

**ENABLERS AND BARRIERS TO INVOLVEMENT IN  
COMMERCIALISATION**

BY

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## DECLARATION

I, **Mary-Ann Chetty**, hereby declare that:

The work in this research paper is my own original work.

All sources used or referred to have been documented and recognised.

The research paper has not been previously submitted in full or partial fulfilment of the requirements for an equivalent or higher qualification at any other recognised educational institution.



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15 March 2016

Mary-Ann Chetty

Date

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## **ABSTRACT**

Universities are facing growing pressure to contribute towards innovation which has social impact and which contributes to economic development. Researchers mainly in the Science and Engineering fields are the primary sources of innovation outputs from universities and as such their involvement in commercialisation activities directly adds to the growth of innovative outputs from publicly financed research. Technology Transfer Offices (TTO) have been established at universities across South Africa to foster the involvement of researchers in commercialisation activities, to champion the innovation conversation within higher education institutions and to progress innovations from concept to application in society. This study focussed on understanding the factors which enable or create a barrier to the involvement of researchers in commercialisation activities at the Nelson Mandela Metropolitan University.

The key elements examined in this study include the researchers' perception of enablers (monetary and nonmonetary incentives) and barriers to involvement at national, institutional and individual levels. This study undertook to understand the perceptions of researchers of enablers and barriers to involvement in commercialisation at the Nelson Mandela Metropolitan University. Researchers in the two faculties of Science and Engineering, Built Environment and Information Technology were approached to anonymously complete an electronic survey, the questions for which were developed from literature. The results from the survey were analysed using descriptive statistics and hypothesis testing.

This study finds that a combination of incentives is necessary to enable researcher involvement and to lower barriers to involvement in commercialisation research. A set of recommendations based on the study are put forward on how such recommendations can be implemented.

**Key words:** academic entrepreneurship; commercialisation activities; technology transfer; enablers of involvement in commercialisation activities; barriers to involvement in commercialisation activities.

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## LIST OF ABBREVIATIONS

CSIR	Council for Scientific and Industrial Research
DST	- Department of Science and Technology
EBEIT	- Engineering, Built Environment and Information Technology
HEI	- Higher Education Institution
IP	- Intellectual Property
IPR- PFRD	- Intellectual Property Rights from Publicly Financed Research
NACI	- National Advisory Council on Innovation
NMMU	- Nelson Mandela Metropolitan University
NSI	- National Space of Innovation
RECH	- Research Ethics Committee – Human Research
R&D	- Research and Development
SARCHi	- South African Research Chairs Initiative
SME	- Small and Medium Enterprises
TTO	- Technology Transfer Office

# CHAPTER ONE: INTRODUCTION AND PROBLEM STATEMENT

## 1.1 INTRODUCTION

In the past, universities were places of higher learning and research where the dissemination of new knowledge was limited to producing new graduates and research publications (Rasmussen, Moen and Gulbrandsen, 2006). Now, universities are expected to play a distinct role in uplifting social and economic conditions through the direct transfer of innovative knowledge products to industry and the private sector (Bercovitz and Feldman, 2006). This is also fuelled by the pressure for economies to become knowledge driven (Edquist, 2010).

In order to address this transformed role from a research university to one which is more entrepreneurial and to emphasise the boldness of this progression, Etzkowitz (2003a: 109) coined the term 'entrepreneurial university'. This effectively reflects the orientation and involvement of researchers in activities that lead to greater interaction of the university with industry and the commercialisation of research outputs. This involvement, in turn, positions the university as a key partner with industry contributing to economic and social development and not just a generator of knowledge (Etzkowitz, 2003b).

The process by which universities are able to make this contribution is known as technology transfer and is directly linked to the extent of involvement of researchers in commercialisation activity (O'Shea, Allen, Chevalier and Roche, 2005). Technology transfer is the process by which intellectual property (IP) developed within a research environment is shared with society for application and use. The transfer of technology and knowledge from research institutions is important for stimulating economic growth in a country by increasing industry competitiveness and establishing new businesses (Martinez Sanchez and Pastor Tejedor, 1995).

The definition of research commercialisation refers to the transfer of knowledge products from a university to society for social or commercial benefit. The definition is drawn from the South African Intellectual Property Rights from Publicly Financed Research and Development Act (Act 52 of 2008) (DST, 2010): "the process by which any intellectual property emanating from publicly financed research and development is or may be adapted or used for any purpose that may provide any benefit to society or commercial use on reasonable terms". The involvement of researchers in commercialisation activities is considered entrepreneurial within the higher education and research environment and thus while reference is made to commercialisation activities, the phenomenon of researcher involvement in such activities is considered entrepreneurial

# Chapter 1

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(Markman, Phan, Balkin and Gianiodis, 2005; Mars and Rios-Aguilar, 2010; Trencher, Yarime, McCormick, Doll and Kraines, 2014).

In South Africa, university-industry interaction has taken place over many years and the concentration of industry-related research has been limited to a few fields and mostly to contract research (Petersen and Rumbelow, 2008). Industry benefited significantly from the interactions, gaining enhanced technical capabilities and cost efficiencies without fairly or transparently rewarding researchers for the contribution to innovation put into practice. In 2010, the Intellectual Property Rights from Publicly Financed Research and Development Act was enacted by the South African parliament. The Act states that IP arising from publicly funded institutions is owned by the state unless it is funded at its full cost by industry (DST, 2010). With the introduction of this new legislation, Technology Transfer Offices (further referred to as TTOs) at South African institutions are faced with the task of ensuring that IP generated by researchers is disclosed, protected appropriately, managed and commercialised where possible.

The Nelson Mandela Metropolitan University (NMMU) is a higher education institution established under the Higher Education Act of 1997 situated in Port Elizabeth, South Africa. The University prides itself on promoting several values including the value of 'excellence'. This reverberates across all missions of the university and extends towards innovation and engagement (NMMU, 2014).

The NMMU established a TTO in 2006 to foster a culture of innovation within the University in order to promote the commercialisation of knowledge products and services developed by researchers. These services are known as Innovation Support and Technology Transfer.

## **1.2 PROBLEM STATEMENT**

The purpose of this study is to identify and understand the factors that enable researchers to be involved in commercialisation activities and those factors that impede or create barriers to researcher involvement within an institution.

This is a relatively new area of research, having arisen from a study performed by Walter, Ihl, Mauer and Brettel (2013) on the incentives (considered to be enablers) implemented by institutions to encourage involvement and so assist the institution to meet objectives of social and economic upliftment to the local economy. Perceived barriers to involvement encourage precisely the opposite effect and it is important to identify the



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barriers within existing frameworks of the institution so that strategies to overcome them can be set in place.

The involvement of researchers in commercialisation activities (such as involvement in the process of identification, protection and commercialisation of IP relating to research outputs) is critical to successfully transferring technology to society and generating social and economic benefit for the institution, the inventors, society and the organisation to which the technology is transferred (Jensen and Thursby, 2001). This study of researcher involvement in commercialisation activities is supported by research on researcher entrepreneurship, university-industry interaction and technology transfer. The involvement of researchers in commercialisation activities is considered entrepreneurial in its nature and to be in direct relation to the commercialisation process managed and guided by the technology transfer office. However, the involvement of researchers in these activities is often considered to be in conflict with the norms, policies and measurements prescribed by the university because researchers are expected to conduct research and development in order to generate new knowledge. This is known as the 'Mertonian way' of thinking about the role of researchers and was documented in a seminal paper by Merton (1973: 275).

The objective of this study is to identify the factors that enable and create barriers to researcher involvement in commercialisation activities from literature and to understand the prevailing opinions of researchers at the NMMU. The outcome of this study will be a set of recommendations to improve researcher involvement in commercialisation activities at the NMMU.

## 1.3 RESEARCH OBJECTIVES

The main research objective of this study is as follows:

**RO<sub>M</sub>:** To identify and understand the enablers and barriers to the involvement of researchers in commercialisation activities.

In order to achieve the above-stated main research objective, the following secondary objectives need to be achieved:

**RO<sub>1</sub>:** Perform a literature review to define the enablers and barriers to involvement in commercialisation activities and to define commercialisation activities within the context of technology transfer;

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**RO<sub>2</sub>**: Define the importance of researcher involvement in commercialisation activities;

**RO<sub>3</sub>**: Explain the research methodology used for this research study with sufficient detail to allow it to be reproduced in future;

**RO<sub>4</sub>**: Conduct a structured survey to be completed by researchers at the NMMU;

**RO<sub>5</sub>**: Use the outcome of the survey to provide informed recommendations to improve researcher involvement in commercialisation activities.

## 1.4 RESEARCH QUESTIONS

The main research question was formulated based on the Main Research Objective:

**RQ<sub>M</sub>**: Are researchers at the NMMU optimally involved in commercialisation activities?

In order to analyse the above main research problem, the following research questions based on the secondary research objectives, need to be answered:

**RQ<sub>1</sub>**: What are commercialisation activities at a university?

**RQ<sub>2</sub>**: What are the enablers to researcher involvement in commercialisation activities on a global, national, regional and local level?

**RQ<sub>3</sub>**: What are the barriers to researcher involvement in commercialisation activities on a global, national, regional and local level?

**RQ<sub>4</sub>**: How can a detailed description of the research methodology be provided in order to understand and reproduce this research study in future?

**RQ<sub>5</sub>**: To what extent are NMMU researchers involved in commercialisation activities?

**RQ<sub>6</sub>**: What is the perception of researchers on involvement in commercialisation activities?

**RQ<sub>7</sub>**: What is the general perception held by NMMU researchers on the existing enablers and barriers to involvement in commercialisation activities?

**RQ<sub>8</sub>**: How can barriers be lowered and enablers enhanced to encourage involvement in commercialisation activities?

# Chapter 1

## 1.5 RESEARCH DELIMITATION

This study is designed to gain an understanding of the perception held by researchers as to whether involvement in commercialisation activities is enabled or impeded at the NMMU. As such, the research is limited to the NMMU. The NMMU comprises seven faculties: Arts; Business Economics; Education; Engineering, Built Environment and Information Technology (EBEIT); Health Sciences; Law and Science. The scope of the study is limited to researchers employed on a full time basis at the NMMU within the faculties of EBEIT and Science.

**Table 1.1: Layout of Treatise**

Research Question	Research Objective	Chapter
RQ <sub>1</sub> : What are commercialisation activities at a university?	RO <sub>1</sub> : To define commercialisation activities	Chapter Two: Literature review
RQ <sub>2</sub> : What are the enablers to researcher involvement in commercialisation activities on a global, national, regional and local level?	RO <sub>2</sub> : Perform a literature review to define the enablers and barriers to involvement in commercialisation activities, and to define commercialisation activities within the context of technology transfer	Chapter Two: Literature review
RQ <sub>3</sub> : What are the barriers to researcher involvement in commercialisation activities on a global, national, regional and local level?	To define the importance of researcher involvement and the enablers and barriers to researcher involvement	Chapter Two: Literature review
RQ <sub>4</sub> : How can a detailed description of the research methodology be provided in order to understand and reproduce this research study in future?	RO <sub>3</sub> : Explain the research methodology used for this research study with sufficient detail to allow it to be reproduced in future	Chapter Three: Research Methodology

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RQ <sub>5</sub> : To what extent are NMMU researchers involved in commercialisation activities?	RO <sub>4</sub> : To conduct a structured survey to be completed by researchers at the NMMU	Chapter Four: Results and analysis of empirical study
RQ <sub>6</sub> : What is the perception of researchers on involvement in commercialisation activities?		
RQ <sub>7</sub> : What is the general perception held by NMMU researchers on the existing enablers and barriers to involvement in commercialisation activities?		
RQ <sub>8</sub> : How can barriers be lowered and enablers enhanced to encourage involvement in commercialisation activities?	RO <sub>5</sub> : To use the outcome of the survey to provide informed recommendations to enhance researcher involvement in commercialisation activities	Chapter Five: Findings, recommendations and conclusion

## 1.6 RESEARCHER INVOLVEMENT IN COMMERCIALISATION ACTIVITIES

### 1.6.1 *Commercialisation Activities*

In this study, commercialisation activities are defined as:

- i. Discussion of innovative research findings with the Technology Transfer Office (TTO); typically called a disclosure (at the NMMU, the TTO is the Innovation Office);
- ii. Protection of IP through patenting of inventions, registration of functional and aesthetic designs, and filing of trade marks;
- iii. Involvement in the formation of a university spin-off company;
- iv. Licensing of research outputs to external organisations.

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Wood (2011) points out that researcher involvement in commercialisation activities is broadly covered under the title of academic entrepreneurship. O'Shea et al. (2005: 1006) define academic entrepreneurship as an all-encompassing term, which refers to the “efforts and activities undertaken by universities and their industry partners... in the hope of commercialising research outputs which will generate revenue”. This is supported by previous work done by Chrisman, Hynes and Fraser (1995) which demonstrated that researchers could successfully be involved in spin-off companies and that their involvement was in fact crucial to the success of several spin-offs which generated a significant amount of income for the University of Calgary.

Critical, however, are the individual and institutional factors that enable or impede researcher involvement in commercialisation activities, which affect the successful commercialisation of research outputs. The majority of the literature on this topic focuses on the involvement of researchers from a commercial firm's perspective and the efficiency of the TTO as an enabler in the process. Little attention has been paid previously to the motivations of the individual researchers or the enabling and hindering factors of the institution. In addition, an emphasis in the literature has been placed on the formal commercialisation activities (such as the number of licenses concluded and spinouts created) rather than the informal ones, as the impact of the former are easier to measure and observe (McDevitt, Mendez-Hinds, Winwood, Nijhawan, Sherer, Ritter and Sanberg, 2014).

## **1.6.2 Institutional Barriers**

### *1.6.2.1 Institutional management support*

Bercovitz and Feldman (2008) showed that researchers may be reluctant to engage in commercialisation activities even though institutional management may encourage it. The study will provide an understanding on whether researchers at the NMMU perceive that direct line managers as well as institutional management are supportive of researchers being involved in commercialisation activities and whether this makes a difference to their involvement.

### *1.6.2.2 Researchers unaware of the TTO*

The literature is lacking regarding researcher awareness of the functions of the TTO or the commercialisation process. This is due to most of the research in the fields of technology transfer and research policy emanating from developed countries such as

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the United States, the United Kingdom and European countries. In these developed countries, programmes exist to educate researchers on the process and implications and thus awareness is not a need or a challenge among researchers. These countries have also been commercialising research outcomes for a much longer period compared to developing economies such as South Africa where the oldest TTO is about fifteen years old. Legislation has been in place for a lot longer in the developed countries. Alessandrini, Klose and Pepper (2013) reported that there was a distinct lack of awareness of IP, the function of the TTO and benefits of commercialisation amongst researchers in South Africa.

Owen-Smith and Powell (2001) found that when researchers decide whether to patent or not, their awareness of the TTO functions and the benefits of commercialisation influenced the likelihood of their disclosing the invention to the TTO. In essence, the perceived benefits of involvement in commercialisation activity incentivised disclosure. Nilsson, Rickne and Bengtsson (2010) discussed the ways in which researchers make decisions to commercialise their research. They concluded that there is a significantly positive relationship between the awareness of TTO functions and the likelihood of disclosure. The lack of awareness of TTO functions is worth investigating at the NMMU, as the results will have an effect on the concluding strategy where particular interventions will be recommended for the institution.

### **1.6.3 Institutional incentives**

Walter et al. (2013) carried out a study to determine how the goals of the entrepreneurial university can be achieved. Their study outlines the role of incentives and researcher motives for involvement in commercialisation activities in stimulating technology transfer. The study further validated the use of institutional incentives in the USA in increasing the likelihood of invention disclosure. Walter et al. (2013) undertook to analyse the effects of combinations of incentives using several case studies from European universities from a statistical perspective. They categorised eighteen influential factors into three categories: 1) monetary motives and incentives, 2) non-monetary motives and incentives, and 3) favourable working conditions, including the reduction of barriers to technology transfer. These are explained and defined further in Chapter Two.

**Table 1.2: Characterisation of incentives by Walter (2013)**

Incentive Type	Incentive
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Monetary incentives	Once-off payment for granted patents Percentage of revenues paid to the inventor Percentage of revenues paid to the work group of inventors Percentage of revenues paid to the faculty of the inventor(s)
Non-monetary incentives	Inclusion of patent counts in researcher performance assessments Award for granted patents
Facilitators of negative incentives	Technology transfer office characteristics Grace period*

\*The grace period refers to a period after publication of research where researchers are still allowed to patent the invention (Walter et al., 2013). This is not permissible under South African patent law (Act 57 of 1978) (RSA, 2002).

## **1.6.4 Individual Motives**

It is important to understand the types of motives held by researchers within the institution so that suitable incentives can be reinforced or recommended to encourage involvement in commercialisation activities. Individual motives include monetary and non-monetary rewards. Monetary rewards include once-off payments for granted patents and revenue shares from successful commercialisation. Non-monetary incentives include the inclusion of patent counts in researcher performance, awards for granted patents and presence of a centralised TTO (Walter et al., 2013). The relationship between institutional incentives and individual motives will be investigated and the results used to inform the strategy.

## **1.6.5 Research Design Objectives**

In order to meet the primary and secondary objectives, the following research design objectives are undertaken:

- i. Conduct a literature review on the enablers and barriers at national and institutional levels – addressed in Chapter Two;

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- ii. Construct a structured questionnaire for collection of data. A copy of this questionnaire is attached in Annexure A;
- iii. Distribute the questionnaire electronically to researchers in the NMMU Faculties of Science and Engineering, Built Environment and Information Technology;
- iv. Capture the data in MS Excel;
- v. Analyse the data – addressed in Chapter Four;
- vi. Interpret the results and draw conclusions – addressed in Chapter Four;
- vii. Provide recommendations for the enhancement of researcher involvement in commercialisation activities at the NMMU in the form of strategic interventions – Addressed in Chapter Four.

## **1.6.6 Hypothesis**

The management conclusion rests in the alternative hypothesis:

**H1:** There is a significant difference between the perceptions held by researchers involved versus those not involved in commercialisation activities with respect to institutional support provided to enable involvement in commercialisation activities.

**H2:** Researchers perceive that there is a significant correlation between institutional non-monetary support and involvement in commercialisation activities.

**H3:** Researchers perceive that there is a significant correlation between management support and involvement in commercialisation activities.

**H4:** Researchers perceive that there is significant correlation between TTO support and involvement in commercialisation activities.

**H5:** There is a significant correlation between researchers' individual monetary motives and institutional monetary incentives for involvement in commercialisation activities.



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## 1.7 METHODOLOGY OF THE STUDY

### 1.7.1 *Research Paradigm*

Collis and Hussey (2009: 56-67) describe two paradigms (positivism and interpretivism) that provide frameworks within which research is conducted. Positivism refers to a quantitative approach where research variables are broken down into simple elements and hypotheses are formulated. The relationship between the variables is then tested. Interpretivism refers to a quantitative approach where the perception of different phenomena is investigated.

This research is conducted in the positivistic paradigm using a quantitative approach where the hypothesized relationships between enablers and barriers and involvement in commercialisation activities will be tested. The primary research data will be collected by means of an electronic questionnaire and the statistics resulting from responses will be analysed, reported and interpreted. The outcomes of the analysis of data will inform a set of recommendations for interventions discussed in Chapter Five, which will be useful to the NMMU.

### 1.7.2 *Literature Study*

The literature study was conducted to define key concepts relating to the topic. Literature will be sourced from online databases or journal publications, textbooks, public policy documents such as legislature and conference proceedings.

### 1.7.3 *The Measuring Instrument*

The instrument will be used to measure the effect of factors on researcher involvement in commercialisation activities. This will be done by means of an electronic questionnaire comprising the following sections:

- i. Respondent demographic profile;
- ii. Extent to which respondent conducts research and the type of research;
- iii. The extent to which researchers have been or expect to be involved in commercialisation activities;
- iv. Respondent's opinion of existing institutional support

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- v. Respondent awareness of TTO support;
- vi. Respondent's perceived value of TTO support;
- vii. Respondent's opinion of the importance of involvement in commercialisation activities;
- viii. Respondent's understanding and opinion of personal incentives for involvement in commercialisation activities;
- ix. Respondent's opinion of proposed interventions to improve researcher involvement in commercialisation activities.

## **1.7.4 The Sample**

The electronic questionnaire was distributed by means of an electronic link to an online internal (NMMU) survey. The link to the survey was distributed by email to researchers and academic staff of the Science and EBEIT faculties at the NMMU. The responses received were divided into two groups – Group 1: researchers not involved in commercialisation activities and Group 2: researchers involved in commercialisation activities. The sample number for each group was at least 15 respondents. The identities of the respondents remain anonymous and untraceable. The study aims to meet a response rate in line with a 95% confidence interval.

## **1.7.5 Validity**

In order to validate the proposed research questions, the questionnaire was reviewed and assessed by a senior professional in the technology transfer profession. The questionnaire was edited and designed to improve the validity according to this review.

## **1.7.6 Data Analysis**

Since data that are numeric, interval-scaled, ratio-scaled and continuous allow for greater statistical methods to be applied compared to data that are categorical, nominal-scaled, ordinal-scaled and discrete, the former were used to correspond to questions which are relevant and in the correct format.

Descriptive statistics (mean, median, standard deviation proportions and percentages) will be reported from the data collected in the forms of tables and graphs.

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Inferential statistics will be used to infer findings from the data collected by using the following methods: confidence intervals, hypotheses tests (single sample and two samples). The t-test and paired t-test methods will be used to test the hypotheses noted in the Research Design to determine whether there is sufficient evidence to support the management claims.

## **1.7.7 Ethics**

Approval to distribute the electronic questionnaire was sought from the NMMU REC-H Ethics committee. Endorsement of the study from the Deputy Vice Chancellor: Research and Engagement was sought and provided to the REC-H Ethics committee as supporting documentation as well as to the Deans of Faculties before the questionnaire was distributed electronically. The approval reference number from the REC-H committee was noted on all correspondence.

## **1.7.8 Outline of the study**

The study is comprised of the following chapters:

- i. Chapter one provides an introduction and overview of the study, the problem statement, conceptual model, research objectives, sample and measuring instruments.
- ii. Chapter two provides an overview of key underlying constructs relevant to the study and a literature review that supports the study.
- iii. Chapter three discusses the methodology of the study and the approach used. The sample, measuring instruments and data analyses procedures.
- iv. Chapter four reports the data collected, analyses and interpretation.
- v. Chapter five comprises a discussion of the results and conclusions drawn from the results.

Figure 1.1 illustrates an overview of the chapters. Chapter two which follows comprises a detailed literature review.

# Chapter 1

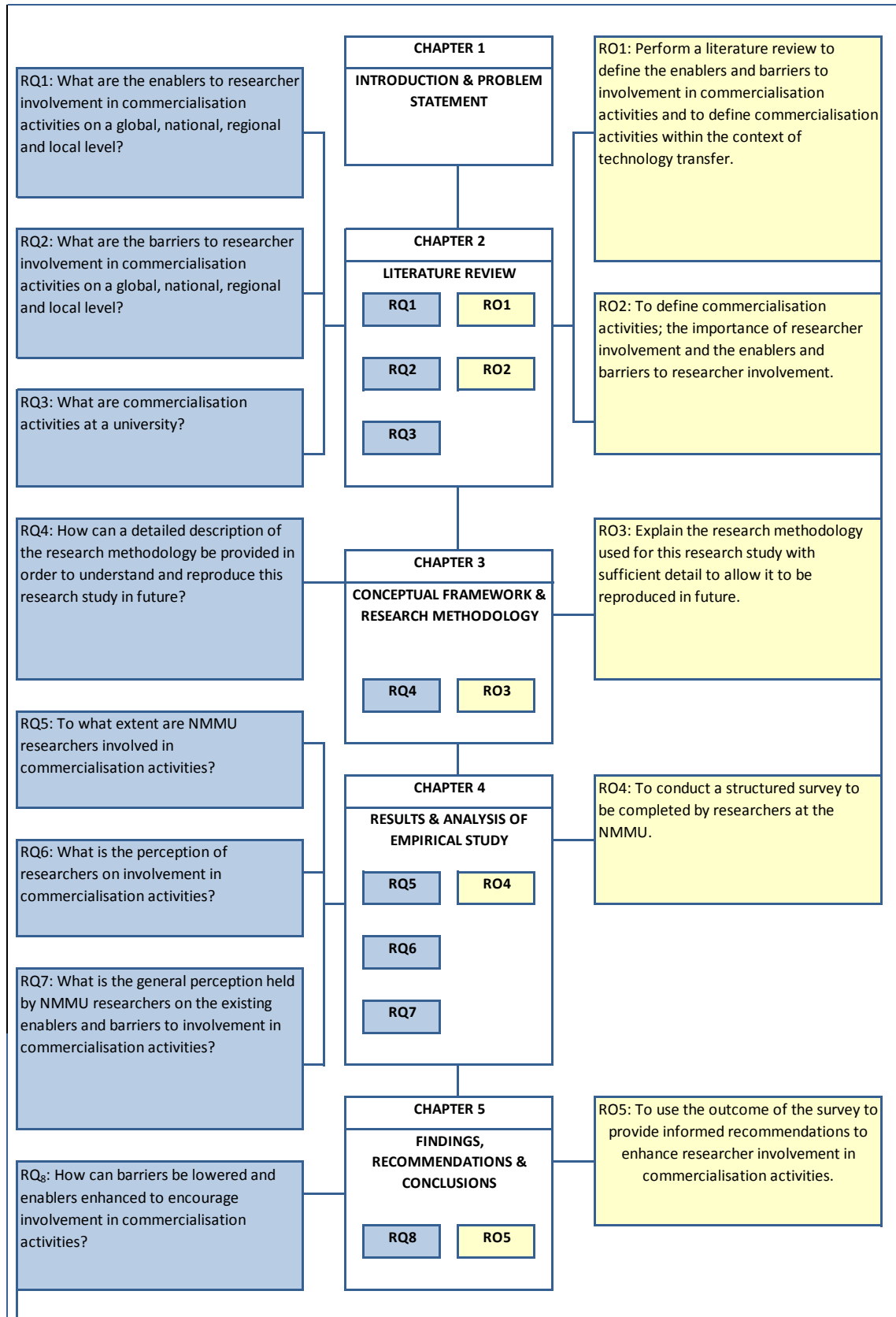


Figure 1.1: Overview of Treatise

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## CHAPTER TWO: LITERATURE REVIEW

### 2.1 INTRODUCTION

Chapter 1 provided an outline of the research questions which need to be investigated and research objectives which need to be achieved. This chapter comprises a literature study to provide a background to the need for the research.

