.3	33.3	52.8
	Neutral	4	11.1	11.1	63.9
	Disagree	9	25.0	25.0	88.9
	Strongly Disagree	4	11.1	11.1	100.0
	Total	36	100.0	100.0	

Research informs and complements teaching

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	19	52.8	52.8	52.8
	Agree	14	38.9	38.9	91.7
	Neutral	1	2.8	2.8	94.4
	Disagree	1	2.8	2.8	97.2
	Strongly Disagree	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

Teaching has nothing to do with research and vice versa

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	18	50.0	50.0	50.0
	Strongly Disagree	18	50.0	50.0	100.0
	Total	36	100.0	100.0	

A strong record of successful academic entrepreneurship activity is important in faculty evaluation at CPUT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	7	19.4	19.4	19.4
	Agree	12	33.3	33.3	52.8
	Neutral	5	13.9	13.9	66.7
	Disagree	11	30.6	30.6	97.2
	Strongly Disagree	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

To your knowledge, to what extent does CPUT provide commercialisation training opportunities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Constantly	2	5.6	5.6	5.6
	Sometimes	12	33.3	33.3	38.9
	Hardly ever	15	41.7	41.7	80.6
	Never	6	16.7	16.7	97.2
	Cannot answer	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

To your knowledge, to what extent does CPUT provide academic entrepreneurship training opportunities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Constantly	2	5.6	5.6	5.6
	Sometimes	8	22.2	22.2	27.8
	Hardly ever	17	47.2	47.2	75.0
	Never	8	22.2	22.2	97.2
	Seldom	1	2.8	2.8	100.0
	Total	36	100.0	100.0	

Does CPUT provide opportunities for you to apply for financial support to participate in commercialisation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	17	47.2	48.6	48.6
	No	3	8.3	8.6	57.1
	Don't know	15	41.7	42.9	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		36	100.0		

To your knowledge, does CPUT provide opportunities for you to apply for university–industry funding of your research projects?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	66.7	68.6	68.6
	No	3	8.3	8.6	77.1
	Don't know	8	22.2	22.9	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		36	100.0		

Division of Research Directorate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	29	80.6	87.9	87.9
	No	4	11.1	12.1	100.0
	Total	33	91.7	100.0	
Missing	System	3	8.3		
Total		36	100.0		

Technology Transfer Office

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	58.3	61.8	61.8
	No	13	36.1	38.2	100.0
	Total	34	94.4	100.0	
Missing	System	2	5.6		
Total		36	100.0		

I have grown as an academic researcher since I started working at this institution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	11	30.6	30.6	30.6
	Agree	17	47.2	47.2	77.8
	Neutral	4	11.1	11.1	88.9
	Disagree	2	5.6	5.6	94.4
	Strongly Disagree	2	5.6	5.6	100.0
	Total	36	100.0	100.0	

The university where you're employed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	94.4	94.4	94.4
	No	2	5.6	5.6	100.0
	Total	36	100.0	100.0	

Government entities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	21	58.3	58.3	58.3
	No	15	41.7	41.7	100.0
	Total	36	100.0	100.0	

Business firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	25.0	25.0	25.0
	No	27	75.0	75.0	100.0
	Total	36	100.0	100.0	

Private foundations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	16.7	16.7	16.7
	No	30	83.3	83.3	100.0
	Total	36	100.0	100.0	

International organisations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	36.1	36.1	36.1
	No	23	63.9	63.9	100.0
	Total	36	100.0	100.0	

Other research grants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	WRC – not sure where that fits	1	2.8	100.0	100.0
Missing		35	97.2		
Total		36	100.0		

Do you have professional work contacts with colleagues who are employed at any private companies?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	27	75.0	75.0	75.0
	No	9	25.0	25.0	100.0
	Total	36	100.0	100.0	

Do you have professional work contacts with any private companies?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	20	55.6	55.6	55.6
	No	16	44.4	44.4	100.0
	Total	36	100.0	100.0	

Are you willing to participate in a 20-minute face-to-face interview?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	27	75.0	75.0	75.0
	No	9	25.0	25.0	100.0
	Total	36	100.0	100.0	

Are you willing to provide a copy of your curriculum vitae?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	29	80.6	82.9	82.9
	No	6	16.7	17.1	100.0
	Total	35	97.2	100.0	
Missing	System	1	2.8		
Total		36	100.0		