With the changing role of the university in today's society and pressures from national government to carry out a third mission of contributing to socio-economic development in the country, the involvement of researchers in commercialisation activities becomes crucial to carrying out this third mission. Literature on academic entrepreneurship or the involvement of academics in commercialisation activities at South African higher education institutions is distinctly lacking. It is from this perspective that the study has been proposed.

In order to carry out a study on researcher involvement in commercialisation activities, it is important to take note of the underlying constructs, which gave rise to the study of academic entrepreneurship and the enablers and barriers to involvement in commercialisation activities.

This provides the context to the review of enablers and barriers at national level as described by Rasmussen et al. (2006); Macho-Stadler and Pérez-Castrillo (2010); Walter et al. (2013). Institutional level barriers include a lack of institutional management support (Walter et al., 2013) and a lack of awareness of TTO support (Alessandrini et al., 2013). Institutional level enablers include monetary and non-monetary incentives (Rasmussen et al., 2006) and individual researcher motives for involvement in commercialisation activities (Walter et al., 2013; Markman et al., 2005). This addresses RQ<sub>1</sub> and RQ<sub>2</sub>.

The involvement of researchers in commercialisation activities is important to the institution performing its third mission. Implementing policies, influencing social norms and promoting the appropriate culture to encourage researchers to be involved is critical to carrying out the third mission. Thus it is important to understand the perceptions of researchers in relation to the existing norms and incentives for involvement to formulate whether existing schemes and policies are creating barriers or enabling the process of innovation.

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The policy and management environment of the university is prescribed by government legislation and the values promoted by the institution (Edquist, 2001). The institutional policy framework, therefore, prescribes a framework within the context set forth by the legislation and the implementation of the policy reflects the values promoted by the institution. The institutional policy describes the obligations of researchers as well as the incentives and benefits for abiding by the policy (Kreitner, Kinicki and Buelens, 2004: 54).

This chapter seeks to provide the following:

- i. a review of the concepts of innovation, the entrepreneurial university, technology transfer as a process, the associated commercialisation activities and the types of interaction that take place through industry engagement;
- ii. to report the literature on academic entrepreneurship;
- iii. to provide an overview of the enablers and barriers associated with academic entrepreneurship;
- iv. to discuss the development of the South African National System of Innovation;
- v. to discuss the enablers and barriers to researcher involvement in commercialisation activities at the level of the institution; and
- vi. to discuss the individual motives and barriers to involvement in commercialisation activities.

An outline of the chapter is provided in Figure 2.1.

# Chapter 2

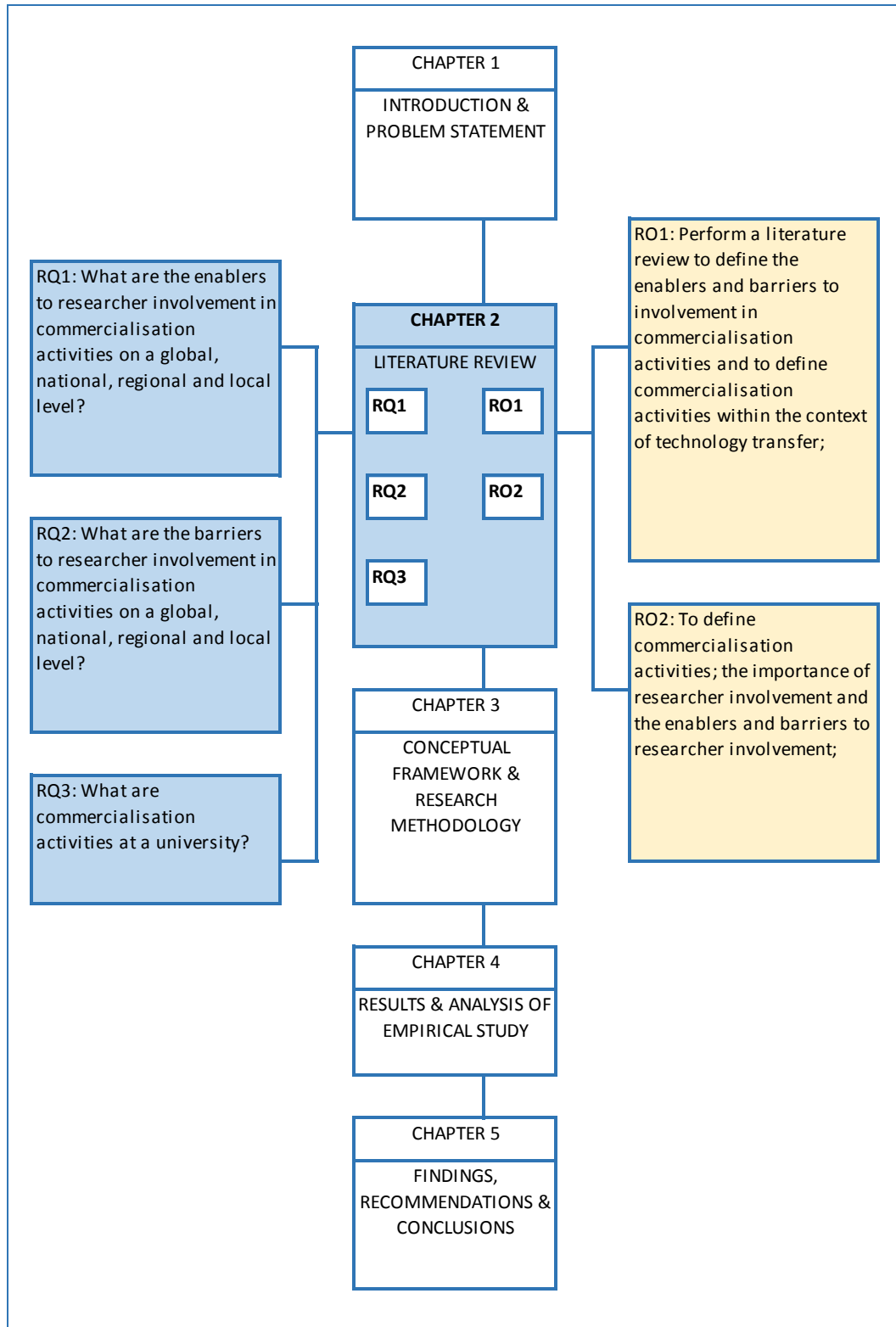


Figure 2 1: Overview of Chapter Two

# Chapter 2

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## 2.2 KEY UNDERLYING CONSTRUCTS AND DEFINITIONS

### 2.2.1 Innovation

Innovation is described by several publications as a key driver for regional economic development (Hassink and Berg (2014); (Meliciani and Savona, 2014; Audretsch, Coad and Segarra, 2014). It is also a driver of global competitiveness and is essential for the improvement of the quality of life (Hausman and Johnston, 2014). Baregheh, Rowley and Sambrook (2009: 1334), in their analysis of definitions of innovation, arrived at the following description: “Innovation is the multi-stage process whereby organisations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace”. Within this context, a university is considered to be an organisation and while its primary aim is to generate new knowledge, the embodiment of the new knowledge can be in new innovations, which can be transferred to the market place. The types of research which researchers undertake at universities are classified as basic, applied and user-inspired. Any one of these types may give rise to innovation.

An innovation (in the noun form) is an idea perceived as new and can be described at four different levels with increasing novelty according to the guideline provided by the Organisation for Economic Co-operation and Development (OECD):

- i. Innovations that are only new to the firm;
- ii. Innovations that are new to the market and the firm;
- iii. Innovations that are new to the country; and
- iv. Innovations that are a world first (OECD/Eurostat, 2005).

In general, technology transfer at universities deals mostly with innovations that are new to the market and the firm, to the country and the world. Innovations that are new to the market and the firm are innovations adopted for a different utility in a recipient industry e.g. a polymer utilised in the cable insulation industry that can also be used in the clothing and fabric industry as an insulative material to retain heat. Sometimes the link between the application of a known product that provides the same utility is not immediately apparent to the firm and in-depth research is required to assess the application and whether modification is needed. The researcher can thus play a role in identifying materials and processes, which have a cross-application.



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Innovations that are new to the country are generally technologies imported to improve industry competitiveness (Moses, Sithole, Labadarios, Blankley and Nkobole, 2012; Carayannis, Del Giudice, Della Peruta, Chase and Dumay, 2014) e.g. turnkey solutions for the manufacture of rapid diagnostic test kits for the detection of infectious diseases. Innovations that are a world first are those that are completely novel and have not been put into practice before.

The requirements for patenting of inventions are: i) strict novelty (must be a world first), ii) utility (can be applied in a practical context by industry) and ii) inventiveness. There must be some improvement over the prior art, which is evident in the claims. Patents are generally granted in territories (countries or regions which include a set of countries) where examination of the invention by an expert in the subject matter, reveals that the patent meets the three requirements (Bosworth, Bosworth and Webster, 2006: 33).

## 2.2.2 Technology Transfer versus Innovation Diffusion

The uptake of university-developed technology by society has been described to occur either through some technology transfer mechanism which places the technology into practice, or by the diffusion of the innovation into society. While both of these processes are instigators of a change process, they are distinct concepts. Diffusion of innovation is the process through which an innovation is communicated via certain channels over time among the units in a social system (Rogers, 2002). The differences in the concepts can be understood through the table below.

**Table 2.1: Key Differences between Technology Transfer and Diffusion of Innovation (adapted from (Rogers, 2002))**

Factor	Technology transfer	Innovation diffusion
<b>Orientation</b>	Producer-orientated	User-orientated
<b>Process differences</b>	R&D is conducted by an organisation and users are in another organisation	Developers of innovation can also be users emphasising person to person social network through which innovation spreads

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<b>Research and Development process</b>	Planned and directed	Spontaneous and more likely to be under the control of users
<b>Key commercialisation questions</b>	How do research results get commercialised?	How does an innovation once available spread among system members?

Both processes play a role in the adoption of technology, however, it is more likely that technology diffusion takes place more rapidly when an innovation is made available at low or no cost (whether or not the intellectual property rights are protected or not). Often referred to as open-source or open innovation, the technology is generally released in its rudimentary form to a group of users who are free to develop it further for their own use and for the use of the original developer for the broadest application of the technology. An example of this is software applications for smart phones.

### **2.2.3 Entrepreneurial University**

Some critics argue that the role of universities in a knowledge-based economy is to be a source of human capital by acting as strategic infrastructure to build competitive human capacity (Van Looy, Callaert and Debackere, 2006). Others such as Nelson (2004) say that commercial activities may be a threat to traditional academic freedom and compromise the expansion of basic research (also see (Slaughter and Leslie, 1997). However, in a knowledge-based economy, universities certainly serve as a critical element of the innovation system as the source of human capital and of new firms (Etzkowitz, Webster, Gebhardt and Terra, 2000). This evolution of the role of universities in society is commonly referred to as “a shift away from the ivory tower” towards becoming a more entrepreneurial university (Etzkowitz, 2003b: 110) and is supported by an increase in public funding for commercialisation activities and technology transfer. Etzkowitz (1998) describes the ‘entrepreneurial university’ as one where the relationships between faculty researchers and the private sector form an integral part of commercialising research outputs for social and commercial benefit.

Universities largely use the opportunity of commercialising research outputs to respond to some social or economic need and in so doing enhance their reputation and add value in general (Trencher et al., 2014). Acknowledging the dependency of the

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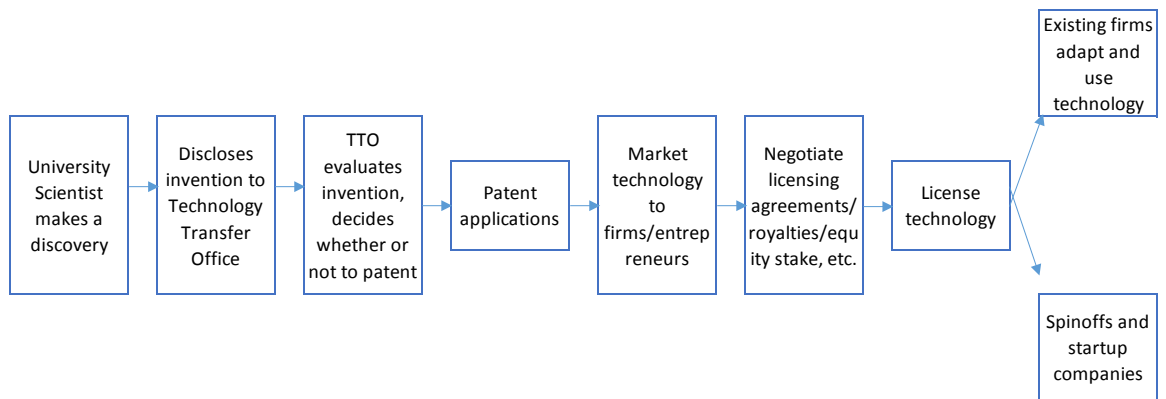
commercialisation process on the involvement of researchers, literature has drawn focus towards them as critical enablers of the commercialisation process (Rasmussen et al., 2006). The involvement of researchers in commercialisation activities is guided by their decision-making process (Göktepe-Hulten and Mahagaonkar, 2010). Their involvement is considered entrepreneurial and recently there has been much development in the understanding of 'academic entrepreneurship' as a concept and the use of incentives to stimulate the process of technology transfer (Walter et al., 2013).

### **2.2.4 Technology Transfer**

Technology transfer is regarded as the application of information and as Rogers (2002) describes, is a two-way communication process between the receptors (who can be profit making or not) of a technological innovation and the researchers who created or developed the technology in order to commercialise the innovation into a product or process which can be put to use. Rogers (2002) points out that while technology transfer is fundamentally a communication process by which the results of scientific research are put to use, it is a difficult process subject to a range of changing external and internal influences. In a seminal paper by Eveland (1987) 'technology' is described as information put to use to accomplish some task usually stemming from the development of scientific knowledge and a 'technological innovation' is some concept, invention or process that is perceived by an individual or other organisation as new and useful. 'Transfer' refers to the movement of the technological innovation (or information) via a communication channel assisted or enabled by a transfer mechanism (license or sale or other informal mechanism) from one organisation to another for application (Rogers, 2010). The process of technology transfer is described as a series of particular events from the discovery or development of an innovation to the utilisation of the innovation or practice of the technology by consumers (Rogers, Takegami and Yin, 2001; Siegel, Waldman, Atwater and Link, 2004).

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**Figure 2.2: The Traditional Model of Technology Transfer as depicted in (Siegel et al. 2004)**

Technology Transfer Offices (TTOs) play a central role in the identification, protection, management and transfer of knowledge and technology from the institution to industry and society (Colyvas, Crow, Gelijns, Mazzoleni, Nelson, Rosenberg and Sampat, 2002). The components that enable technology transfer to occur include technological innovations, scientific knowledge and often IP. The involvement of researchers is critical to the process and the extent of involvement can determine the success of the transfer (Colyvas et al., 2002).

University technology transfer and commercialisation are complex processes and require the support of the researchers, the institution and the regional industry in order for value to be created (Friedman and Silberman, 2003). Technology transfer mechanisms involve licensing inventions or starting up new companies (called spin-offs) based on the university's research. Research and development (R&D) resources, infrastructure, seed capital, entrepreneurial incentives and culture, university-industry interaction, intermediary agents, leadership, political, academic and corporate are only a few of the efforts involved in shaping workable processes. Moreover, a successful technology transfer practice in one environment may not be a successful practice in another since resources, cultures, environments and priorities vary from university to university, community to community and region to region in terms of local government (Colyvas et al., 2002; Hall, Matos, Bachor and Downey, 2014).

To facilitate and enable the process of commercialisation of knowledge, many universities in the US and many in South Africa have established technology transfer offices to carry out the tasks of filing and managing the legal protection as well as the formulation of strategies, which lead to commercialisation of promising technologies.

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South African technology transfer offices in terms of the IPR Act (Act 51 of 2008) are responsible for identification, protection, management and commercialisation of intellectual property

### **2.2.5 Commercialisation Activities**

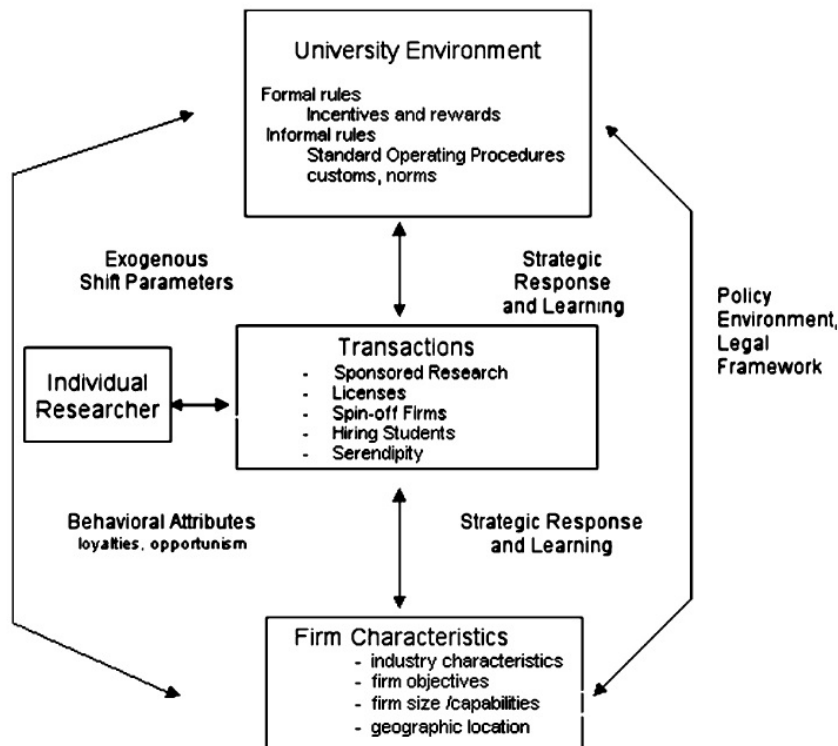
In studying academic entrepreneurship, Wood (2011) describes a process of activities involving researchers and the TTO in identifying, protecting and ascertaining the commercial potential (which includes social and financial return) and licensing of research outcomes. While Wood's process model of academic entrepreneurship supports the technology transfer process developed by Rogers et al. (2001), academic entrepreneurship literature has considered researcher involvement in these stages as commercialisation activities. Although the model developed by Rogers et al. (2001) compliments the model presented by Bercovitz and Feldman (2006), it represents the process as linear which is not a true reflection.

The process of progressing innovative research outcomes from the laboratory to practical use by an industry partner, society or a newly-formed company involves a complex process of diverse activities performed by various role players, but definitively starts with the researcher disclosing the innovative findings or output to the technology transfer office. The role players include the researchers, the technology transfer office, the licensee or entrepreneur of a new spin-off company, funders and other peripheral role players like intermediaries, consultants, business incubators and science parks (Metcalfe, 1995).

Bercovitz and Feldman (2006) proposed a conceptual framework (Figure 2.3) to describe the interactions and factors that affect the players and processes involved in the exchange between industry and the university. This is applicable to institutions which have a central technology transfer office (as opposed to a regional TTO that services two or more universities (Smith, Chapman, Wood, Barnes and Romeo, 2014)) as well as to entrepreneurial academics that take the responsibility themselves to commercialise their research outcomes - an institutional policy phenomenon known as 'professors privilege' (Sampat, 2006) This treatise only considers literature where the TTO is a central office. The TTO in this context is generally the co-ordinator of several commercialisation activities and according to Markman et al. (2005) plays one of the most central roles in the commercialisation process.

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There are several factors that affect interactions and decisions for technology transfer and commercialisation to occur. The model presented by Bercovitz and Feldman (2006) in Figure 2.3 makes reference to the environmental factors which shape the interactions among the TTO, inventors/researchers, the university and the firms to which transfer may take place. The fact that it is considered entrepreneurial for researchers to be involved in them is further explained in the section on Academic Entrepreneurship (Section 2.4,p29).



**Figure 2.3: University-industry Conceptual Framework (Bercowitz & Feldman, 2006)**

Specific areas of this model of the entrepreneurial university are studied in this research to understand the factors that enable or create barriers to researcher involvement in commercialisation activity, specifically: researchers’ perceptions of the institutional enablers and barriers to pursuing commercialisation activities.

### 2.2.6 Industry Collaboration

While the traditional roles as sources of technological advance for industry through teaching and research remain for universities, university-industry collaboration has increased significantly in recent years due to four inter-related factors:

- i. the development of new high-opportunity technology research platforms such as Computer Science, Biotechnology and Material Science;

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- ii. the general growth of scientific and technological content of industrial production;
- iii. the need for new sources of research funding created by budgetary stringency;  
and
- iv. the prominence of government policies aimed at raising the social and economic returns of publicly funded research by stimulating university technology transfer (Bercovitz and Feldman, 2006).

The inclusion of contributing to social and economic development as a third mission (the first and second being teaching and research) has been conceptualised in the 'Triple Helix model' (Leydesdorff and Etzkowitz, 1996) which takes into account the role of universities as knowledge creation and dissemination players in their interaction with government and industry to meet social and economic needs of society. A means by which the impact of the triple helix interaction is maximised is through the commercialisation of research outputs. Private firms and publicly funded research universities, however, have profoundly different missions and often display mutual distrust (Rhoades and Slaughter, 2004). The notion that the presence of a university will automatically lead to economic development due to the important assets which it holds, is also a misguided conception (Bercovitz and Feldman, 2006) and technology transfer offices play a central in enabling the connections between university and industry to be made and for knowledge transfer to occur (O'Shea et al., 2005). University infrastructure, researcher prestige and the ease of doing business with the institution also contribute significantly to the triple helix model being implemented and exploited for maximum value to the local economy (Bruneel, d'Este and Salter, 2010).

## ***2.2.7 Legislation and National Policy – The National Intention to Enable Innovation***

Legislation and policies within a country intend to enable society to work within a framework towards achieving national goals. Patent legislation in the last thirty years has received significant attention in terms of the incentive framework provided for universities and researchers to become involved in commercialisation of research outputs (Perkins and Tierney, 2014; Grimaldi, Kenney, Siegel and Wright, 2011). South Africa, like many other countries (developed and developing), drew its inspiration from the Bayh-Dole legislation in the United States (Barratt, 2010) with an expectation that the behaviour of economic growth and social benefits following its enactment may occur in South Africa (SAnews.gov.za, 2013).

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### *2.2.7.1 The inspiration of the Bayh-Dole Act to other countries including South Africa*

In the United States, the passing of the Bayh-Dole Act (USA, 1980) encouraged and enabled universities to strengthen their technology transfer capacity with a medium- to long- term view for the university to recoup its investment from successful products. Some authors viewed the legislation as an incentive for universities to commercialise a wealth of research which was 'sitting on the shelves' not being put to use (Walter et al., 2013). Others viewed the Bayh-Dole Act as an enabling policy which placed the certainty of patent ownership and the rights to license in the hands of publicly funded research institutions and provided the institution with the opportunity and flexibility to decide on how to benefit from its commercialisation efforts (Mowery, Nelson, Sampat and Ziedonis, 2001; Sampat, 2006). Prior to the passing of this uniform federal policy, universities would have go through a burdensome and time-consuming petition process to retain patents that they produced. The same effort was applicable to industry players who wanted to license or buy the rights to technologies. In short, the federal government was ill-equipped to deal with commercialisation of early stage technologies that arose from their laboratories and universities (Sampat, 2006).

Essentially, Bayh-Dole moved the incentive structure that governed the research and development route of federally funded inventions by allowing institutions to own inventions resulting from federally funded research and to exclusively license those inventions. The legislation also requires the institution to establish policies specifically relating to the disclosure, protection and development of patentable technologies for its employees. Beyond these requirements, the legislation leaves much to the discretion to the institutions. This flexibility has been a source of strength and weakness for Bayh-Dole (Boettiger and Bennett, 2006).

The passing of Bayh-Dole Act is not without its criticism and most recently debates have emerged on the rights of the public to commercialised inventions which they perceive to have already paid for through their tax money (Perkins and Tierney, 2014). This is important to the South African context as similar debates may arise as new products developed by universities enter the market. The economic effects of the Bayh-Dole Act have, however, been placed into context with supportive statistics on the number of jobs created, whole industries that have been created and the monetary contribution to the US economy (McDevitt et al., 2014; Anonymous, 2002). Whether the effects are strong



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enough to get the public onto the side of the university TTOs who undertake to commercialise new inventions, however, remains to be seen.

### *2.2.7.2 The Intellectual Property from Publicly Financed Research and Development Act*

The Intellectual Property from Publicly Financed Research and Development Act (Act 51 of 2008) was promulgated on 2 August 2010 in South Africa and, as the short title suggests, applies only to intellectual property that arises as a result of state-funded expenditure into research and development. The legislation takes its cue from the Bayh-Dole Act, placing the ownership of intellectual property generated from publicly funded research with the recipient (the institution). The legislation places obligations on the institutions as well as the researchers. The IPR Act obliges the institutions to establish technology transfer offices and policies for the disclosure, identification, protection, development, management and commercialisation of intellectual property. The IPR Act also obliges researchers to disclose inventions to their technology transfer offices prior to public disclosure of their research (RSA, 2010).

As result of this prescribed structure, the act also prescribes that the researcher/inventor(s) receives a monetary benefit (at least 30%) from revenue derived from the successful commercialisation of the intellectual property. The IPR Act allows the institution a substantial amount of flexibility to establish policies that have a direct bearing on these benefits yet states that a benefit of at least thirty percent of income commercialisation received by the institution must be awarded to the inventor(s).

The IPR Act also makes provision for the establishment of the National Intellectual Property Management Office (NIPMO), a government entity whose purpose and mandate is to regulate the implementation of the Act (RSA, 2010) through the development of guidelines and dispute resolution.

In interacting with industry, typically where a private partner funds research, the research may fall under the IPR Act unless paid for on a 'full cost' basis. Since the enactment of the legislation, a process of engagement with stakeholders has taken place to assist the interpretation of stakeholders. A full cost model has been developed and guidelines to the implementation of the Act are being published or are still under development by NIPMO (NIPMO, 2013). South African institutions were asked to analyse the general expenditure that can be associated with research projects.

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While the IPR Act does not place emphasis on an economic return from commercialisation, it allows the institution the flexibility to make money or make an impact through commercialisation of research outputs.

### **2.3 THE ROLE OF THE UNIVERSITY IN THE KNOWLEDGE-BASED ECONOMY**

Universities are increasingly pressured to contribute to economic development in diverse ways and are expected to play a distinct role in uplifting social and economic conditions through the direct transfer of innovative knowledge products to society (Bercovitz and Feldman, 2006). Fuelled by the pressure for economies to become developed as knowledge-based, universities are further expected to add value to local development through community outreach (Breznitz and Feldman, 2012), engagement with industry, the establishment of university spin-off companies (Clarysse, Tartari and Salter, 2011) and the creation of new employment opportunities (Kirchhoff, Newbert, Hasan and Armington, 2007). Innovation and specifically patenting activities in countries are viewed internationally as a measure of innovative competitiveness (OECD, 2007). Universities utilise a percentage of Gross Domestic Product to research, develop and innovate. As such the role of the university is to contribute to the economic development of the country and so improve innovative competitiveness.

The university is expected to facilitate and become involved in commercialisation activities. This has led to the conceptual development of the entrepreneurial university (Baregheh et al., 2009) and placed emphasis on the role of researchers in undertaking to achieve organisational objectives through their involvement in commercialisation activities (Etzkowitz, 2003b).

The movement towards becoming more entrepreneurial as an institution is fuelled by national objectives and incentives for innovation (Killeen, 1985; Friedman and Silberman, 2003). Enabling researchers to become involved in commercialisation activities is important for enhancing the identity of the institution. The NMMU has expressed its mission to be a leader in generating cutting-edge knowledge. This is a significant statement when framed within the notion of becoming a more entrepreneurial university (NMMU, 2014).

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## 2.4 ACADEMIC ENTREPRENEURSHIP

The concept of academic entrepreneurship has arisen from the process of entrepreneurship as defined by Shane (2000) by a few widely recognised characteristics:

- i. The activity involves bearing risks on the part of the entrepreneur as risk implies uncertain outcomes;
- ii. It involves an organising effort in that it involves creating a new way of exploiting an opportunity; and
- iii. The activity must have some inherent aspect of novelty or innovation i.e. it has not been done before.

In an effort to understand the concept of academic entrepreneurship in terms of commercialisation activities arising from academia, the literature has focussed on operational definitions that refer to the formation of new firms and the related activities that lead to the commercialisation of research outputs (invention disclosure, patents, licenses etc.). Shane (2000: 4) narrowly defines academic entrepreneurship almost exclusively related to university spin-offs as “a new company founded to exploit a piece of intellectual property created in an academic institution”. Klofsten and Jones-Evans (2000); Shane (2004) and Abreu and Grinevich (2013) defined academic entrepreneurship activities very broadly. Their definitions of entrepreneurial activities are depicted in Table 2.1 where the shaded activities and descriptions refer to those which are considered peripheral to current definitions provides by other authors.

**Table 2.1: Academic Entrepreneurship Activities according to Klofsten and Jones-Evans (2000:300); Shane (2004) and Abreu and Grenevich (2013)**

Activity	Description	Reference
Large scale science projects	Obtaining large externally funded research projects, either through public grants or through industrial sources	Klofsten and Jones-Evans (2000);

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External teaching	Provision of short courses to non-university personnel/students and external organisations	Klofsten and Jones-Evans (2000);
Testing	Provision of testing and calibration facilities to non-university individuals and external organisations	Klofsten and Jones-Evans (2000); Abreu and Grenevich (2013)
Contracted research	Undertaking specific research projects with the university system for external organisations	Klofsten and Jones-Evans (2000); Abreu and Grenevich (2013)
Sales	Commercial selling of products developed within the university	Klofsten and Jones-Evans (2000); Abreu and Grenevich (2013)
Consulting	The sale of personal scientific or technological expertise to solve a specific problem	Klofsten and Jones-Evans (2000); Abreu and Grenevich (2013)
Patenting/licensing	The exploitation of patents or licenses by industry from research results	Shane (2004)
Spin-off firms	The formation of new firm or organisation to exploit the results of the university research	Shane (2004)

The type of research undertaken also influences the probability of researcher involvement in commercialisation activities. Abreu and Grenevich (2013) found that user-inspired research and applied research are more likely to give rise to innovations protectable through formal intellectual property mechanisms such as patents, design

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registrations etc. Abreu and Grenevich (2013) also found that it is more likely for older male researchers to be involved in more entrepreneurial activities than any other demographic group.

Etzkowitz (2003b) refers to both the institution and the academic activity when discussing entrepreneurship in an academic context. According to this, there are two main elements of an emergent entrepreneurial university: the first is the development of organisational mechanisms to progress commercialisable research across institutional borders; and the second is the integration of academic and non-academic elements in a common framework (similar to Klofsten and Jones-Evans (2000)). Etzkowitz (1998) first described the entrepreneurial scientist as someone with an entrepreneurial perspective in which results are examined for commercial and intellectual potential. While this certainly broadens the definition and begins to recognise technologies which cannot be formally protected, it does not give credit to contract research and consultancy work which are important activities in engaging with industry and establishing the first motivations towards other entrepreneurial activities which can reap academic or commercial benefit (Franzoni and Lissoni, 2006).

In contrast to the operational approach, other literature has further emphasised the need for the concept of academic entrepreneurship to include the generation of social or intangible value. Mars and Rios-Aguilar (2010) advocate that the concept of academic entrepreneurship needs to be studied in a manner which utilises and acknowledges the fundamental economic and managerial science constructs of creative destruction, economic (dis)equilibrium; innovation, value creation and the role of the 'institutional entrepreneur' as referred to by (Lachmann, 2007: 480). Subsequently, Mars and Rios-Aguilar (2010) contend that any characteristic of the individual which gives rise to the creation of value in some innovative way within the institution is entrepreneurial provided that there is a disruption or creation of equilibrium in the environment of the institution. This suggests that non-market driven (social) behaviours of individuals focused on creating value can be considered entrepreneurial.

Academic entrepreneurship has been viewed by some critics as distinctly altering the purpose of a research university (Slaughter and Rhoades, 2000). Etzkowitz (2003b) argued that the distinct entrepreneurial role developed as leaders of research groups found their roles diversifying and straying away from the laboratory bench towards leading and sustaining the research group. Further development of the entrepreneurial role took place as graduates were specifically trained for organisations and as new

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inventions needed a home for commercialisation, new organisations were developed and incubated before they operated independently. Concurrent to this, Etzkowitz (2003b) cites examples of where universities partnered with local regional forums to guide the developmental goals of innovation as a means to improve and sustain local businesses and the local economy.

O'Shea et al. (2005) discuss academic entrepreneurship as an all-encompassing term which refers to the efforts and activities undertaken by universities and their industry partners in the hope of commercialising research outputs which will generate revenue. This is supported by previous work done by Chrisman et al. (1995) which demonstrated that researchers could successfully be involved in spin-off companies and that in fact their involvement is crucial to the success of several spin-offs which generate a significant amount of income for the University of Calgary.

Wood (2011) agrees that researcher involvement is crucial to the start of university spin-offs but points out that academic entrepreneurial activities are much broader and take place further upstream than this literature claims. Critically, however, are the individual and institutional factors that contribute to researcher involvement in entrepreneurial activities, which lead to and include the commercialisation of research outputs. The majority of the literature on academic entrepreneurship focuses on the involvement of researchers from the firm's perspective (Shane, 2004; Rothaermel, Agung and Jiang, 2007; O'Gorman, Byrne and Pandya, 2008) and little attention has been paid to the motivations of the individual researchers or the enabling and hindering factors of the institution. In addition, emphasis has been placed on the formal entrepreneurial activities (such as patenting) (Sampat, 2006; Mowery et al., 2001; Thursby, Fuller and Thursby, 2009; Agrawal and Henderson, 2002) rather than the informal ones (such as disclosure to the technology transfer office) (Jensen, Thursby and Thursby, 2003; Walter et al., 2013) as the impact of the former are easier to measure and observe on a broad scale.

Commercialisation of research outputs (theses, patented inventions and processes, know-how generated through in-depth study and practice, published works etc.) is generally understood in literature as the transfer of knowledge products from within the institution to a firm which exists in the industry sector for commercial application and utilisation (Rogers, 2002). The process of commercialisation takes place through formal and informal mechanisms. Formal mechanisms involve intellectual property rights and obligations. These include co-operative research and development agreements (Siegel and Phan, 2005); licenses and assignments; and university spin-off companies. Informal

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mechanisms of technology transfer include research joint ventures between universities or universities with industry; consulting and training of graduates who are currently or later employed by a firm and the existence of a science park or business incubators (Link, Siegel and Bozeman, 2007).

Wood (2011) proposes a process model which includes activity at the stage of disclosing an innovation to the Technology Transfer Office (TTO) all the way through to supporting the commercialisation of the technology. This model is supported by the previous studies discussed and comprises the activities described in Table 2.2.

Within this context of formal and informal mechanisms of technology transfers, the entrepreneurial role of the researcher has evolved to support economic development (Etzkowitz, 2003a; Lam, 2010) which demonstrates the societal and economic impact of academic entrepreneurship through the improvement of living conditions, job creation and the start-up of new businesses.

**Table 2.2: Formal and Informal Entrepreneurial Activities Synthesized from various references cited within**

Formal entrepreneurial activities	Disclosing new inventions to the TTO (Thursby and Thursby, 2005; Bercovitz and Feldman, 2006). Patenting of research outputs (Agrawal and Henderson, 2002). Formation of new firms (Siegel, Wright and Lockett, 2007). Licensing of research outputs (Jensen et al., 2003).
Informal entrepreneurial activities	Contract research (Klofsten and Jones-Evans, 2000). Consulting (Klofsten and Jones-Evans, 2000).

This study concentrates on formal entrepreneurial activities as defined by Wood (2011) and focuses on enablers and barriers to involvement of academics in formal mechanisms of academic entrepreneurship otherwise referred to as commercialisation activities.

## **2.4.1 Enablers and Barriers of Academic Entrepreneurship**

The enablers of academic entrepreneurship include those factors that contribute to encouraging and improving the chance of involvement of researchers in

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commercialisation activities. This can be analysed at a national policy level, an institutional level and at an individual level.

There is a wealth of literature that details the role of legislation and national policy in establishing obligations and incentives for universities to perform technology transfer. Further to this, the effectiveness of technology transfer as a centralised function within the institution is becoming better understood (e.g. see Spann, Adams and Souder (1995); Rogers, Yin and Hoffmann (2000); Siegel and Phan (2005)). One of the key factors recognised in the successful transfer of technologies to licensees and spin-off companies is the involvement of inventors or researchers in commercialisation activities (Bishop, D'Este and Neely, 2011). There is, however, very little characterisation of the factors which enable or impede the involvement of researchers in commercialisation activities at the institutional level and from the stage of disclosure as suggested by Wood (2011) and Walter et al. (2013).

This treatise proposes that there are factors that may be considered enablers and barriers that can be actively managed by the institution to encourage the desired direct effect on the involvement of researchers in commercialisation activities. Hence the organisational incentives and individual motives need to be congruent. Equally important are the barriers to researcher involvement in commercialisation activities. Understanding what researchers perceive as barriers/impediments to their involvement in commercialisation activities will inform a strategy that can be applied to the institution.

## **2.5 THE NATIONAL SYSTEM OF INNOVATION**

Doloreux (2002) deduced that a regional system of innovation is a social system involving interaction between public and private sector players in a systematic way with the goal of increasing and enhancing localised learning capabilities in the region. The four distinct elements which comprise and enable a regional system of innovation to operate are firms, institutions (research and development universities, governments and other institutions), knowledge infrastructure to support innovation and policy frameworks to support the region's endogenous potential by encouraging knowledge diffusion within the region (Doloreux, 2002). The national system of innovation concept first described by Freeman (1987: 1) as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies".

Universities are a single player within national systems of innovation (NSI). A more encompassing definition which emphasises the role of government as a policy maker



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and regulatory agent is provided by Metcalfe (1995) where the NSI constitutes a set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies (Metcalfe, 1995).

The Organisation for Economic Co-operation and Development (OECD (2007) recognises the role of universities through the NSI approach and emphasises the analytical importance in the technology field for three reasons:

- i. the recognition of the economic importance of knowledge;
- ii. the increasing use of systems approaches; and
- iii. the growing number of institutions involved in knowledge generation.

Universities, therefore, feature strongly as catalysts of innovation (Doutriaux, 2003) in discussions concerning the production, diffusion and deployment of knowledge and innovation which supports economic growth and development due to the fact that they serve as excellent sources of technology development and human capital useful to growing and sustaining economic activity (Trencher et al., 2014).

In recognition of this contribution and role, policy makers and governments needed to consider mechanisms to stimulate technology development, transfer and commercialisation at research universities (Henderson, Jaffe and Trajtenberg, 1998), especially since most governments fund university research and development. Policies such as the Bayh-Dole Act in the United States have been useful in empowering universities to commercialise technologies and to derive economic benefit from such engagements (McDevitt et al., 2014). Prior to the Bayh-Dole Act, the ownership of IP arising from state-funded institutions rested with the federal government. It was well known that federally funded laboratories and universities held a wealth of ideas, research capabilities and technology that would be of great use economically and yet it was extremely difficult for the private sector to gain access to these due to the centralised system of transfer which rested with the federal government. When the Bayh-Dole Act came into effect in 1980, 'almost overnight' universities became hothouses of innovation and some entrepreneurial researchers started commercialising their inventions by establishing companies of their own (Anonymous, 2002).

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There are conflicting views on whether the Bayh-Dole Act has been successful (McDevitt et al., 2014) or not (Mowery, Nelson, Sampat and Ziedonis, 1999; Barratt, 2010; Perkins and Tierney, 2014). Some say that the legislation forced universities to patent and license only what could generate income to the institution and the inventors (Mowery and Sampat, 2005) whilst others say that in general, the US economy is more vibrant as a result of the Act fuelling \$40 billion to the economy each year and having created over 35000 jobs (McDevitt et al., 2014).

In learning from the US and acknowledging that there was a need for some sort of regulation in South Africa for the exploitation of technologies and particularly the associated IP arising from publicly funded research, the government sought to formulate a policy that would stimulate the economy through an expanded science and technology economic sector and stimulate the creation of jobs. In 2002, the South African Department of Science and Technology (DST) published the National Research and Development Strategy (DST, 2002), which provided a way forward for creating an enabling environment for the already existing National System of Innovation. The strategy acknowledged that the players within the NSI were: higher education institutions, public research institutions and the business sector, where research was taking place. Kaplan (2008) argued that this definition described the system too narrowly, placing too much emphasis on the publicly funded R&D institutions thus obscuring the roles of the business sector as performers of R&D and university sponsors overcoming the critical skills shortage through investment in training.

The National R&D strategy advocated that additional structure and stimulus was needed in order to expand the system in a way that would be beneficial to the support of human capital and new industries in the long term. It also provided a way forward for the strengthening of research infrastructure and the development of human capacity within the fields of science, technology and engineering. The strategy also proposed that the DST be the single co-ordinating agent for the NSI and noted the need for the development of a policy on the governance of IP emanating from public funds as well as the need for technology transfer to take place (DST, 2002).

The National Advisory Council on Innovation (NACI) conducted three surveys over the period of 2002-2007 to probe the state of performance of the NSI in relation to the strategic goals set by government. This report outlined the performance of the NSI and identified the developmental challenges which needed to be overcome in relation to achieving national goals of importance (NACI, 2006). The report also informed the review

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conducted by the OECD on the progress of the NSI which provided recommendations directed at the identification of appropriate strategic goals and principles for future government actions (OECD, 2007).

The most important recommendations of the OECD report was that the South African government should focus resources and energy on the generation of skilled and highly qualified graduates within science, engineering and technology fields and expanding existing research and development infrastructure and funding basic and applied research. Another separate recommendation was for the establishment of distinct government organisations to focus on funding innovation support separately to research and development. Emphasis was also placed on the stimulation and support of technology-based small to medium enterprises (SMEs) in the long term (OECD, 2007). In short, the OECD report recommended that a single governance body co-ordinate, streamline and focus more specifically on existing plans with an additional stimulation of skills production (Kaplan, 2008).

Shortly after the OECD report, the DST published its Ten Year Innovation Plan which outlined its vision and targeted goals for the transformation of South Africa towards a knowledge-based economy (DST, 2007). According to (Kaplan, 2008), the plan was too ambitious, setting too many areas or challenges to support and setting targets for higher education institutions to produce ten times the number of doctoral graduates than were currently produced in 2008 within a short time frame. Despite the many shortcomings of the DST Ten Year Innovation Plan in co-ordinating and structuring the NSI since 2007, the Department of Science and Technology has been acknowledged as one of the better performing government departments (Kaplan, 2008).

The following achievements mark the successes the Department has had between 2007 and 2012 with direct relevance as enablers to spur innovation at higher education institutions:

- i. The launch of the Innovation Fund and Biotechnology Regional Innovation Centres established to fund innovative projects arising from universities, science councils and the business sector that can be commercialised;
- ii. The setting up of National Centres of Research Excellence, Centres of Competence as well as the South African Research Chairs Initiative (SARCHi) – awarded and operated to improve research outputs and publications;

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- iii. The promulgation of the Intellectual Property from Publicly Fund Research and Development Act (IPR Act);
- iv. The sustaining of technology stations (some of which are stationed at HEIs, two of these are stationed at the NMMU) that engage with industry and small enterprises to enhance industry competitiveness;
- v. The establishment of the Technology Innovation Agency (a merger of the Innovation Fund, BRICs and other funders) and the National Intellectual Property Management Office (NIPMO), a regulatory agent of the IPR Act tasked with ensuring compliance with the IPR Act;
- vi. The establishment of technology transfer offices at higher education institutions (HEIs) (DST, 2012).

The most recent review of the NSI by the DST acknowledges that the NSI still requires greater steerage at all levels to enable innovation further and proposes a ministerial committee chaired by the Deputy President and a Steering Committee independent from NACI (as NACI is limited to play only an advisory role). The review further recommends that in order to build the NSI and enable innovation, there must be support made available for the provision of “brokerage services and partnering skills needed for cross-boundary collaboration and technology transfer between actors in the system” (DST, 2012).

### **2.6 SOUTH AFRICAN PROGRAMMES WHICH ENABLE UNIVERSITY-INDUSTRY COLLABORATION**

The triple-helix model (Etzkowitz, 2003a) was adopted by South African agencies of state to encourage university-industry collaboration. Several national white papers and strategy documents make reference to ‘bridging the innovation chasm’ (e.g. see (DST, 2002; DST, 2007) by encouraging industry to engage with university researchers in order to take products and processes closer to implementation. The following represents a non-exhaustive list of organisations through their mandates and programmes which have been established by the national government to enable commercialisation activity between universities and industry.

The Council for Industrial Research – The CSIR was established to address the scientific and technological needs of state-owned entities (such as Eskom), large industry (such

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as the mining sector) as well as new or established enterprises by undertaking state-funded research programmes in specific areas of importance. The CSIR now undertakes contract research for industry as part of its mandate and administrates certain funds to sustain enterprises in key economic sectors (CSIR, 2011).

THRIP - The Department of Trade and Industry in partnership with the National Research Foundation (NRF) operate the THRIP (Technology and Human Resources for Industry Programme) fund to financially leverage the projects undertaken by university-industry collaborations. This programme has been successful in its model – where the fund matches or exceeds the contribution by the industry partner to the project to support the development of technology and graduates (NRF, 2013).

Technology Station Programme – Funded by the Department of Science and Technology, technology stations were designed to engage with industry and small enterprises to assist with technical problem solving. Many of the technology stations were housed or located near existing universities. Each technology station specialised in a particular field – generally, the most prominent and innovative research area that the university was known for. Many of these have failed due to a lack of entrepreneurial skills required to promote services and attract business, but the few that remain are relatively successful and continue to be supported by the DST.

### **2.6.1 Barriers at National Level in South Africa**

The most overwhelming barrier to progressing innovation at a national level, and particularly in a developing economy is bureaucratic processes coupled with a lack of understanding of the process of innovation (Wild, 2013). While the South African national government has excellent intentions of stimulating innovation in the country (as laid out in well-written strategy documents), the efficient working of national instruments such as the Technology Innovation Agency, an agency established by the Department of Science and Technology in 2008, has raised serious questions of the government's ability to enable innovation (Wild, 2013).

The ineffective engagement with stakeholders such as research sponsors and industry explanation of legislation, particularly with the IPR Act, has led to a recession of research funding due to misconceptions by the public, in particular the business sector (Terblanche, 2009). This, in effect, creates a barrier to opportunities for researchers to engage with research sponsors on an equal footing of understanding and to promote the value that they can offer. The inefficiency of national instruments reduces the ability of

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the government to remove barriers to innovation and diminishes the likelihood of the researchers becoming involved (further) in commercialisation activities (Edquist, 2010).

### **2.6.2 Enablers at National Level - The Patent Incentive Fund**

In a similar way to which the NRF rewards researchers for publications of research findings in top rated journals, the Department of Science and Technology operated a Patent Incentive Fund to reward researchers for disclosing and protecting their research with commercial potential (Sibanda, 2009). The fund was awarded to reward inventors (researchers) when patents were granted in a foreign territory. A portion of the reward (or the full amount of the award) went to the inventor and in the case where the institution had an operating TTO and an IP Policy, a portion was allocated to the TTO to support the costs of patenting.

The Patent Incentive Fund was discontinued as a national incentive shortly after 2010 when the IPR PFRD Act was promulgated due to budget constraints on the part of the Department of Science and Technology and the fact that institutions were now obliged to reward inventors for commercialisation through an IP policy. There is too little data to suggest that the fund was effective as an incentive (Sibanda, 2009) but it would be interesting to investigate from an institutional perspective whether such a reward would incentivise researchers to become more involved in commercialisation activities and specifically be further encouraged to disclose to their research findings to the TTO.

## **2.7 THE INSTITUTIONAL ENABLERS AND BARRIERS TO INVOLVEMENT IN COMMERCIALISATION ACTIVITIES**

Institutional policies play an important role in communicating the institution's principles, values and philosophies (Kreitner et al., 2004). In this case, it is with respect to the management of registrable IP (or IP which can be protected against use by another person without permission or authorisation). The implementation of policies is sometimes prescribed by legislation, as is the case for universities in the United States that operate under the Bayh-Dole Act (Perkins and Tierney, 2014) and for South African universities under the IPR-PFRD Act (RSA, 2010). Policies generally provide the boundaries which define who and what behaviours fall within or outside of the acceptable norms of the environment (Kreitner et al., 2004: 74).

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IP policies have an impact on researchers' perceptions of the personal and professional benefits of disclosing research findings to the TTO (Owen-Smith and Powell, 2001). The policy framework in general affects research outputs and performance as it creates expectations and encourages researchers to juggle research (and in particular publication of research findings), teaching and engaging in innovation and commercialisation activities (Lam, 2010). Several questions are raised in the literature regarding IP rights and the incentives for researchers to disclose their research findings or engage in commercialisation activities (Harhoff and Hoisl, 2007; Baldini, Grimaldi and Sobrero, 2007; Lach and Schankerman, 2008; Walter et al., 2013).

Walter et al. (2013) carried out a qualitative study of how the goals of the entrepreneurial university can be achieved. Their study outlines the role incentives and researcher motives for involvement in commercialisation activities in stimulating technology transfer. Their study further validated the use of institutional incentives in the US in increasing the likelihood of invention disclosure.

The requirements for patenting of inventions is strict novelty (must be a world first), utility (can be applied in a practical context by industry) and inventiveness (there must be some improvement over the prior art claimed) (Bosworth et al., 2006: 10-12). The design of incentives for researcher involvement in commercialisation activities is critical to attracting involvement. Rewards are similarly important as they reinforce acceptable behaviours (Edquist, 2001). It is therefore important to understand the different types of incentives which act as enablers for involvement of researchers in commercialisation activities.

### **2.7.1 Institutional Incentives as Enablers**

Incentives can be described as positive incentives or negative incentives. Positive incentives raise the expectancy of value in the form of rewards or the decline of negative incentives (Killeen, 1985). Negative incentives in this instance thus refers to incentives that are designed to discourage university researchers from not being directly involved in commercialisation activities at the institution. In other words, not making their research findings available for technology transfer by disclosing to the TTO within a prescribed period or engaging with industry privately to commercialise their research (Walter et al., 2013). Jensen and Thursby (2001), in their study of spin-off formation, noted that the involvement of researchers in commercialising IP was essential to the process, as most inventions emanating from universities are usually at an early stage of development

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when disclosed and require substantial input from the researcher for a reasonable chance of successful commercialisation.

The NMMU provides for both monetary and non-monetary incentives communicated via the IP policy (NMMU, 2013b), through TTO publications and direct engagement with researchers. The NMMU TTO is situated on the campus and the TTO staff have regular contact with the researchers. This in itself forms an incentive to utilise the TTO support. The presence of a centralised TTO (as opposed to a regional TTO which services many universities) has been the subject of a few recent qualitative studies (Macho-Stadler and Pérez-Castrillo, 2010; Göktepe-Hulten and Mahagaonkar, 2010) but there is no quantitative evidence in the literature to support this assumption.

### *2.7.1.1 Institutional monetary incentives*

Researchers and inventors are generally aware that the process of commercialisation can take a very long time from the disclosure of an invention and it can be an even longer time before any commercialisation income can be realised (Colyvas et al., 2002). The provision of monetary incentives, however, are important to stimulating and rewarding the intellectual contribution to innovation which can be easily measured (Mowery et al., 2001).

#### *2.7.1.1.1 Percentage of revenues paid to the inventor*

National legislation often provides a reward system to incentivise inventors to disclose research findings (Harhoff and Hoisl, 2007). As observed in the Bayh-Dole Act, inventors are entitled to a share of the revenue derived from commercialisation of their inventions (Baldini, 2010) and is payable by the state-funded institution. It is important to note that the legislation in many Bayh-Dole inspired countries (including South Africa, the United Kingdom, Germany and Italy to name a few (Siepmann, 2004)) prescribe a share of revenue payable to inventors as at least 30% of the net or gross revenues received. In general, the legislation affords the institution the flexibility to provide greater incentives. Walter et al. (2013) confirmed that there is a practical importance to allocating a monetary incentive to commercialisation success, however, they reported a certain reluctance among the participants in their study to allocate a greater share than necessary.

The NMMU's policy on IP is compliant with legislation (RSA, 2010) in awarding a revenue share from commercialisation income to inventors. The policy states that "Creators shall



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receive 20% of the first R1 million of revenues received (by the institution) before the deduction of expenses; and 30% of the residue of revenue received in excess of R1 million after deduction of expenses” (NMMU, 2013b: 6).

### *2.7.1.1.2 Percentage of revenues paid to the work group of the inventor(s)*

The persons who contribute intellectually to specific features of an invention are listed as inventors on a patent. Unlike publications where authors who provide funding, editing or general intellectual input are listed as authors on a publication, the contribution of an inventor to invention is fact and must concur with the inventive claims listed in the patent (Bosworth et al., 2006). However, many research groups comprise a greater number of people without whose support and enabling contribution, the invention would not have been possible. It is thus considered suitable within the university environment to reward such people (to a lesser extent than the inventors in some cases) for their support to the process of invention (Harhoff and Hoisl, 2007). These people could even be other entities e.g. in the case where a sponsorship and technical support is provided by a corporate sponsor on a research project, it is considered appropriate to consider the corporate sponsor an enabler of the process which led to the invention.

In such an example, university research groups enter into a benefit-sharing scheme in the form of an agreement. The TTO generally facilitates such an agreement based on commercialisation potential of the invention and the value of the contribution provided by the corporate partner. This form of incentive encourages the relationship with the corporate sponsor to engage with the university and the research group on research-related projects. The same can be said for groups of inventors within the university. If a monetary incentive is provided for groups of researchers (as inventors on patents) to benefit from engaging in commercialisation activities, there is a greater likelihood that researchers will engage with the TTO to disclose new inventions (Walter et al., 2013).

Research groups at the NMMU include formalised self-funded entities such as eNtsa and InnoVenton. As an incentive to the research group to encourage innovation, particularly where team members contribute significantly in a non-intellectual way to the development of a protectable form of IP, the group is allocated a share of revenues as depicted in Table 2.3.

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**Table 2.3: Effective Split of Revenues Received from Commercialisation (Extracted and adapted from NMMU IP Policy)**

		Where a self-funded entity is NOT involved	Where a self-funded entity is involved
Inventors/creators	< R1 million revenue	20% before expenses	
	> R1 million revenue	30% after expenses	
<b>Balance Split Between</b>			
Self-funded entity			42%
Faculty <sup>1</sup>		42%	13%
NMMU		42%	35%
Technology transfer office <sup>2</sup>		16%	10%
<b>Effective split after expenses after first R1 million revenue:</b>			
Inventors/creators		30%	30%
Self-funded entity			29.4%
Faculty <sup>1</sup>		29.4%	9.1%
NMMU		29.4%	24.5%
Technology transfer office <sup>2</sup>		11.2%	7.0%

1. or administrative structure in case of non-academic staff creating IP,
2. or commercialisation vehicle.

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### *2.7.1.1.3 Percentage of revenues paid to the faculty of the inventor(s)*

Baldini (2010) and (Walter et al., 2013) reported indications that researchers share some sense of responsibility for the financial well-being of the faculty. It is postulated by Baldini (2010) that inventors acknowledge the support provided by faculty and also expect future support from the faculty whether through provision of research funding, space or strategic support of research activities within and outside of the institution.

The NMMU IP policy states that the faculty receives a share of revenue as described in Table 2.3. This is understandable as the faculty provides the support to conduct future improvements (NMMU, 2013b). It would not, however, add significantly to the faculty sustainability (Nilsson et al., 2010). While the opinion of researchers on faculty rewards is important, it does not necessarily add value to an incentive system targeting individuals and could be an area of future research.

### *2.7.1.2 Institutional non-monetary incentives*

#### *2.7.1.2.1 Inclusion of patent counts in academic performance assessments*

Traditionally, academic performance has been evaluated according to the number of publications produced, the number of publications published by locally and internationally accredited journals, students supervised and graduated, and other teaching and research-related measures of performance (Kaplan, 2008; Walter et al., 2013). With the encouragement of universities to become more entrepreneurial (Trencher et al., 2014) and increased policy pressure to contribute more to the development of the economy, a few recent studies have been undertaken to look at how institutional policy structures incentivise researchers to fulfil these diverse roles (Harhoff and Hoisl, 2007). The question is whether there is a change in the traditional outlook of researchers from the 'publish or perish' state towards acknowledging the importance of involvement in innovation with high utility and application.

Powell and Owen-Smith (1998) found, through an analysis of national productivity and incentive systems for researchers in the United States, that prestige and patent productivity go hand in hand. In light of the evolution of the role of the university towards one which encompasses a greater deal of entrepreneurial activities, Aldridge and Audretsch (2011) studied variables pertaining to involvement in commercialisation activities which can be considered by researchers in the field as measures of academic performance e.g. the inclusion of granted patents. Walter et al. (2013) found supporting

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evidence in their study that the inclusion of granted patents on an equal basis as peer-reviewed publications in academic performance assessment is perceived as an incentive for invention disclosure. This research holds importance to institutions when considering performance measures for academics applicable for promotions and new appointments.

### *2.7.1.2.2 Award for granted patents and commercialised research*

It is a well-known characteristic of researchers that respect amongst their peers for their work in the field not only enhances their own reputation but brings prestige to their research group and attracts research funding (Lubango and Pouris, 2009; Etzkowitz, 2003b). Activities related to reputational enhancement include publishing research findings in journals rated by their peers as high quality and credible. Prestige and reputation are noted by Baldini et al. (2007) as important immaterial drivers of researcher involvement in commercialisation activity. Equally important is personal satisfaction (Giuri, Mariani, Brusoni, Crespi, Francoz, Gambardella, Garcia-Fontes, Geuna, Gonzales and Harhoff, 2007). Walter et al. (2013) confirmed in their study that recognition of innovation achievements is important to reinforcing the involvement of researchers and that the award itself provides some incentive towards this involvement.

The NMMU recognises researchers involved in commercialisation activities in the following ways:

- i. Formal publications such as the annual research report which is distributed internally and nationally to other universities and national stakeholders and national reports submitted to the Department of Higher Education and the National Research Foundation (e.g. see (NMMU, 2013a);
- ii. Informal publications such as newsletters, websites and local news articles (NMMU, 2014);
- iii. Formal award ceremonies such as research, teaching and engagement awards (NMMU, 2013c);
- iv. Recognition by the TTO awarding small honours such as certificates of recognition for their contribution to innovation.

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### *2.7.1.2.3 Presence of a TTO on campus*

The presence of a central technology transfer office at an institution certainly limits the amount of research which is commercialised by researchers independently or directly with industry partners without the involvement of the TTO (Nilsson et al., 2010). Regional TTOs are technology transfer offices that are usually based at one institution while servicing several local universities within a region. This structural model has been adopted for cost efficiency where the institutions within a region are either developing their general or specialised research capacity, or do not have a high turnover rate of patentable or commercialisable innovations. This is often the case for universities that do not have a research medical school, faculties of science or engineering (Hassink and Berg, 2014).

The lack of TTO presence on campus can influence the propensity of researchers to engage in disclosure-like discussions with a regional TTO for several reasons. Some of these reasons include the regional TTO being under-capacitated to service all the campuses, other reasons revolve around the preference for researchers to engage with TTO staff face to face rather than by email or over the telephone (Baldini et al., 2007). Often in the case of developing research capacity at an institution, the establishment of a trust-based relationship between the researcher and the TTO supersedes all other factors of importance to encouraging researchers to disclose to the TTO (Debackere and Veugelers, 2005).

### *2.7.1.2.4 Science Park*

A science park is understood to be a physical property development of high technology enterprises with close links and proximity to a university (McAdam and McAdam, 2008). According to the International Association of Science Parks, a science park is a property-based initiative that carries the following purposes:

- i. To stimulate and manage the flow of knowledge and technology between universities and companies;
- ii. To facilitate the communication between companies, entrepreneurs and technicians;
- iii. To provide environments that enhance a culture of innovation, creativity and quality;

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- iv. To focus on companies and research institutions as well as on people - the entrepreneurs and 'knowledge workers';
- v. To facilitate the creation of new businesses via incubation and spin-off mechanisms, and accelerate the growth of small and medium sized companies; and
- vi. To work in a global network that gathers many thousands of innovative companies and research institutions throughout the world, facilitating the internationalisation of their resident companies (IASP, 2014).

Usually discussed as part of regional economic development and innovation strategies to create or sustain employment, access to a space at a science park is open to technology-based firms and new university IP-related firms. The advantages of science parks include the enhanced university-industry interaction; pooling of resources, sharing of resources, improved public image, networking advantages and funding support (McAdam and McAdam, 2008). They are, however, not without criticism, and evidence to support the success in undertaking broad missions have yet to show comparative success outside of the United States (Storey and Tether, 1998).

### *2.7.1.2.5 Business incubator*

Business incubators as the term suggests are centres where newly-formed companies are able to leverage pooled resources, business development training through structured programmes and entrepreneurial mentorship during the critical stage of establishment (McAdam and McAdam, 2008). While there is no unified or accepted definition, incubation typically involves a training programme for company owners of businesses in a specific technical field.

The NMMU has supported an informal Design Incubator for arts and design students wanting to pursue the establishment of their own businesses and can prove that there is a demand for their product.

### **2.7.2 Institutional Barriers**

#### *2.7.2.1 Institutional management support*

Organisational practices and norms set the framework for technology transfer by its policy and strategic decisions, and by the way these are implemented. This framework

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directly affects the culture of the institution through the social norms, organisational structure and incentives e.g. inventor revenue share or promotions (Kreitner et al., 2004). The institutional culture therefore influences the choice made by researchers to disclose to the TTO or not. Researchers may be reluctant to engage in commercialisation activities even though the institutional management may encourage it (Bercovitz and Feldman, 2008). Chrisman et al. (1995), however, found that providing institutional management support to researchers involved in commercialisation activities was more important than supporting specific programmes for economic development and allowed the institution to send a clear message to faculty that their entrepreneurial efforts were valued. The support is rendered through the IP policy and implemented through committee structures where innovation is driven and discussed as an institutional strategic priority. Faculty management support and line manager support also plays a role in encouraging entrepreneurial behaviour amongst researchers and can have an impact on involvement in commercialisation activities (Chrisman et al., 1995).

At the NMMU, researchers may be involved in the development of spin-off companies but only to the extent that they are not owners of the company whilst retaining their employment at the NMMU, as this constitutes a conflict of interest as described in the IP policy (NMMU, 2013b).

### *2.7.2.2 Lack of awareness of TTO support, commercialisation activities and process*

Owen-Smith and Powell (2001) found through a qualitative study that when researchers undertake a decision-making process of whether to patent or not, their awareness of the TTO functions and the benefits of commercialisation influenced the likelihood of disclosing the invention to the TTO.

A barrier to the involvement of researchers in commercialisation activities, and in particular patenting, is a lack of awareness of the TTO. This usually goes hand in hand with a lack of understanding the benefits of and requirements for patenting, intellectual property protection or the commercialisation process in general (Alessandrini et al., 2013).

Coupled to this lack of awareness, Slaughter and Rhoades (2000) raised concerns that increasing research activities of commercial value deviates researchers from conducting the primary missions of the university (teaching and generating new knowledge). Gulbrandsen and Smeby (2005) argued that there are benefits to increasing patent

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activities and skills through inventions while maintaining a balance between fundamental and applied research activities. These represent conflicting perceptions that are held by researchers.

Lubango and Pouris (2009) concluded from a study of the universities in South Africa that researcher activities leading to patenting inventions and those significant towards academic performance (those which meet the university mission of teaching and knowledge production) can co-exist. They also observed that the researchers ranked highest in terms of academic performance (according to the NRF rating system) in their sample were also more likely to be involved in commercialisation activities such as patenting inventions and were therefore more likely to engage with industry because they were respected in academic and industry circles. Their study was however, unique because funding for research at South African universities is dominantly provided by industry whereas previous research (Slaughter and Rhoades, 2000; Slaughter and Leslie, 1997) was conducted in developed countries such as the US where state and federal funding dominates the source of research funding for universities (Lubango and Pouris, 2009).

### **2.8 INDIVIDUAL MOTIVES AND BARRIERS FOR INVOLVEMENT IN COMMERCIALISATION ACTIVITIES**

It is necessary for researchers to perceive their involvement in commercialisation activities as a desirable and manageable activity. This perception is shaped by work experience from industry and training in entrepreneurship and business administration (Reitan, 1997).

Under the IPR Act (Act 51 of 2008), researchers are obliged to disclose inventions which may have the potential to have commercial value and which may be protected through registrable IP. As such, through the efforts of the institution and the TTO, researchers are encouraged to disclose their inventions and become involved in commercialisation activities by doing so. In order to promote the involvement of researchers in commercialisation activities, an understanding of the motives for and barriers to involvement, need to be tested. These fall into two broad categories of monetary and non-monetary incentives. Monetary incentives at the NMMU include a revenue share from commercialisation income received by the institution (NMMU, 2013b) and research income from a patent incentive fund under discussion for implementation by NIPMO (NIPMO, 2013).



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The incentives to be involved in commercialisation activities are either magnified or minimised based on the perceived costs and gains of engaging with industry and TTOs (Owen-Smith and Powell, 2001). Siegel, Waldman and Link (2003) concluded through a qualitative study that researchers perceived that inadequate rewards existed to support their engagement with the technology transfer office and their involvement in commercialisation activities.

The efficiency of the TTO is directly related to this cost-benefit analysis e.g. the efficiency with which the TTO responds and assists researchers with queries, and engages with them to enable the process of IP protection (Siegel et al., 2003), marketing of inventions and prototypes (Jensen and Thursby, 2001).

This is also supported by evidence that researchers perceive the involvement in commercialisation activities as time-consuming and detracts from focussing on the generation of new knowledge through basic research (Thursby, Jensen and Thursby, 2001). The efficiency with which the TTO operates and the knowledge gained by the researcher through engagement with the TTO is classified as 'perceived value' in this study for the purpose of simplicity.

### ***2.8.1 Monetary rewards as motives***

While non-monetary motives of inventors are noted sparsely in literature there is an overwhelming amount of evidence for economic motives for involvement in commercialisation activities and, specifically, the involvement of researchers in starting new companies or university spin-offs (e.g. see (Lach and Schankerman, 2008; Markman et al., 2005; Bercovitz and Feldman, 2008). Upstream of spin-off creation, however, is the disclosure and patenting process. Powell and Owen-Smith (1998) found that due to limits of research and development funding in the United States, researchers were effectively incentivised to disclose their inventions and be closely involved in the commercialisation of their inventions as successful commercialisation would provide a new stream of funding for R&D.

### ***2.8.2 Once-off Payment for Granted Patents***

The idea of a once-off payment for a granted patent, irrespective of whether it is or can be subsequently commercialised through a license or sale to a third party like a company, can be very appealing to researchers (Walter et al., 2013).

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The NMMU does not provide a once-off payment incentive for granted patents for several reasons including a lack of financial resources. The operation of a national patent incentive fund has been an incentive advocated for by the TTOs nationally in South Africa. Originally implemented by the Innovation Fund, an agency that merged into the Technology Innovation Agency, the fund is now managed by NIPMO but is currently not operational. A patent incentive fund would not only incentivise the increase of the disclosure rate and patent productivity from universities, but would empower researchers to progress innovations further using the same funds.

At present, universities carry the costs partially or fully for patenting, operation of a TTO and commercialisation. While the need to increase disclosure rates and patent productivity at some institutions is significant, others struggle with demands on TTO capacity to assist researchers cover costs associated with patents and commercialisation. It is appropriate that such a fund is managed and operated by an organ of the state such as NIPMO. In that way the national system of innovation will be incentivised and stimulated to progress and produce innovative outputs.

Since the patent incentive fund previously operated by the Innovation Fund was successful (Sibanda, 2009), the question raised is whether researchers involved in commercialisation activities perceive that a patent incentive fund will significantly increase the patenting of research outputs.

### ***2.8.3 Revenue Share from Commercialisation of Research Outputs***

Typically, revenue from the successful commercialisation of IP takes a long time to be realised (sometimes longer than 10 years) and researchers generally understand that the process is lengthy (Aldridge and Audretsch, 2011).

It will be important to note in this study whether researchers involved in commercialisation activities (particularly those involved in spin-off companies) are motivated by personal wealth creation to be involved in commercialisation activities or motivated by other factors.

### ***2.8.4 Non-monetary Rewards as Motives***

It is well known that patenting can enhance the reputation and increase scientific productivity of researchers by independently affirming novelty, inventiveness and utility of research outputs (Owen-Smith and Powell, 2001). Further to this, there is the intrinsic

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satisfaction which is considered professionally rewarding for researchers (Baldini et al., 2007).

Göktepe-Hultén (2008), as cited by Göktepe-Hulten and Mahagaonkar (2010), investigated the motives of inventors to patent and specifically questioned whether non-monetary or monetary rewards were important incentives for patenting. Their study showed that social rewards and personal rewards were considered by researchers to be of greater importance than monetary rewards and career advancement.

Dietz and Bozeman (2005) undertook a study to analyse the résumés of several hundred researchers in the science and engineering disciplines to determine whether the trajectory of career development of academics remained the same or whether an increasing engagement with industry led to other achievements noteworthy for career progress, including involvement in commercialisation activities such as patents. Their findings revealed that researchers in the United States felt that their involvement in activities that promote the engagement of the university with industry, local communities and addressing national imperatives was of importance to their overall career progression as researchers.

## 2.9 CONCLUSION

This chapter covered the underlying concepts and processes relevant to the understanding of academic entrepreneurship, specifically, the concepts of innovation, the entrepreneurial university, the process of technology transfer, enablers (RQ<sub>1</sub>) and barriers (RQ<sub>2</sub>) to involvement in commercialisation activities and the definition of commercialisation activities (RQ<sub>3</sub>). An overview of literature detailing the conceptual development of academic entrepreneurship is provided. Academic entrepreneurship is defined according to literature and the enablers and barriers to the involvement of researchers in commercialisation and / or entrepreneurial activities are discussed. At a national level, enablers and barriers are discussed within the context of legislation and the national system of innovation in South Africa. The roles and obligations of the university as an institution are discussed within this framework and the conflicting missions of teaching and research versus commercialisation of research outputs is noted within the context of the national objective of becoming a knowledge-based economy.

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Institutional monetary and non-monetary incentives as well as institutional barriers are identified and discussed. The position of the NMMU is noted and the existing policies and activities are discussed within this context. The individual researcher's motives and barriers to involvement are identified from literature as monetary and non-monetary rewards. These aspects are discussed in relation to the institutional environment and policy framework. The NMMU IP policy is explained within the context of other existing policies and the monetary and non-monetary incentives provided by the institution are discussed.

The following chapter will address RQ<sub>4</sub> which states: "*How can a detailed description of the research methodology be provided in order to understand and reproduce the study in future?*". The chapter will achieve the objective by detailing the research design and methodology.

# Chapter 3

## CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

### 3.1 INTRODUCTION

The research problem statement, primary objective and secondary objectives were introduced in Chapter One. Chapter Two provided a review of literature on academic entrepreneurship in relation to researcher involvement in commercialisation activities. This chapter describes the theoretical model that led to the study and the means by which analysis of data will take place to draw conclusions. Figure 3.1 shows the layout of Chapter three.

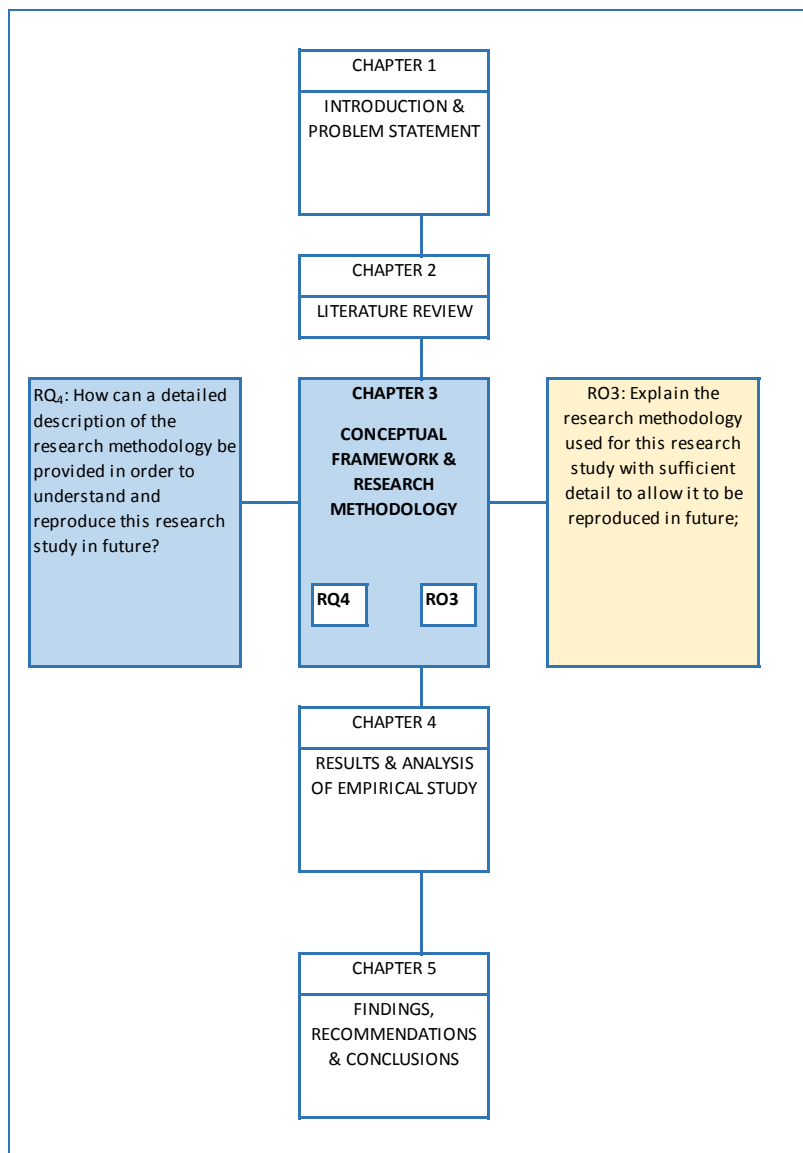


Figure 3.1: Outline of Chapter Three

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## 3.2 CONCEPTUAL FRAMEWORK

This study builds on previous studies of academic entrepreneurship to assess the perceptions held by researchers of institutional enablers and barriers to involvement. In understanding the perception of researchers both involved and not involved in commercialisation activities, specific institutional incentives and barriers are investigated concurrent to researcher motives for involvement. From the data collected through a questionnaire, hypotheses of relationships between the identified five independent variables (institutional monetary incentives, institutional non-monetary incentives, management support, TTO support and individual motives) and the dependent variable (involvement in commercialisation activities) will be tested.

**Table 3.1: Research Design Part 1: Objectives and Variables**

Research design	
<b>Primary objective</b>	
It is the primary objective of this research to understand the enablers and barriers to researcher involvement in commercialisation activities.	
<b>Secondary objectives</b>	
i. To understand the National System of Innovation as a macro-environment and legislation in providing incentives for innovation	
ii. To understand the role of the university in a knowledge-based economy	
iii. To identify and understand the enablers of and barriers to researcher involvement in commercialisation activities at an institutional level	
iv. To identify and understand the enablers of and barriers to researcher involvement in commercialisation activities at an individual level	
v. To understand the perceived value of the technology transfer office support in enabling involvement of researchers in commercialisation activities	
vi. To recommend interventions to increase researcher involvement in commercialisation activities	
Dependent variable	Independent variables
Involvement in commercialisation activities	Institutional monetary incentives Institutional non-monetary incentives Management support TTO Support Individual motives

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**Table 3.2: Research Design part 2: Hypotheses**

Hypotheses
H1: There is a significant difference between the perceptions held by researchers involved versus those not involved in commercialisation activities with respect to institutional support provided to enable involvement in commercialisation activities
H2: Researchers perceive that there is a significant correlation between institutional non-monetary support and involvement in commercialisation activities.
H3: Researchers perceive that there is a significant correlation between management support and involvement in commercialisation activities.
H4: Researchers perceive that there is significant correlation between TTO support and involvement in commercialisation activities.
H5: There is a significant correlation between researchers' individual monetary motives and institutional monetary incentives for involvement in commercialisation activities.

## 3.3 RESEARCH DESIGN OBJECTIVES

In order to meet the primary and secondary objectives, the following research design objectives were undertaken:

- i. Conduct a literature review on the enablers and barriers at national and institutional level – this was addressed in Chapter Two;
- ii. Construct a structured questionnaire for collection of data. A copy of this questionnaire is attached in Annexure B;
- iii. Distribute the questionnaire electronically to researchers in the NMMU Faculties of Science; and Engineering, Built Environment and Information Technology;
- iv. Capture the data in MS Excel;
- v. Analyse the data;
- vi. Interpret the results and draw conclusions; and
- vii. Provide recommendations for the enhancement of researcher involvement in commercialisation activities at the NMMU in the form of strategic interventions.

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## 3.4 RESEARCH PARADIGM

This study takes place primarily in the positivistic paradigm. A quantitative research approach is used to test the variables. The research location is artificial and the sample will be drawn from within the NMMU. Hypotheses based on the relationship between dependent variables identified in Chapter Two and the independent variable (involvement in commercialisation activities) are proposed. As with most quantitative research approaches, the aim is to be as objective as possible. Conclusions from the results of the statistical analysis will be drawn and recommendations to management on suitable interventions will be proposed.

## 3.5 RESEARCH METHODOLOGY

### 3.5.1 *Questionnaire Development*

A semi-structured questionnaire was designed to investigate the researchers' (both involved and not involved) perceptions of incentives and barriers to involvement in commercialisation activities. The questionnaire has arisen from the literature mentioned below in addition to others cited in Chapter Two.

#### 3.5.1.1 *Institutional enablers*

Walter et al. (2013) carried out a qualitative study of how the goals of the entrepreneurial university can be achieved. Their study outlines the role of institutional incentives and researcher motives for researcher involvement in commercialisation activities in stimulating technology transfer. This qualitative study undertook to analyse the effects of combinations of incentives using several case studies from European universities from a statistical perspective. They essentially categorised eighteen influential factors into three categories: 1) material motives and incentives, 2) immaterial motives and incentives and 3) favourable working conditions, including the reduction of barriers to technology transfer. The study validated the use of institutional incentives in the US in increasing the likelihood of invention disclosure. Specific findings included:

- i. Single incentives may not be sufficient but rather a combination of incentives would be effective;
- ii. Financial incentives had the greatest impact on involvement: once-off payments for granted patents are worth considering; mandatory inventor revenue share from commercialisation is essential to encouraging involvement;



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- iii. Awards had a limited effect in relation to other incentives;
- iv. The importance of a TTO on campus was not significant to researchers that had limited or no involvement in commercialisation activities;
- v. The significance of including patent counts in performance evaluation was limited as patenting activity varied across disciplines;
- vi. A grace period between publishing and patenting proved effective; and
- vii. The inclusion of patent counts in performance evaluation proved effective in combination with TTO support and the grace period.

### *3.5.1.2 Management support*

Chrisman et al. (1995), however, found that providing institutional management support to researchers involved in commercialisation activities was more important than supporting specific programmes for economic development and allowed the institution to send a clear message to faculty that their entrepreneurial efforts were valued.

### *3.5.1.3 TTO support*

Siegel et al. (2003) found that TTOs lower the financial and time cost of researchers engaging in disclosure and patenting activities by assisting with the completion of disclosure forms, devising a protection strategy and completing the filing of patents. Owen-Smith and Powell (2001); also found through a qualitative study that when researchers undertake a decision-making process of whether to patent or not, their awareness of the TTO functions and the benefits of commercialisation influenced the likelihood of disclosing the invention to the TTO. Alessandrini et al. (2013) reported from anecdotal evidence from a national study in South Africa that there was a distinct lack of awareness of IP, the function of the TTO and benefits of commercialisation amongst researchers.

### *3.5.1.4 Individual motives*

Individual motives include monetary and non-monetary rewards. Monetary rewards include once-off payments of granted patents and revenue shares from successful commercialisation. Non-monetary incentives include the inclusion of patent counts in academic performance, awards for granted patents and presence of a centralised TTO

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(Walter et al., 2013). The relationship between institutional incentives and individual motives will be investigated and the results used to inform the strategy.

## 3.5.2 The Instrument

A semi-structured questionnaire was used to measure the dependent variables in this study. The questionnaire comprised the following sections:

Section A: Respondent's personal profile;

Section B: Characteristics of respondent's research activity;

Section C: Respondent involvement in commercialisation activities;

Section D: Perception of Technology Transfer Office support;

Section E: Perception of the NMMU's institutional support for involvement in commercialisation activities;

Section F: Perception of personal incentives for involvement in commercialisation activities; and

Section G: Perception of interventions which could increase researcher involvement in commercialisation activities.

The questionnaire was designed to collect the following types of data: categorical data, interval scaled data in the form of Likert scale (1: Strongly disagree – 5: Strongly agree), nominal scaled data, ordinal scaled data and ratio scaled data. Table 3.3 summarises the type of data and the number of questions associated with each type:

**Table 3.3: Summary of Questions According to Data Type**

Summary of questions	
Type of data	No. of questions
Categorical data	3
Interval scaled	33
Nominal scaled	11
Ordinal scaled	1
Ratio Scaled	4
Total	52

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A copy of the questionnaire can be referred to in Annexure B.

### **3.5.3 The Sample**

The sampling frame is identified as researchers resident at the Faculties of Science and Engineering, Built Environment and Information Technology (EBEIT). These faculties host approximately 200 researchers across several disciplines. The faculties of Science and EBEIT constitute disciplines most likely to give rise to new inventions and, as such, were chosen for this suitability as a target population. The Deans of the faculties will be approached by email to offer their support for the distribution of the link to the electronic questionnaire.

It is estimated that at least 30 respondents (15 that are involved and 15 that are not involved in commercialisation activities) are required to represent a 95% level of confidence with a margin of error of 5%.

### **3.5.4 Data Collection Method**

Information for this study was collected by desk research and electronic survey.

Literature information was collected using NMMU's online library facility and internet search engines such as Google Scholar. The online searches were performed using key words such as, "Technology transfer" in combination with "academic entrepreneurship"; "university commercialisation activities", "researcher involvement in commercialisation activities". The sources produced from these searches comprised mostly journal articles, government documents and books. The sources were then analysed and related literature cited within the sources was investigated further.

The literature studied was then synthesised or reported in the literature review of Chapter Two. The literature review informed the questions developed in the questionnaire and the data will be collected by means of an electronic questionnaire. The questionnaire will be distributed by means of an email containing an electronic link and a cover letter (see Annexure A). The electronic link leads to the questionnaire, which is hosted on the NMMU internal survey system. The identities of the respondents shall remain anonymous and untraceable or identifiable. The questionnaire shall be open for response for a two week period.

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### **3.5.5 Research Ethics**

The three most important issues when eliciting data from respondents are anonymity, confidentiality and voluntary participation (Collis and Hussey, 2009: 46-47). Respondents were informed of the purpose of the research and that the three issues mentioned above are catered for during the data acquisition phase. Research ethical clearance was sought from the NMMU REC-H committee, since NMMU academics will be asked to participate in the study. Approval for the study and distribution of the research questionnaire was granted and a reference number provided H15-BES-BUS-028. The reference number was inserted on the cover letter distributed electronically and the online survey introduction.

### **3.5.6 Data Analysis Methods**

Since data that are numeric, interval-scaled, ratio-scaled and continuous allow for greater statistical methods to be applied, compared to data that is categorical, nominal-scaled, ordinal-scaled and discrete, the former were used to correspond to questions which are relevant and in the correct format.

Descriptive statistics (i.e. mean, median, standard deviation, and percentages) will be reported from the data collected in the form of tables and graphs.

Inferential statistics were used to infer findings from the data collected by using the following methods: confidence intervals and hypotheses tests. Had the data been normally distributed, then the ANOVA or paired t-test methods would have been used to test the hypotheses noted in the Research Design to determine whether there is sufficient evidence to support the management claims. Since the data was not normally distributed, the Kruskal-Wallis test was used to compare two or more independent samples of equal or different sizes. The Kruskal-Wallis test was used to determine whether there were statistically significant differences between two or more groups of the independent variable on the continuous dependent variable (Zar, 1999: 214-219).

### **3.5.7 Reliability and Validity**

The reliability of the study refers to how credible the findings of the study are. The outcome of the study is considered reliable if the study is repeated and the results do not differ when compared to the original study (Collis and Hussey, 2009: 64-65). Should the findings of the study accurately reflect the variables in question, then the research is considered valid. This study is conducted in the positivistic paradigm and, as such, the

# Chapter 3

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reliability is expected to be high. As it is the first time that such an instrument has been used to conduct the study, the validity may be considered to be mediocre.

The validity of the questions compiled in the questionnaire was assessed in two ways: firstly, by drawing the questions from literature and secondly, by requesting a review by a senior professional in the technology transfer space.

## 3.6 CONCLUSION

This chapter has addressed RO<sub>3</sub>: *Explain the research methodology used for this research study with sufficient detail to allow it to be reproduced in future* and RQ<sub>4</sub>: *How can a detailed description of the research methodology be provided in order to understand and reproduce this research study in future?*

The chapter has addressed the above by providing an overview of the conceptual framework for the study including the research design and paradigm. The key literature that informed the questionnaire development has been discussed. The format and structure of the instrument provides an overview of the logic used to construct the questionnaire. The data collection and analysis methods provide an indication of how the data will be treated to test the hypotheses. Research ethics is briefly covered to outline the process of ethical approval of the study prior to data collection.

# Chapter 4

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## CHAPTER FOUR: RESULTS AND ANALYSIS OF EMPIRICAL STUDY

### 4.1 INTRODUCTION

The previous chapter described the conceptual framework for the study detailing the research design and paradigm. It addressed Research Question 4 (RQ<sub>4</sub>) which states *“How can a detailed description of the research methodology be provided in order to understand and reproduce this research study in future?”*

This chapter illustrates the analysis and interpretation of primary data beginning with descriptive statistics and followed by inferential statistics. This chapter will address RQ<sub>5</sub> which states *“To what extent are NMMU researchers involved in commercialisation activities?”*; RQ<sub>6</sub> which states *“What is the perception of researchers on involvement in commercialisation activities?”* and RQ<sub>7</sub> which states *“What is the general perception held by NMMU researchers on the existing enablers and barriers to involvement in commercialisation activities?”*. The objectives of this chapter are listed as follows:

- i. To conduct an assessment of the perceptions held by NMMU researchers on involvement in commercialisation activities to understand whether the current enablers are sufficient or whether significant barriers are present within the current NMMU environment. This will be done by analysing the response from researchers that are not involved in commercialisation activities and testing the hypotheses set out in Chapter Three.
- ii. To determine the individual motives for involvement held by researchers involved in commercialisation activities. This will be used to determine if existing enablers are working efficiently or whether they need to be improved.
- iii. To determine whether there are any common barriers amongst both groups of involved and uninvolved researchers which impede involvement.

An overview of this chapter can be seen in Figure 4.1

# Chapter 4

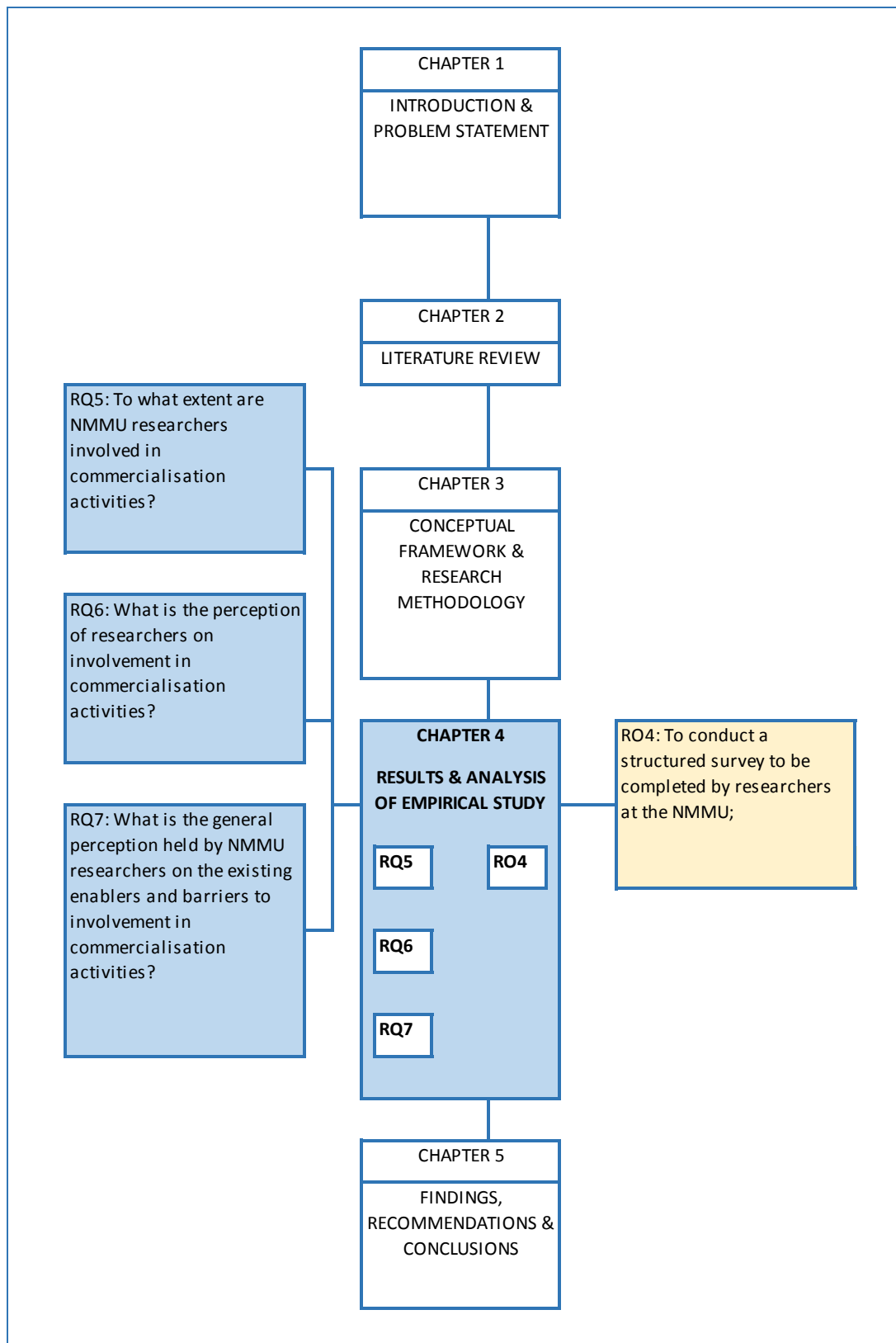


Figure 4 1: Outline of Chapter Four

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## 4.2 DATA ANALYSIS AND INTERPRETATION METHODS

The primary data were checked for errors and 'cleaned'. Built into the survey were various ways of validating the responses to certain primary categorical questions and the data was corrected where necessary. Two data analysis methods will be used to analyse the primary data collected using the electronic questionnaire described in the Chapter Three: univariate analysis and multivariate analysis. These methods will be discussed below.

### 4.2.1 *Univariate Analysis*

Descriptive statistics will be used to analyse individual variables without investigating the relationship present with other variables. The measures for categorical data include counts and percentage calculations presented in the form of pie charts and histograms (Collis and Hussey, 2009).

### 4.2.2 *Multivariate analysis*

Inferential statistics will be used to analyse and interpret the relationships between two or more variables. The data collected was not normally distributed and thus where necessary and particularly with respect to Likert scale data, the Kruskal-Wallis test was used to infer relationships between three or more independent variables and the dependent variable.

#### 4.2.2.1 *The Kruskal-Wallis test*

The Kruskal-Wallis test is a non-parametric test also known as a one-way ANOVA (Analysis of Variance) on ranks, used to compare two or more independent samples of equal or different sizes. The Kruskal-Wallis test was used to determine whether there were statistically significant differences between two or more groups of the independent variable on the continuous dependent variable (Zar, 1999: 214). The test was chosen due to the fact that the data collected was not normally distributed and did not meet the assumptions necessary for an ANOVA to be performed i.e. The validity of the ANOVA findings depends on:

- i. The numeric response (dependent variable is normally distributed
- ii. The variances from the different populations are equal
- iii. The samples are independent (Wegner, 2010)



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Since the first assumption was not met, the Kruskal-Wallis non-parametric test was used.

The only requirements of the Kruskal-Wallis test are:

- i. The k samples are random and independent;
- ii. There are five or more measurements per sample; and
- iii. The probability distributions are continuous.

To conduct the Kruskal-Wallis test the following steps are followed:

**Step 1: State the hypotheses**

$H_0$ : The probability distributions of all samples are identical

$H_1$ : At least two of the k probability distributions differ in location

**Step 2: Calculate the test statistic H**

Combine all sample observations and arrange them in ascending order. Assign a rank to each of the observations. The observations are then scanned and ranks of identical observations are added and divided by the number of observations to assign a single rank to the identical observations. The rank of the observations are then assigned to the individual sample observations. The ranks for each of the samples are added to arrive at R-values for each of the samples.

The test statistic is then calculated using the equation:

$$H = \frac{12}{n(n+1)} \sum_{i=1}^k \frac{R_i^2}{n_i} - 3(n+1)$$

Where:

n: is the total number of observations in the combined sample

k: the number of samples

The equation can be expanded to:

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$$H = \frac{12}{n(n+1)} \sum_{i=1}^k \frac{R_i^2}{n_i} = \left( \frac{R_1^2}{n_1} + \frac{R_2^2}{n_2} + \frac{R_3^2}{n_3} \dots \right) - 3(n+1)$$

### Step 3: Find the rejection region (RR) using the chi-squared table

The rejection region is where H is greater than the critical value from Chi-squared table where  $\alpha = 0.05$ ,  $k-1$

Rejection Region:  $H > \chi_{\alpha,df}^2$

Where  $df = k-1$

Look up the critical value for  $\chi_{\alpha,df}^2$

Look up the p-value in Excel using the formula =CHIDIST(H,df)

The p-value is used to support significance of finding:

p-value must be ( $0.05 < \text{p-value} < 0.01$ ) between 5% and 1% to be significant. This is indicative of the confidence level with which  $H_0$  can be accepted.

Thus if p-value ( $< 0.05$ ): There is significant evidence to support the  $H_0$  is not true.

### Step 4: Decision

If the p-value  $< \alpha = 0.05$  then reject  $H_0$ .

If the p-value  $> \alpha = 0.05$  then fail to reject  $H_0$ .

### Step 5: Conclusion

The data provides sufficient (Reject  $H_0$ ) OR insufficient (fail to reject  $H_0$ ) evidence, at  $\alpha=0.05$ ,  $k-1$ , to conclude that at least two of the  $k$  probability distributions differ in location.

## 4.3 UNIVARIATE ANALYSIS AND DESCRIPTIVE STATISTICS

The questionnaire consisted of nine sections. Section 1 captured demographic data such as age, gender, and race. Other questions to understand professional experience and nature of employment were designed to recognise whether respondents had previous experience of a commercial nature to appreciate if this impacted their outlook on the value of commercialisations activities and involvement in these activities.

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Section 2 probed the activities which the respondent is involved in, in addition to research activities and the type of relevance their research holds.

Section 3 sought to understand whether the respondents were involved in commercialisation activities at any point in their career including being currently involved. It specifically defined 'commercialisation activities' and questioned the type of activities the respondent has been involved in.

Section 4 probed the respondent's awareness of the support offered through the Technology Transfer Office (TTO). Sections 3 to 9 were designed using five-point Likert Scale questions (strongly disagree to strongly agree).

Section 5 was designed to understand the respondent's opinion on the importance of involvement in commercialisation activities used.

Section 6 probed the respondent's opinion of the value of TTO support.

Section 7 was designed to gain an understanding of the respondent's opinion on support provided by the institution.

Section 8 questioned the respondent's personal incentives for involvement in commercialisation activities.

Section 9 suggested a few interventions which could be employed to enhance researcher involvement in commercialisation activities and probed the respondent's opinion of each.

The questionnaire was distributed to all 137 academics in the Science and EBEIT faculties at NMMU. Table 4.1 shows a structural alignment of the questions with the research questions and categorised according to the enablers and barriers to involvement in commercialisation activities described in Chapters One, Two and Three.

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**Table 4.1: Structural Alignment of Survey Questions with Research Questions and the Type of Analysis Conducted.**

Key Constructs investigated	References	RQ	Survey question
<b>Enablers to involvement</b>			
Monetary incentives			
Percentage of revenues paid to the inventor	(Walter et al., 2013; Harhoff and Hoisl, 2007)	7	8.6; 9.7
Once-off payment for granted patents	(Sibanda, 2009)	7	9.6
Monetary rewards - revenue share from commercialisation	(Lach and Schankerman, 2008; Markman et al., 2005; Bercovitz and Feldman, 2008; Aldridge and Audretsch, 2011)	6	8.1;
Non-monetary incentives			
Inclusion of patent counts in researcher performance assessments	(Trencher et al., 2014; Harhoff and Hoisl, 2007; Aldridge and Audretsch, 2011; Walter et al., 2013)	7	9.1
Recognition for granted patents	(Lubango and Pouris, 2009; Etkowitz, 2003b; Baldini et al., 2007; Walter et al., 2013)	7	7.5; 8.4
Personal satisfaction	(Giuri, Mariani, Brusoni, Crespi, Francoz, Gambardella, Garcia-Fontes, Geuna, Gonzales and Harhoff, 2007; Walter et al. (2013)	8	5.1; 5.2; 5.6; 5.7; 5.8; 7.2
Presence of a TTO on Campus	(Nilsson et al., 2010; Hassink and Berg, 2014)	7	6.4
Science Park	(McAdam and McAdam, 2008)	7	9.4
Business incubator	McAdam and McAdam, 2008)	7	9.5
<b>Barriers to involvement</b>			
Institutional management support			
Institutional culture	(Kreitner et al., 2004)	7	5.1; 7.3; 7.4
Faculty management support	(Chrisman et al., 1995)	7	5.4
Line manager support	(Chrisman et al., 1995)	7	7.1
Conflict of interest - ownership in spin-off companies	(NMMU, 2013b)	7	9.8
Researcher knowledge of TTO support			
TTO awareness	(Owen-Smith and Powell 2001)	7	4.1; 4.2; 4.3; 4.4; 4.5
<b>Individual motives and barriers to involvement in commercialisation activities</b>			
Involvement is a desirable and manageable activity	(Reitan, 1997; Owen-Smith and Powell, 2001)	6	5.1; 5.2; 5.6; 5.7; 5.8; 7.2
Efficiency & support of the TTO	(Siegel et al., 2003; Jensen and Thursby, 2001; Thursby, Jensen and Thursby, 2001)	6	6.1; 6.2; 6.3; 6.4
Monetary rewards - revenue share from commercialisation	(Lach and Schankerman, 2008; Markman et al., 2005; Bercovitz and Feldman, 2008; Aldridge and Audretsch, 2011)	6	8.1;
Non-monetary rewards - intrinsic satisfaction	(Owen-Smith and Powell, 2001; Baldini et al., 2007; Göktepe-Hultén 2008)	6	8.3;
Non-monetary rewards - career progression	(Dietz and Bozeman, 2005)	6	8.2
<b>Interventions</b>			
Inclusion of patent counts in performance evaluation	(Trencher et al., 2014; Harhoff and Hoisl, 2007; Aldridge and Audretsch, 2011; Walter et al., 2013)	8	9.1
Training for researchers involved		8	9.2
Proof of concept funds		8	9.3
Science park establishment		8	9.4
Conflict of interest - ownership in spin-off companies	(NMMU, 2013b)	8	9.8

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## 4.3.1 Section 1: Demographic Data, Work Experience and Employment Type

### 4.3.1.1 Questions 1.1 - 1.5: Demographic data

The sample comprised of researchers from the Faculties of EBEIT (Engineering, Built Environment and Information Technology) and Science at NMMU. There were 18 responses received from each faculty. From the demographic data observed in Table 4.3, the greatest number of respondents (44%) were in the age category of 45-54 years old. Just over two thirds (69%) of respondents were male. This response was not unexpected as NMMU has a fairly mature researcher population in these two faculties, the majority of which are male. Table 4.2 shows a summary of demographic data of the sample. Where appropriate the mean and median were calculated.

**Table 4.2: Demographic Data, Work Experience and Type of Employment at NMMU**

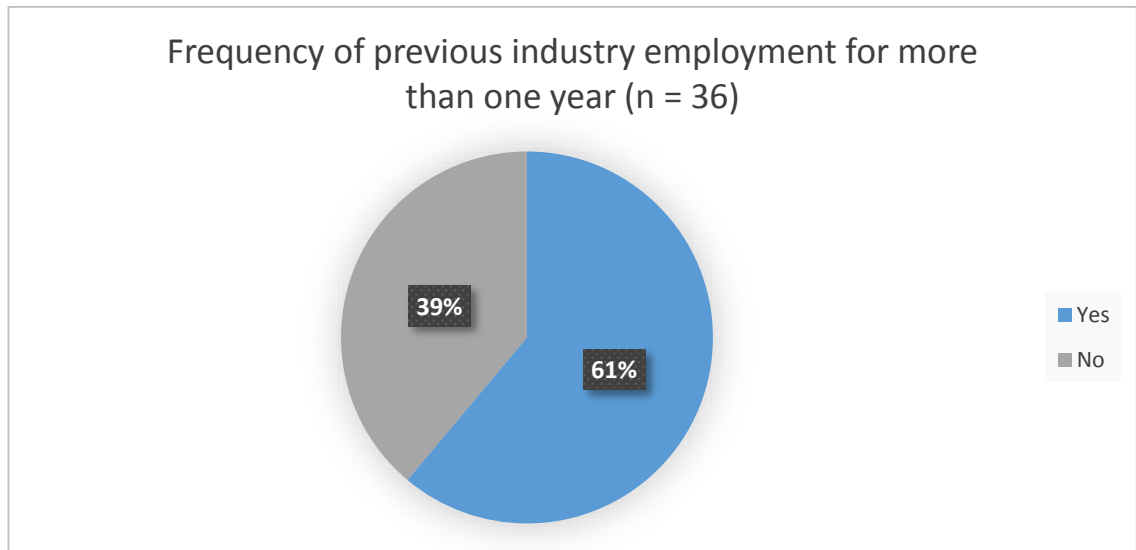
Analysis: Section1		Total Respondents 36				
Q			Count	Percentage	Average	Median
1.1	Faculty	Engineering, Built Environment and Information Technology	18			
		Science	18			
1.2	Age	25-34 years old	5	14%	44.64	44.5
		35- 44 years	13	36%		
		45-54 years	16	44%		
		>55 years	2	6%		
1.3	Gender	Male	25	69%		
		Female	11	31%		
1.4	Language	English	26	72%		
		Afrikaans	10	28%		
1.5	Race	Other	14	39%		
		Caucasian	22	61%		

### 4.3.1.2 Questions 1.6 - 1.9: Work experience

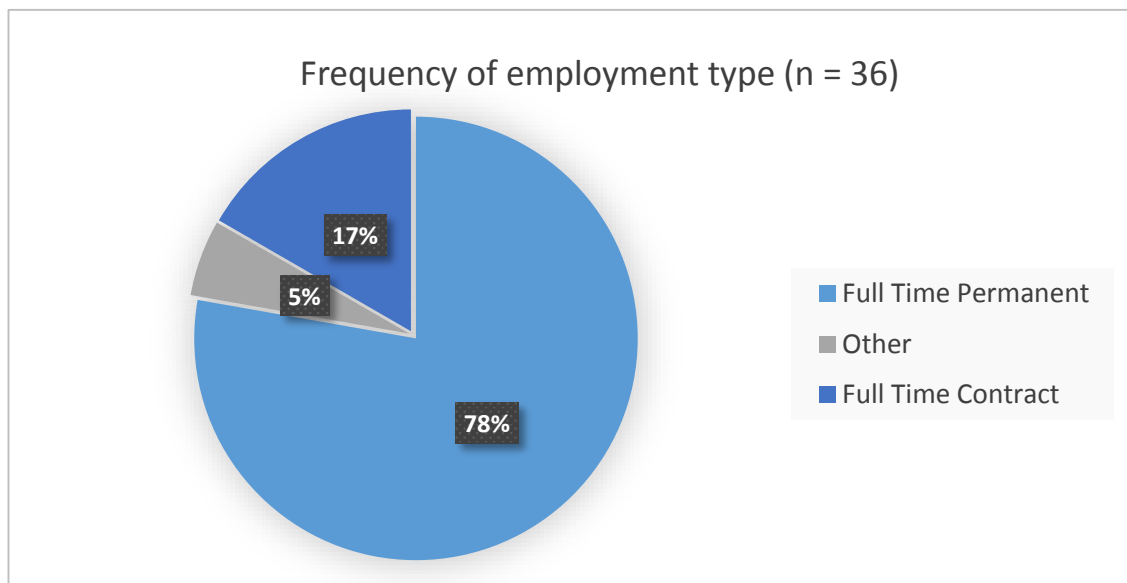
Figure 4.3.1 shows that 63% of respondents stated that they had previous employment in industry. It was interesting to note that 70% (14 of 20) of researchers who are currently involved in commercialisation activities at NMMU had worked for a for-profit company before they worked at NMMU (See Figure 4.3.1 and Appendix C). This finding is consistent with those of Reitan (1997) who found that previous experience industry shapes the perception of researchers and increases the likelihood of their involvement in entrepreneurial or commercial activities in an academic institution.

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**Figure 4.3.1: Frequency of Previous Employment in Industry for More than One Year**



**Figure 4.3.2: Frequency of Employment Type**

As observed in Figure 4.3.2, 78% of respondents said that they were employed on a full-time permanent basis by NMMU. It was important to ensure that a significant portion of the sample held permanent full time positions since short term contract positions (noted as “other” in the survey) are generally assigned larger teaching loads and if this percentage was more than 5% would distort the data. This also relates to a question posed later in the survey on whether NMMU imposes teaching loads on researchers that are too heavy for researchers to be involved in commercialisation activities.

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## 4.3.1.3 Summary of Section 1

Table 4.3 shows that 53% of respondents have worked in the research environment for over 14 years. 56% have worked at NMMU for more than 10 years, confirming that more than half of the sample have extensive experience in the NMMU environment. This validates the questions in Section 7 relating to perceptions of institutional and management support.

**Table 4.3: Summary of data from Section 1 categorised by faculty**

Summary of data from Section 1						
Q			Total	%	EBEIT	SCI
1.1	Number of respondents		36		18	18
1.2	Age	25-34 years old	5	14%	3	2
		35- 44 years	13	36%	3	10
		45-54 years	16	44%	12	4
		>55 years	2	6%	0	2
1.3	Gender	Male	25	69%	14	11
		Female	11	31%	4	7
1.4	Language	English	24	67%	11	13
		Afrikaans	12	33%	7	5
1.5	Race	Other	14	39%	8	6
		Caucasian	22	61%	10	12
1.6	Previous industry employment for more than 1 year	Yes	22	61%	17	5
		No	14	39%	1	13
1.7	Work Experience in research environment	</=14 years	17	47%	9	8
		>14 years	19	53%	8	11
1.8	Employed at NMMU	<10 years	16	44%	8	8
		>10 years	20	56%	10	10
1.9	Type of employment	Full Time Permanent	28	78%	15	13
		Other	2	6%	0	2
		Full Time Contract	6	17%	3	3

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## 4.3.2 Section 2: Academic and Research Activity

### 4.3.2.1 Question 2.1: Frequency of research type undertaken by respondents

Respondents were asked to describe the type of research which they conduct and the relevance of their research to external stakeholders.

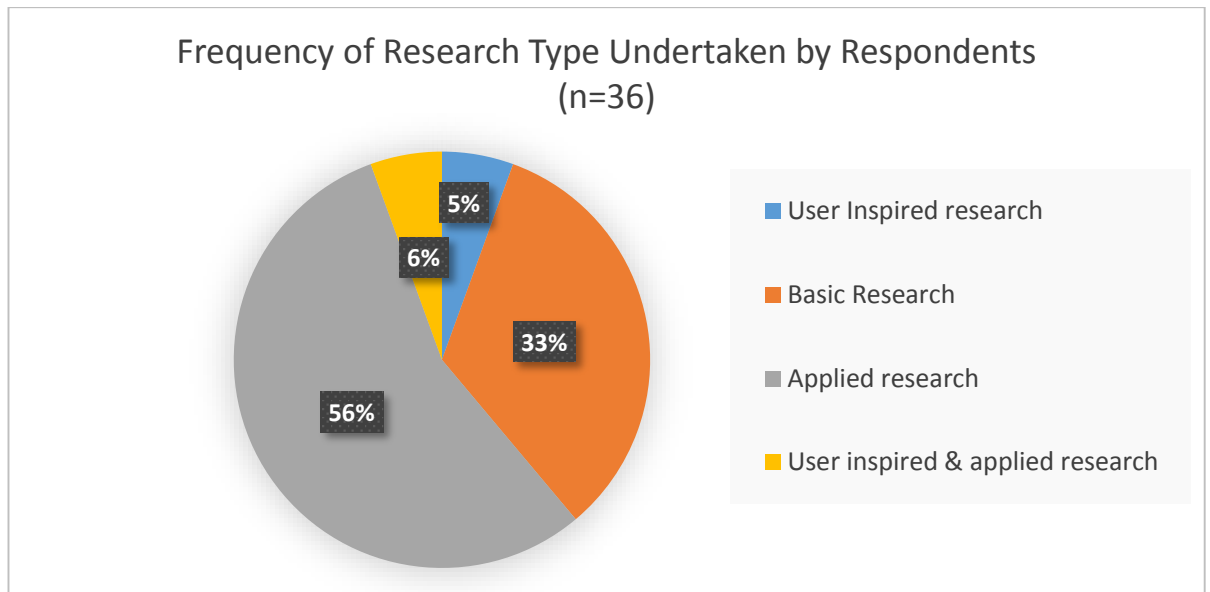


Figure 4.3.3: Frequency of Research Type Undertaken by Respondents

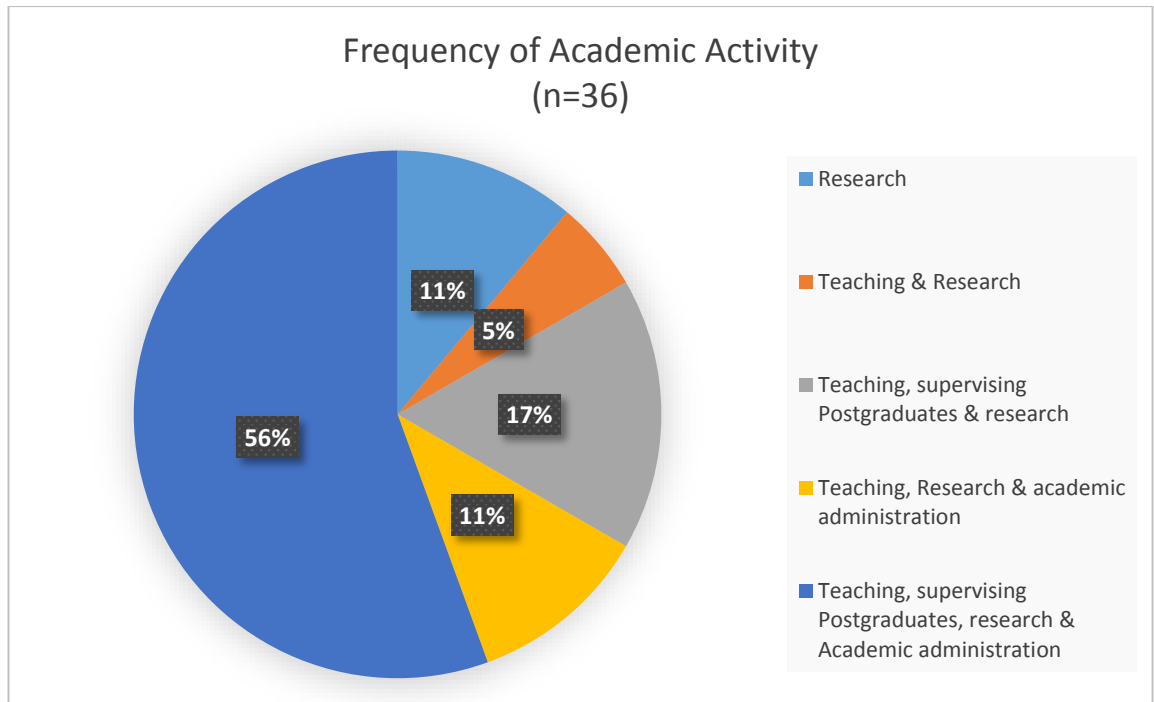
It was important to note the type of research undertaken, as it is generally more likely that researchers who conduct more applied research and research which is user-inspired are more likely to understand the commercial value of research and therefore the value of new inventions and innovations in the market place (Abreu and Grinevich, 2013). As shown in Figure 4.3.3, the majority of responses came from researchers conducting applied research. It is not surprising that the largest percentage of responses to the questionnaire came from these groups of researchers as both scientists and engineers undertake applied research to a large extent at NMMU.

### 4.3.2.2 Question 2.2: Academic activity undertaken by researchers

Respondents were asked to select all activities they are involved in as part of their academic duties. Respondents that did not conduct research were then excluded from the sample data as it was listed as a pre-requisite for completion of the survey that respondents were involved in research activities. The response is summarised in Figure 4.3.4.



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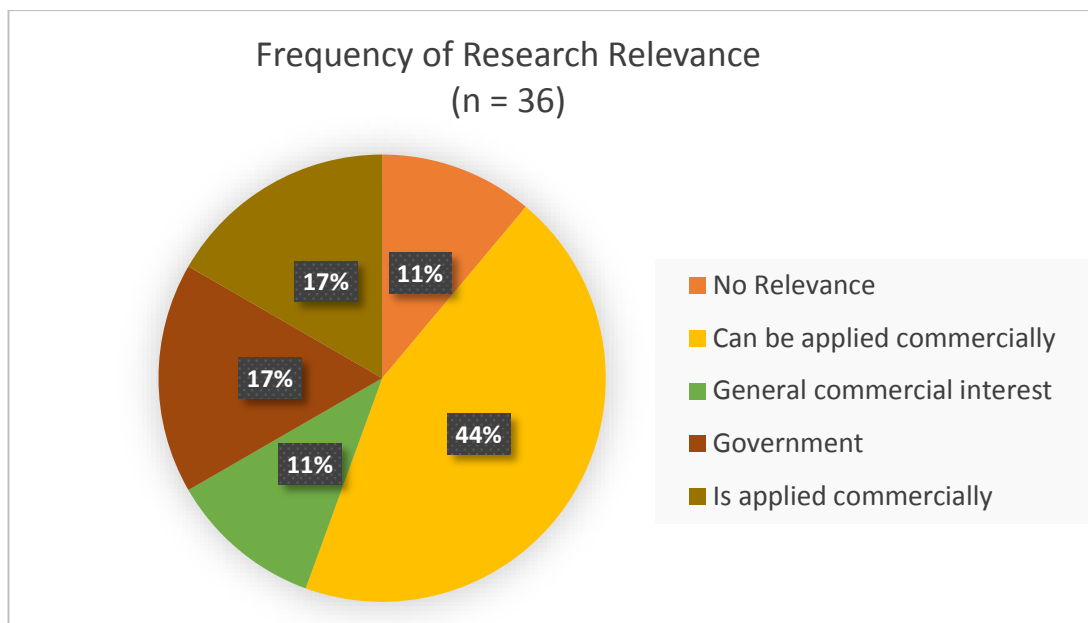
**Figure 4.3.4: Activities Carried out by Respondents as Part of Academic Duties**

### 4.3.2.3 Question 2.3: Relevance of research

Respondents were asked to select one of the following options to best describe their research: No relevance; can be applied commercially; general commercial interest or is applied commercially. Only 11% of respondents stated that their research had no relevance to external stakeholders. 44% stated that their research can be applied commercially and 17% stated that their research is in fact applied commercially.

As shown in Figure 4.3.5 more than half of the respondents stated that they carried out Teaching, Research and Supervision of postgraduates indicating that most of the respondents were of lecturer and senior lecturer positions. The 10% who conduct all activities are likely to be heads of department or directors of schools. A minority of 9% reported to only conduct research, indicating that they are likely to be researchers based at technology stations or holders or research Chairs.

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**Figure 4.3.5: Frequency of research relevance**

**Table 4.4: Summary of research type and relevance of research**

Summary of research type and relevance of research observed							
Type of research	Count	Percentage	No Relevance	Can be applied	General commercial interest	Government	Is applied
User Inspired research	2	6%	0	0	2	0	0
Basic Research	12	33%	4	4	2	2	0
Applied research	20	56%	0	12	0	4	4
User inspired & applied research	2	6%	0	0	0	0	2

### 4.3.3 Section 3: Involvement in Commercialisation Activities

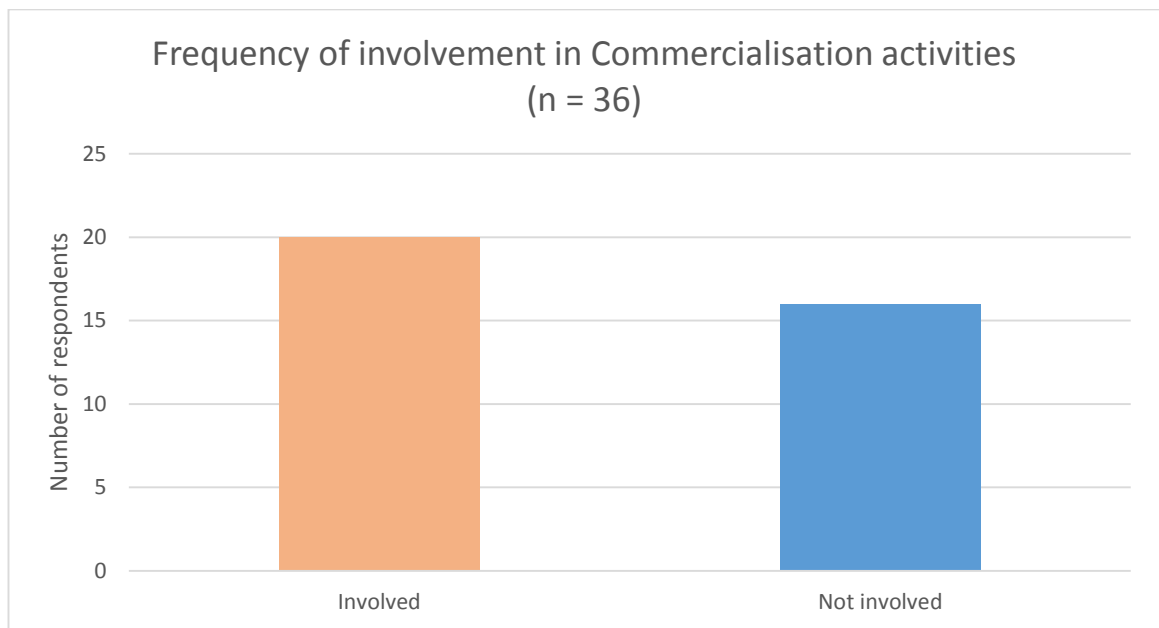
Respondents were asked to state whether they are involved or had been involved in commercialisation activities at NMMU, what specific activities those were and to quantify the amount of research time they spend on those activities. The first two questions were used to define the two sample groups: Involved and not involved. The third question was used to validate the first two questions as well as define the level of activity researchers were involved in.

# Chapter 4

## 4.3.3.1 Question 3.1, 3.2 & 3.4: Frequency of involvement in commercialisation activities

Researchers were asked whether they had been or were currently involved in a list of activities defined as commercialisation activities. The same result was obtained for both questions and is depicted in Figure 4.3.6.

20 respondents were or are involved in commercialisation activities and 16 stated that they were not involved.

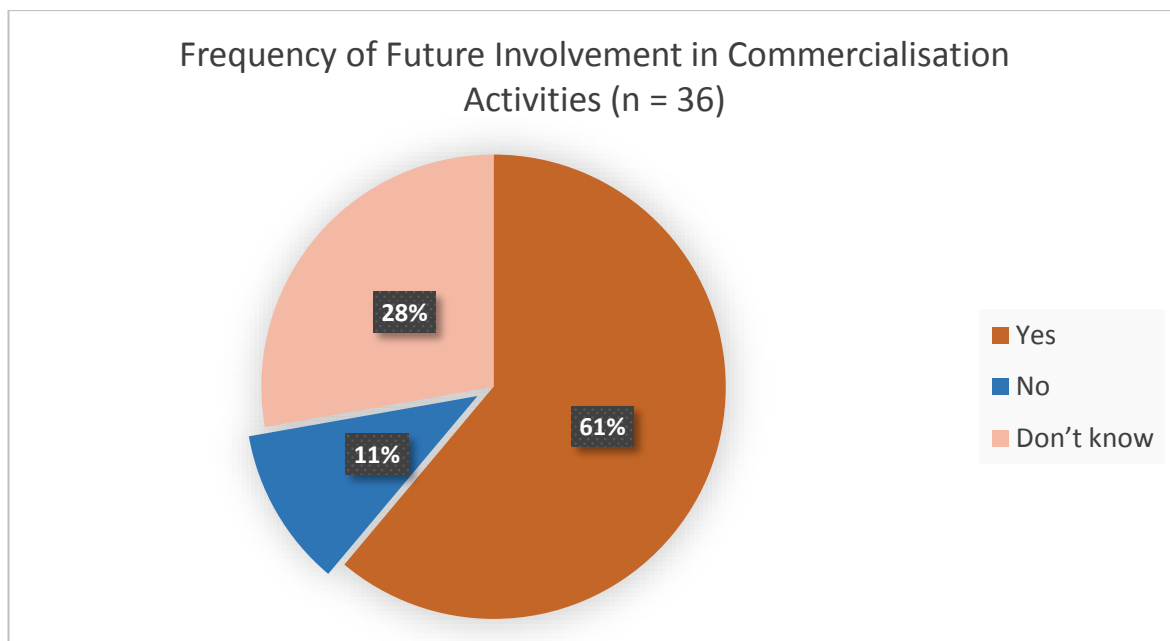


**Figure 4.3.6: Frequency of Involvement in Commercialisation Activities**

Respondents were further asked whether they thought they would be involved in commercialisation activities in the next 5 years. 61% stated that they would be, 11% said they would not be and 28% said they did not know if they would be (Figure 4.3.7).

A summary of the types and the relevance of research is summarised in Table 4.4. It can be noted that while most respondents conducting applied research understand that their research can be applied commercially, a small number are actually applying their research commercially. This is consistent with findings by (Abreu and Grinevich, 2013).

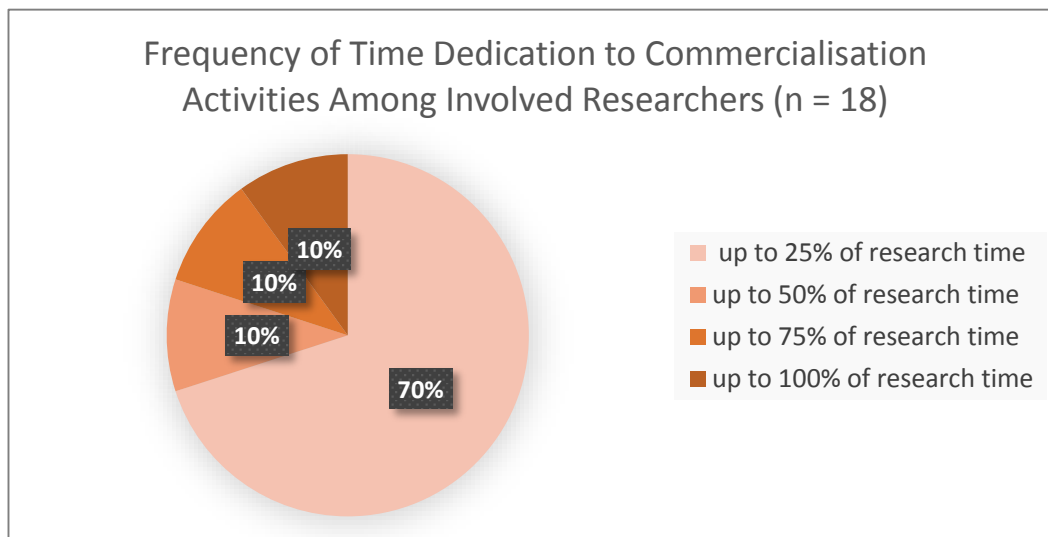
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**Figure 4.3.7: Frequency of Involvement in Commercialisation Activities in the Future**

### 4.3.3.2 Question 3.3: Frequency of time dedication to commercialisation activities

Respondents were asked to estimate the amount of time they spend on commercialisation activities as a proportion of the time they spend on research.



**Figure 4.3.8: Frequency of Research Time Dedication to Commercialisation Activities Among Involved Researchers**

Researchers not involved could select the 'not applicable' option. 70% of respondents involved in commercialisation activities reported that they spend up to 75% of research time on commercialisation activities. The remaining 30% were spread equally across the

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three options of up to 25%, 50% or 100% (Figure 4.3.8). This provided an indication of the level of involvement of involved researchers in commercialisation activities.

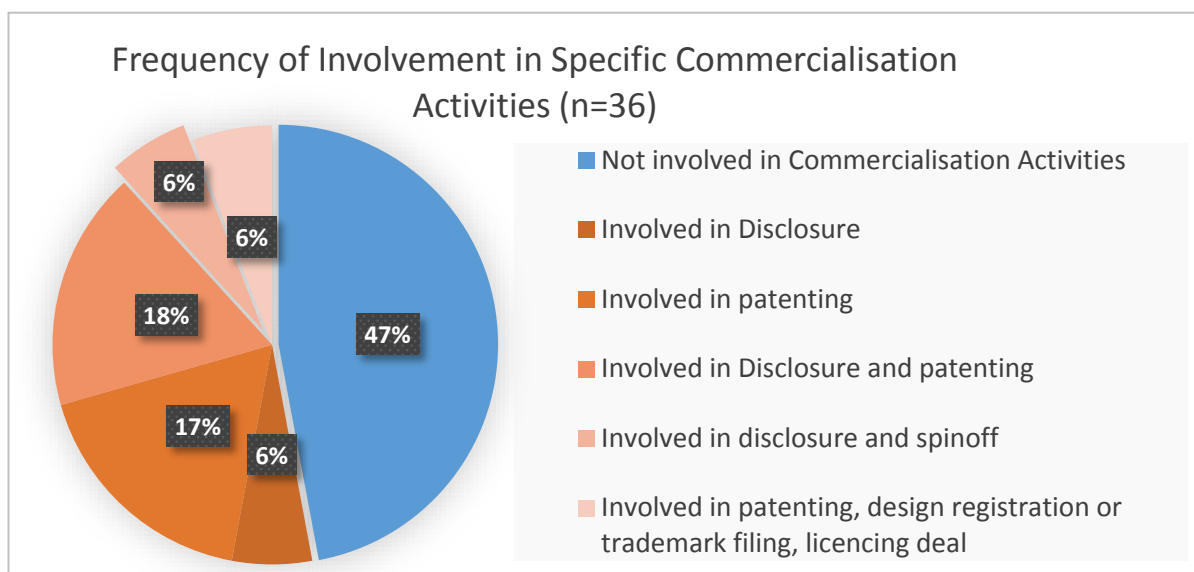
### 4.3.3.3 Question 3.5: Frequency of involvement in specific commercialisation activities

Commercialisation activities includes: disclosure of research findings to NMMU TTO; patenting of an innovation; design registration or trade mark filing; spin-off company and licensing deal. Of the total number of respondents 20 said that they were involved and 16 said that they were not involved (Figure 4.3.6). The same respondents who indicated that they are currently involved validated that answer by confirming the specific activities they are/were involved in.

This confirmed and defined the two groups that would be compared for the study: 'Involved' and 'Not involved'.

Respondents confirmed which activities they had been or are involved in or not. 47% confirmed that they were not involved, 6% stated that they were involved in disclosing research findings to the TTO, 17% said that they were involved in patenting innovations, 18% selected both disclosure and patenting, 6% reported to be involved in disclosure and spin-off and the last 6 % reported to be involved in all activities.

**Figure 4.3.9 Frequency of Involvement in Specific Commercialisation Activities**



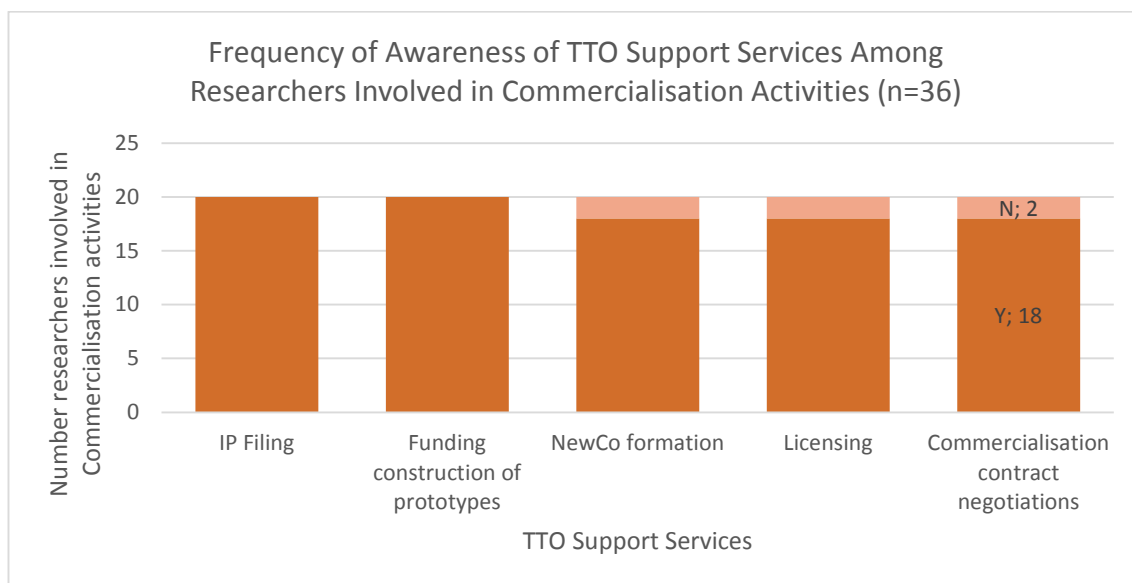
**Figure 4.3.9 Frequency of Involvement in Specific Commercialisation Activities**

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### 4.3.4 Section 4: Awareness of Technology Transfer support activities

#### 4.3.4.1 Questions 4.1 - 4.5: Frequency of awareness of TTO support services among researchers involved in commercialisation activities

A lack of TTO awareness can be a barrier to involvement in commercialisation activities (Alessandrini et al., 2013; Owen-Smith and Powell, 2001). The following questions were designed to probe the researchers' awareness of specific support offered by the TTO. As seen in Figure 4.3.10, of the 20 respondents that are involved, all stated that they were aware that the TTO performs the service of filing of IP and provides funding for the construction of prototypes. Two of twenty respondents stated that they were not aware that the TTO provides support to new company formation, licensing of research outputs and negotiation of commercialisation contracts. It can be concluded that the involved researchers are mostly aware of the functions of the TTO.



**Figure 4.3.10: Frequency of Awareness of TTO Support Activities Among Researchers Involved in Commercialisation Activities.**

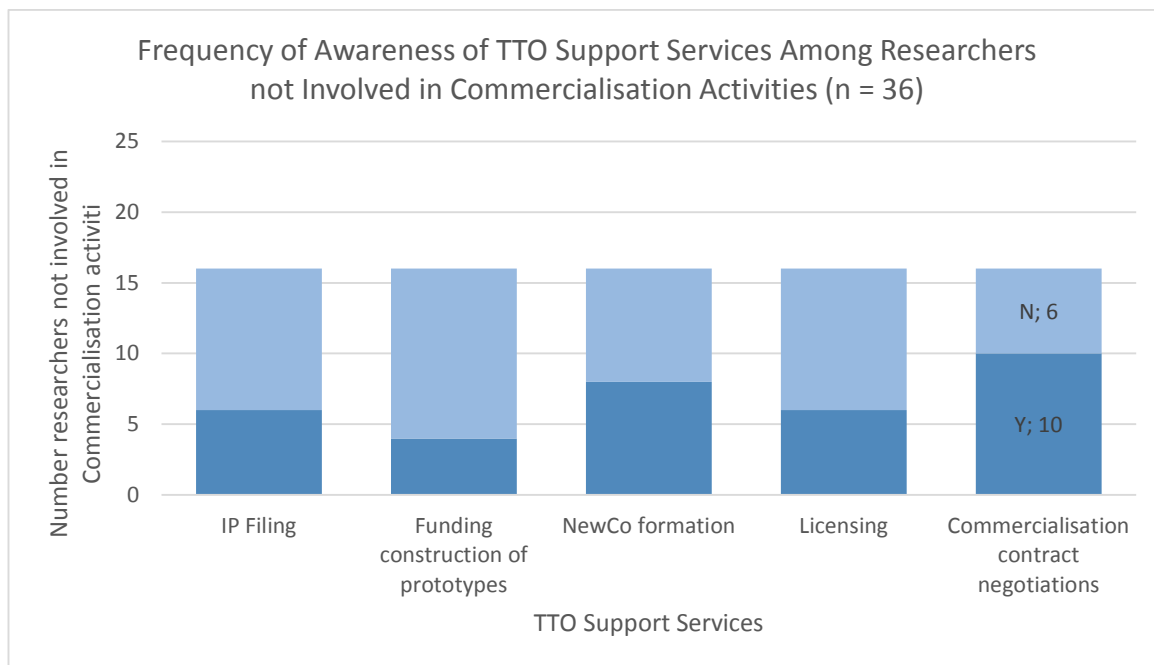
#### 4.3.4.2 Questions 4.1 – 4.5: Frequency of awareness of TTO services among researchers not involved in commercialisation activities

Researchers not involved in commercialisation activities displayed a great lack of awareness of TTO services as observed in

Figure 4.3.11. It was not surprising that most of the researchers in this group were aware that the TTO assists with commercial contract negotiations as the TTO is responsible for

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negotiating research contracts and administrating the signature process for the institution. Most researchers involved in externally funded research contracts would therefore at some point come into contact with the TTO for this reason and so the association can be assumed.



**Figure 4.3.11: Frequency of Awareness of TTO Support Services Among Researchers not Involved in Commercialisation Activities**

This indicated that a lack of TTO awareness could be a significant barrier to encouraging involvement in commercialisation activities among researchers. This lack of awareness could according to Owen-Smith and Powell (2001) negatively influence the researcher's decision to patent because they would not be aware of the perceived benefits of disclosing their invention to the TTO. A lack of awareness also influences the ways in which researchers decide whether they want to commercialise their research (Nilsson et al., 2010). The results shown in Figure 4.3.10 and

Figure 4.3.11 therefore support an intervention to increase awareness of TTO support services among researchers not involved in commercialisation activities.

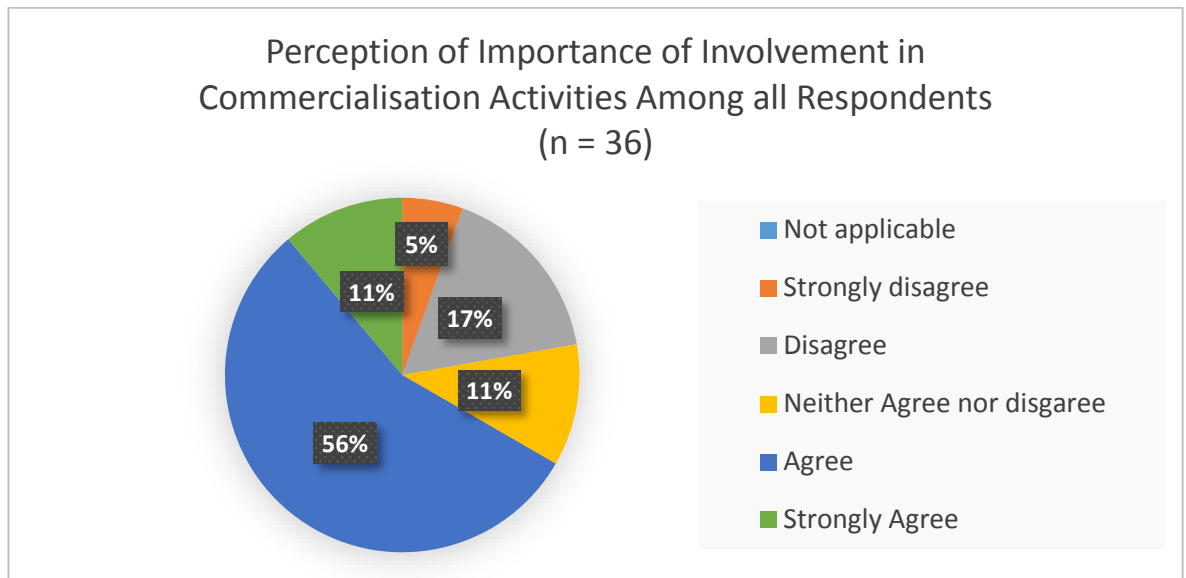
### **4.3.5 Section 5: Importance of Involvement in Commercialisation Activities**

Section 5 of the survey asked a series of Likert scale questions to understand the respondents perceptions of factors associated with enablers and barriers to involvement in commercialisation activities.

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## 4.3.5.1 Question 5.1: Perception of importance of involvement in commercialisation activities among respondents

More than half of all respondents agreed (56%) and strongly agreed (11%) that it is generally important for researchers to be involved in commercialisation activities (Figure 4.3.12).



**Figure 4.3.12: Perception of General Importance of Involvement in Commercialisation Activities**

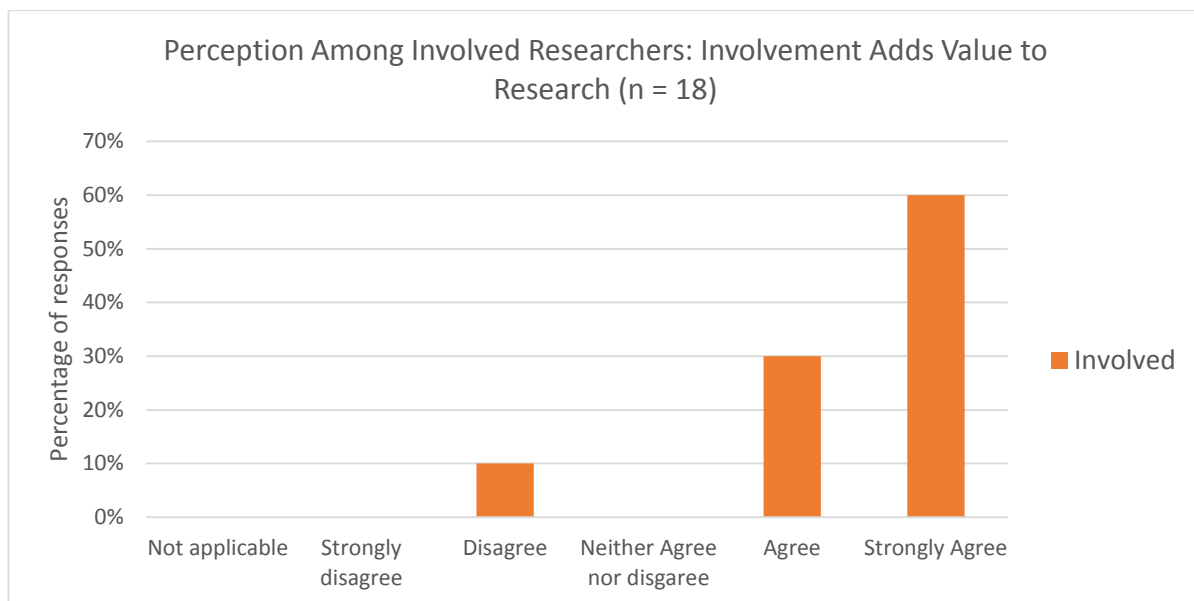
## 4.3.5.2 Question 5.2: Involvement adds value to research

This question probed a general perception of involved researchers to understand whether involvement was beneficial to the traditional activities associated with academia. Respondents were asked to state their agreement with the statement: “involvement in commercialisation activities adds value to my research”. Only the responses from involved researchers were considered during analysis. 10% of involved respondents disagreed with the statement while the remaining 90% agreed or strongly agreed with the statement (Figure 4.3.13).

The results shown in Figure 4.3.12 and Figure 4.3.13 indicate that researchers are inclined towards entrepreneurial activities and see their research as an integral part of building local economic and human capacity. This indicates that at NMMU there is a shift away from the “ivory tower” towards an engaged university that is more entrepreneurial as described by Etzkowitz et al. (2000).



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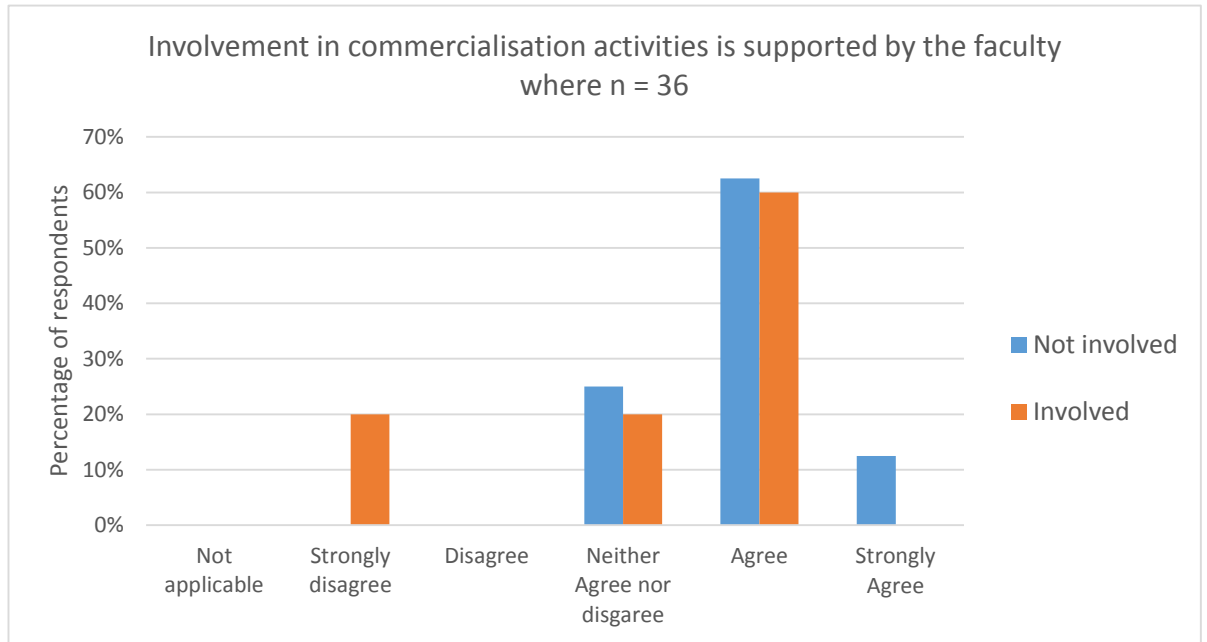
**Figure 4.3.13: Perception Among Involved Researchers of involvement adding value to research activity**

### *4.3.5.3 Question 5.3: Involvement in commercialisation activities adds value to sustaining a research group*

The data from involved respondents were considered. 80% of involved researchers agreed or strongly agreed that sustaining their research group was a benefit for involvement. The results are shown in

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## 4.3.5.4 Question 5.4: Faculty support for involvement in commercialisation activities



**Figure 4.3.14: Perception of faculty management support for involvement in commercialisation activities**

The aim of this question was to question whether there was a perception of support from the faculties for involvement. The perception of faculty management support is important to informing the researchers choice to be or continue being involved in commercialisation activities (Chrisman et al., 1995). Figure 4.3.14 shows that 20% of researchers involved were either undecided or strongly disagreed while 60% agreed with the presence of faculty management support. 25% of researchers not involved were undecided while 63% agreed and 12% strongly agreed.

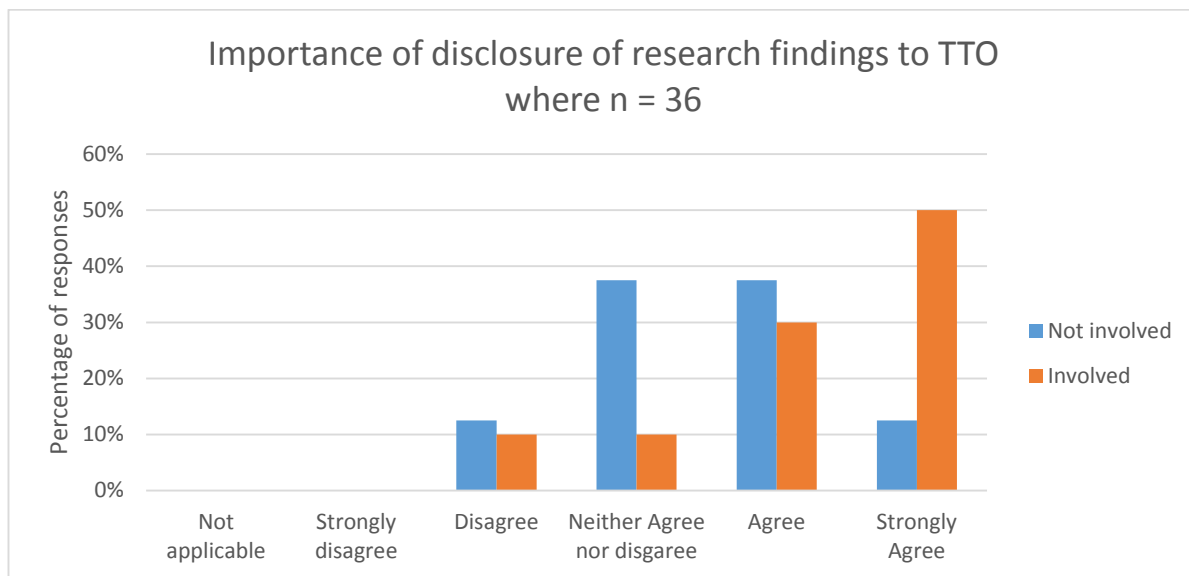
Further research would be needed to understand why 20% of involved researchers strongly perceived that there is not enough faculty management support for involvement.

## 4.3.5.5 Question 5.5: Importance of disclosure to TTO

This question was asked in order to gain an understanding of the researcher's decision making process to continue being or become involved in commercialisation activities. There was a distinct difference in the responses among the two groups. Figure 4.3.15 shows that the majority of involved researchers (80%) agreed (30%) or strongly agreed (50%) that disclosing new innovations to the TTO. A smaller majority (52%) of

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researchers not involved agreed (37%) or strongly agreed (12%) that disclosure was important.



**Figure 4.3.15: Response among groups on importance of disclosure of research finding to TTO**

While legislation obliges researchers to disclose new innovations to the TTO, this result shows quantitatively that the majority of NMMU researchers perceive that it is important to disclose to the TTO and for this to take place there is a need for a trust-based relationship (Debackere and Veugelers, 2005). Whether they perceived that there is benefit to their engagement with the TTO will be answered later.

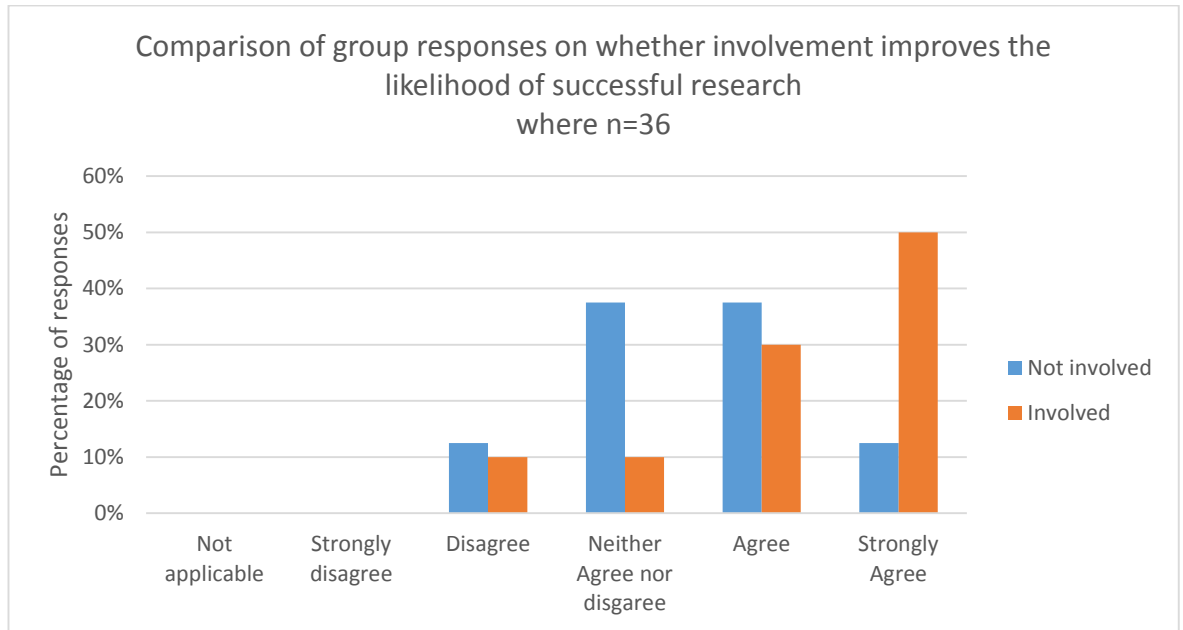
### *4.3.5.6 Question 5.6: Perception of whether involvement improves the likelihood of successful research*

Respondents were asked whether they perceived that involvement in commercialisation research improves the likelihood of successful research. A comparison of the responses from involved and researchers not involved in commercialisation research is depicted in Figure 4.3.16.

It was important to assess whether researchers perceived that involvement improved the likelihood of successful research since this would add value to their primary research activities. As shown in Figure 4.3.16 the majority (80%) of involved researchers agreed (30%) or strongly agreed (50%) that involvement improved the likelihood of successful research. A large percentage of researchers not involved were undecided (38%) and 50% either agreed (38%) or strongly agreed (12%). The last two results are important

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perceptions as it indicates that they are aware of the benefits to research through their peers.



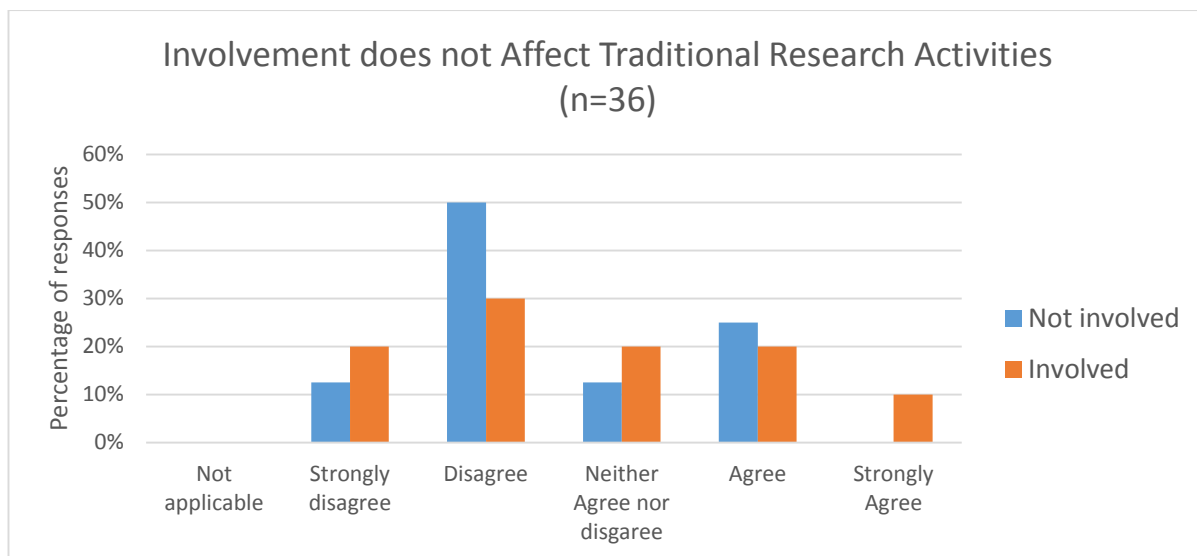
**Figure 4.3.16: Comparison of group responses on whether involvement improves the likelihood of successful research**

This result also builds on the role of the university through the views and perceptions of the researchers. If researchers generally perceive that there is a benefit for their research, they are likely to become more involved in entrepreneurial activities which lead to commercialisation (Etzkowitz, 2003b) and or address some social need (Trencher et al., 2014).

### *4.3.5.7 Question 5.7 Perception of the influence of commercialisation activity involvement on traditional research activities.*

Respondents were asked whether they perceived that involvement in commercialisation activities does not affect traditional research activities such as publication of research findings; supervision of postgraduate students who need to produce research outputs such as treatise and theses. More than half of all of the respondents disagreed indicating that involvement does affect traditional research activities; 50% were involved researchers and more than 60% were researchers not involved in commercialisation activities (Figure 4.3.17).

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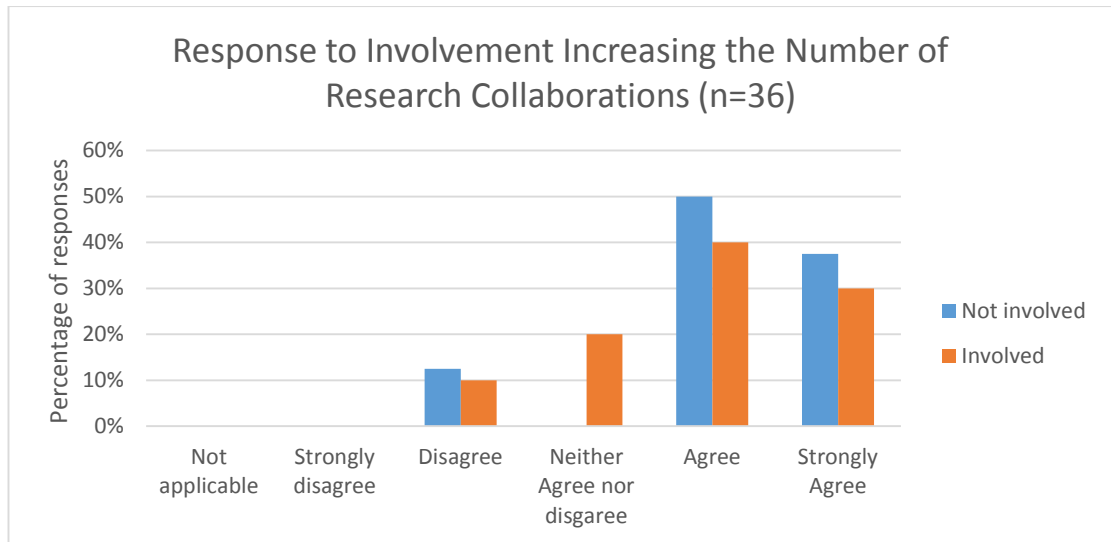
**Figure 4.3.17: Response Among Groups to Whether Involvement Affects Traditional Research Activities**

### *4.3.5.8 Question 5.8 Involvement can increase collaborations with external organisations*

Respondents were asked whether they think that involvement in commercialisation activities leads to a greater number of research collaborations. It was surprising to note (see Figure 4.3.18) that a greater number (18%) of researchers not involved compared to those involved in commercialisation activities thought that this was true. Also worth noting is that researchers not involved made a distinct choice of either agreeing or disagreeing with the statement while 20% of involved researchers chose to neither agree nor disagree with the statement.

This provides an indication of the perception that involved researchers are engaged with industry and derive benefits through their engagement such as the growth of technical and scientific knowledge and sources of additional funding for collaborative projects. The result shown in Figure 4.3.18 confirms the findings of Baregheh et al. (2009) and confirms a perception among researchers not involved that engagement with industry has a positive effect on creating new collaborations.

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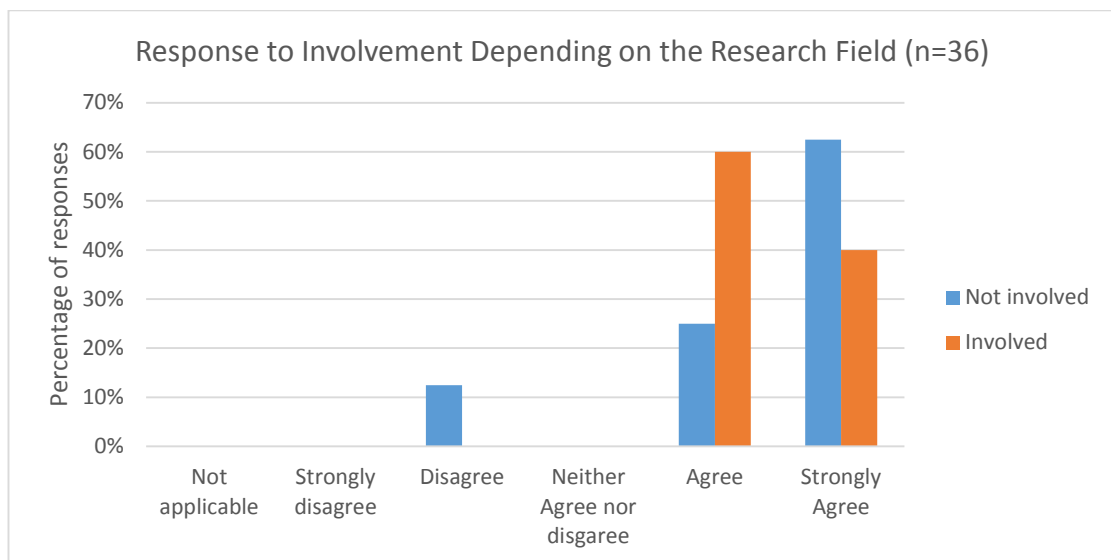


**Figure 4.3.18: Response Among Groups to Whether Involvement Increases the Number of Research Collaborations**

### 4.3.5.9 Question 5.9: The extent of involvement depends on the research field

Respondents were asked their opinion on whether involvement in commercialisation activities is dependent on the research field. Generally both groups agreed that this was true with only 12% of the researchers not involved responding that they disagreed (

Figure 4.3.19).



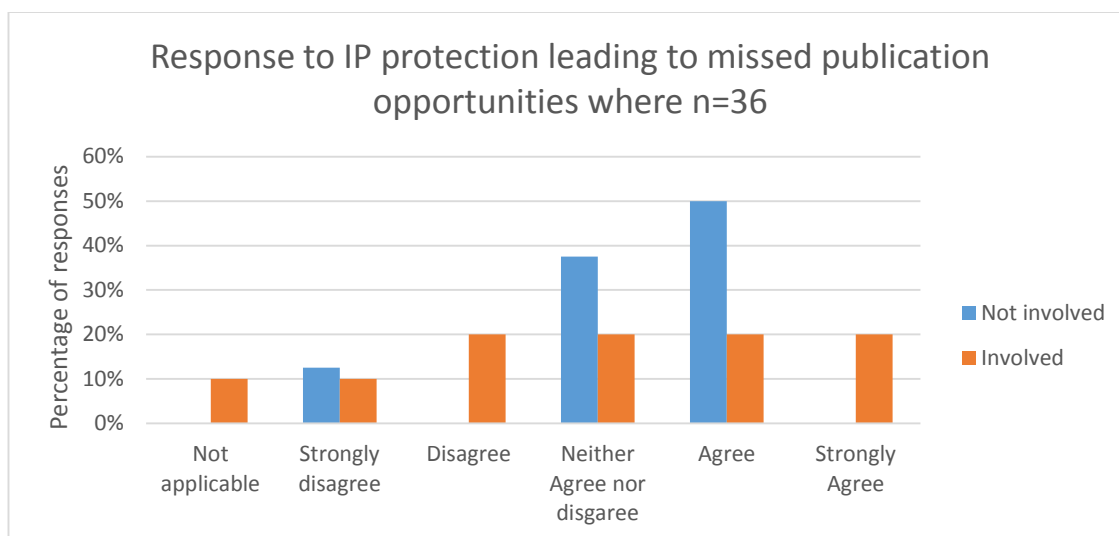
**Figure 4.3.19: Involvement Depends on Research Field**

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### 4.3.5.10 Question 5.10: The process of obtaining statutory protection can lead to missed publication opportunities.

Researchers were asked whether they thought that the process of obtaining statutory protection led to missed publication opportunities. It is a requirement of patent law that inventions must be completely novel and not obvious to persons skilled in the art. Disclosing the nature and impacts of inventions through publications in journal articles, proceedings of conferences, poster exhibitions and presentations would destroy the novelty of the invention and render it not patentable.

Access to the TTO for disclosure is critical to ensure that the TTO can act efficiently for inventions to be protected quickly if required so that disclosure for research benefit can take place (Siegel et al., 2003). That being said, it does depend on the stage of the invention and whether it has commercial value in the long term as to whether protection should be put in place immediately. The risk with protecting too early in the lifecycle of the invention could lead to reduced time for commercial benefit as patents only have a lifespan of 20 years in the chosen territories.



**Figure 4.3.20: Response Among groups on Whether the IP Protection Process Leads to Missed Publication Opportunities**

Only a small percentage of involved researchers (10%) strongly disagreed with this statement while 40% agreed or agreed strongly with it (Figure 4.3.20). 50% of researchers not involved agreed with this statement indicating that there is a greater need for awareness of how protection decisions are taken among researchers and the TTO as well as the speed at which protection can be put in place.

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Since only 17% of involved researchers have been involved in patenting and disclosure, it is difficult to make a conclusion that the TTO is inefficient in its process of protecting IP. Since there is no distinct result obtained through this question, it can be concluded that the TTO is working efficiently to protect IP such that researchers do not miss publication opportunities. The result can add to the motivation for an intervention for additional awareness of the IP protection process being needed among both involved researchers and those not involved.

### **4.3.6 Section 6: Value of the TTO**

Respondents were asked a set of four questions directly relating to the support offered by the TTO. The effectiveness of the TTO can be viewed as an enabler or a barrier to involvement of researchers in commercialisation activities. It was important to assess the perception of the respondents as to whether the TTO functions effectively as an enabler for involvement or a barrier.

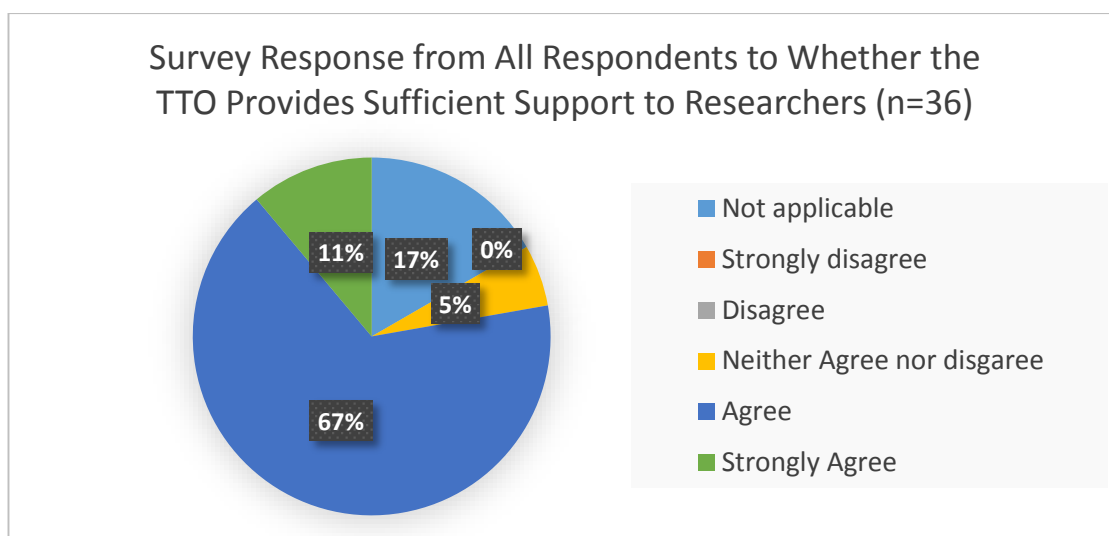
#### *4.3.6.1 Question 6.1: TTO provides sufficient support to researchers*

Typically, researchers not involved would not be receiving support from the TTO but they would likely have had contact with the TTO for other reasons relating to research contract matters. Researchers that are involved would be receiving support directly through the functions mentioned in Section 4.

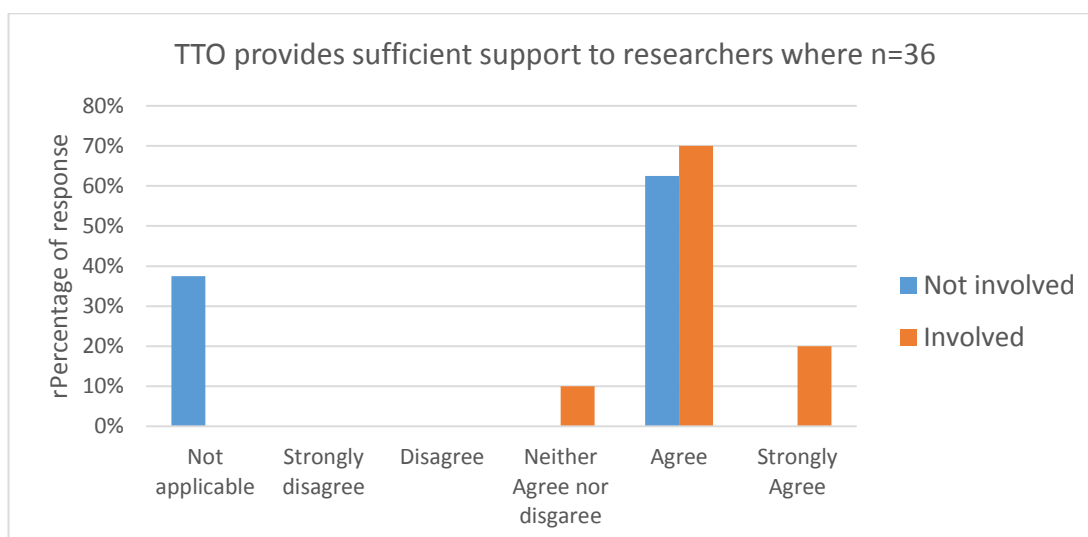
Figure 4.3.23 shows that generally respondents agreed that the TTO provided sufficient support. Figure 4.3.24 shows the difference in response between the two groups. 63% of researchers not involved in commercialisation activities chose to answer this question by agreeing that support offered was sufficient. 70% of researchers involved agreed with the statement while 10% neither agreed nor disagreed and 20% strongly agreed. In effect, it can be deduced directly from this response that the TTO is functioning effectively to offer sufficient support to researchers and can be considered an enabler consistent with findings by Jensen et al. (2003).



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**Figure 4.3.21: Pie chart Showing Response from all Respondents to Whether the TTO Provides Sufficient Support to Researchers**

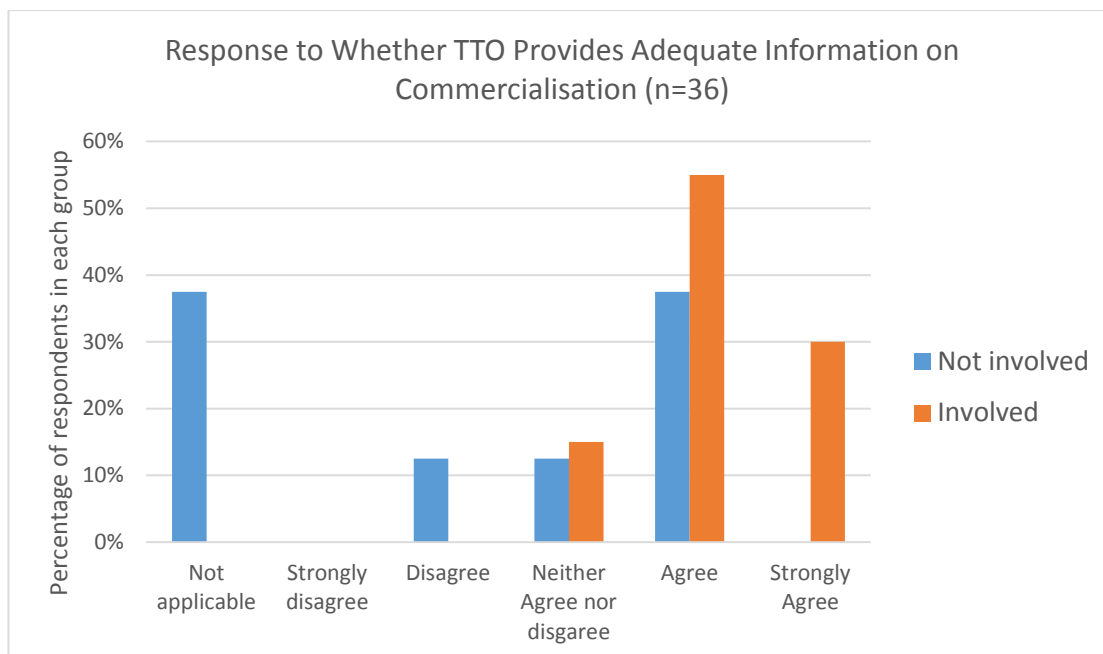


**Figure 4.3.22: Histogram Showing Response from Groups to Whether TTO Provides Sufficient Support to Researchers**

### 4.3.6.2 Question 6.2: TTO provides adequate information on the process of commercialisation

The dissemination of relevant information on the process of commercialisation is essential for researchers to perceive that the TTO is there to support them. Understanding the process of commercialisation within the statutory legal framework is important together with the commercial options.

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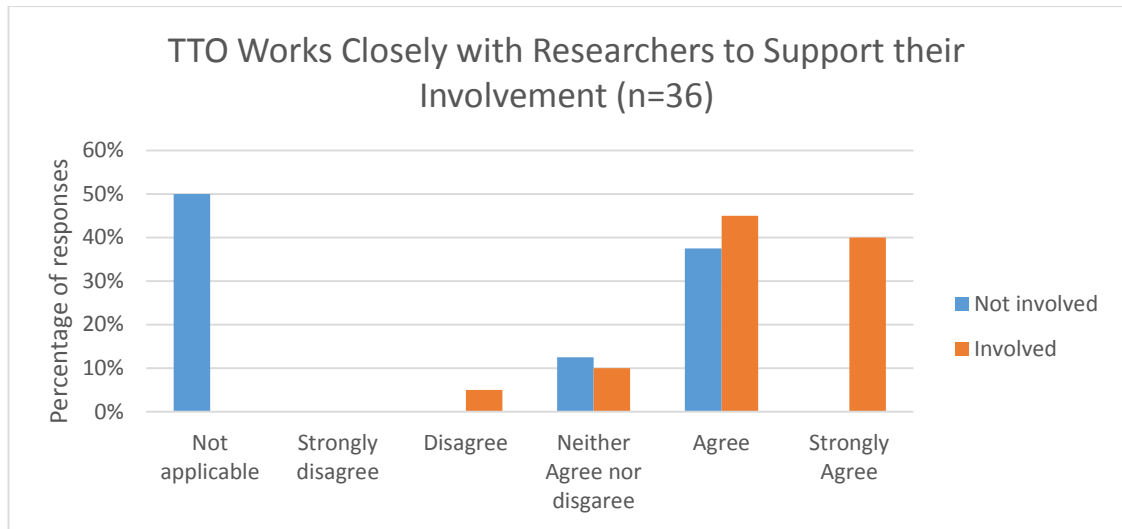
**Figure 4.3.23: Histogram showing Response from Groups to Whether the TTO Provides Adequate Information on the Process of Commercialisation**

Figure 4.3.23 shows that there was a notable difference between the responses from involved researcher compared to those not involved. 56% Involved researchers responded stating that they agree and 30% stated that they strongly agreed. None of the researchers not involved strongly agreed. Further inferential analysis will determine whether the observations were statistically significant.

### *4.3.6.3 Question 6.3: TTO works closely with researchers to support their involvement in commercialisation*

It is important for the relationship between the TTO and researchers who are involved with commercialisation activities to have a good working relationship. In order for the TTO to effectively enable involvement of researchers, it is critical for researchers to have the choice to be involved in the process of commercialisation. Since the TTO is a service department it is also imperative that researchers utilise the service so that the TTO can sustain its function in the university. The perceptions held by both involved and not involved researchers is therefore important to understanding two issues: a) whether the researchers involved perceive that the relationship with the TTO is not one which is an arm's length one and that they are free to approach the TTO with their questions and b) that uninvolved researchers perceive that the relationships held between the TTO and involved researchers is one where the TTO provides an open door to the support which they offer.

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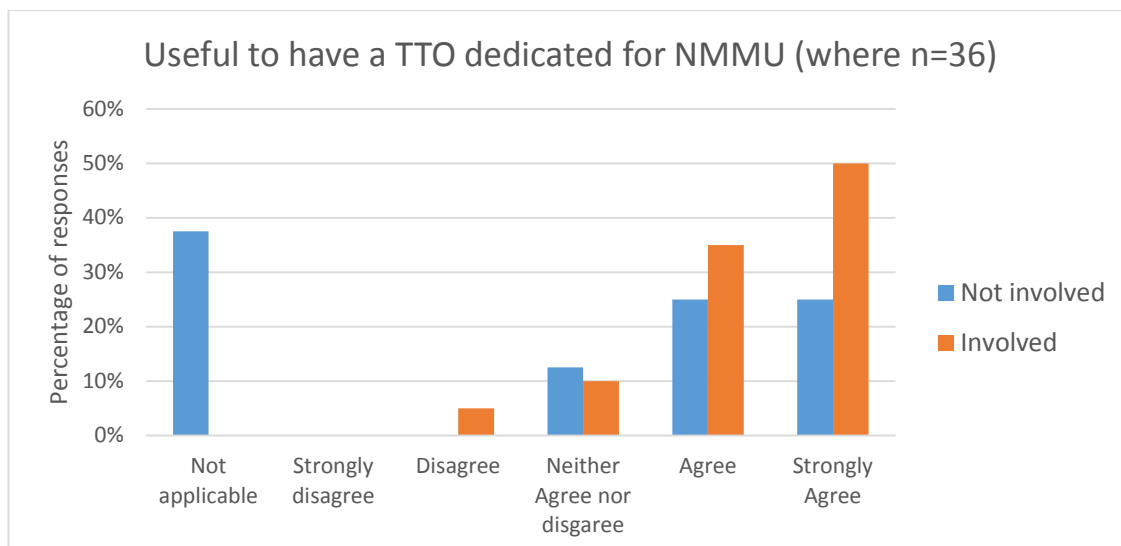
**Figure 4.3.24: Response Among Groups on Whether the TTO Works Closely with Researchers to Support their Involvement in Commercialisation Activities**

It can be noted from Figure 4.3.24 that the majority of involved researchers agree (44%) or strongly agree (40%) with the statement and that at least 37% of uninvolved researchers agreed that they perceived the same. Although a small percentage (5%) of involved researchers disagreed with this finding, the result shows that there is an element of trust which exists between involved researchers and the TTO. This is supported by previous work done by Debackere and Veugelers (2005) and Jensen et al. (2003).

#### *4.3.6.4 Question 6.4: Useful to have a TTO dedicated to supporting only NMMU's needs*

In comparing the responses from the two groups shown in Figure 4.3.25, while 37% of researchers not involved chose to not answer the question, the remainder mostly were neutral or agreed with the statement.

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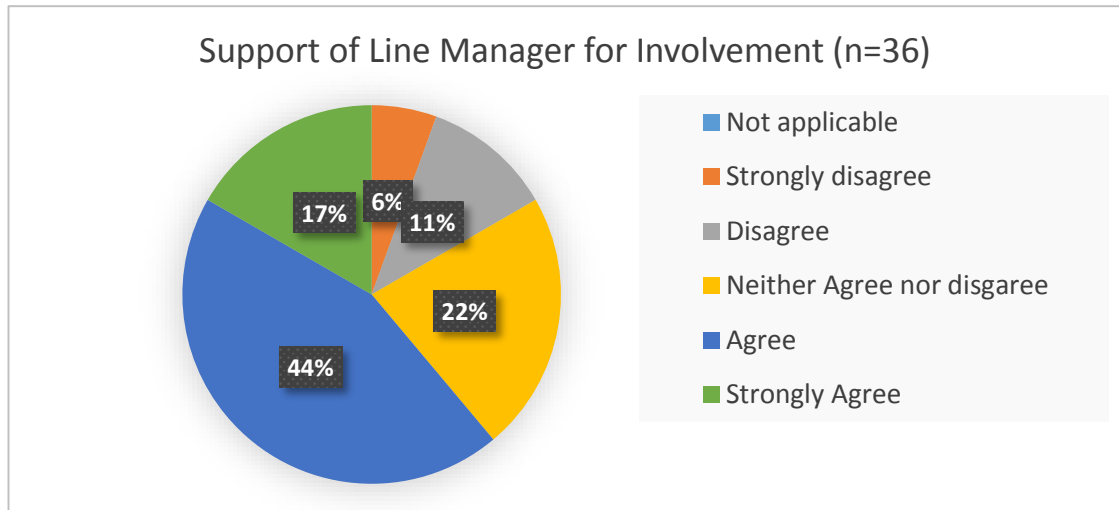
**Figure 4.3.25: Response among Groups to Whether it is Useful to have a Dedicated TTO for NMMU**

### **4.3.7 Section 7: NMMU support for involvement in commercialisation activities**

Faculty and line management support can act as an enabler or a barrier to increasing involvement of researchers in commercialisation activities (Chrisman et al., 1995). It was therefore important to identify the level of support for involvement at different levels of institutional management.

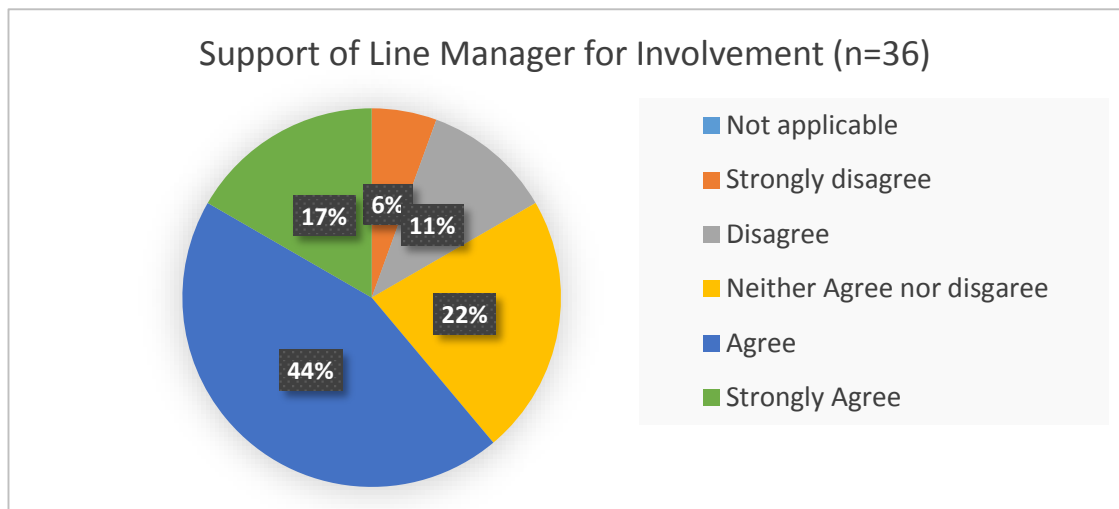
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## 4.3.7.1 Question 7.1: Line manager support for involvement



**Figure 4.3.26: Perception of Support from Line Manager for Involvement in commercialisation activities**

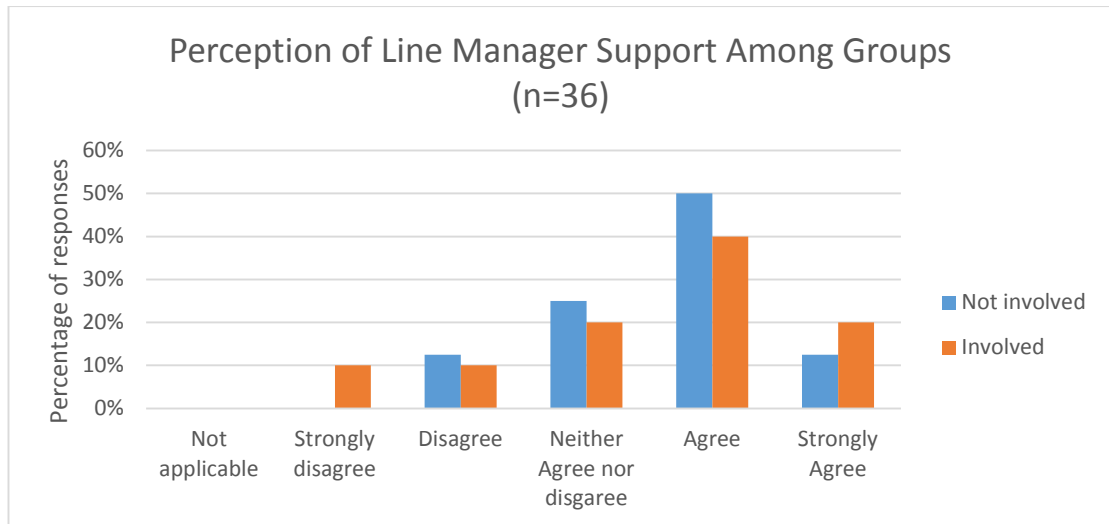
## 4.3.7.2 Support of Line Manager for Involvement



**Figure 4.3.26: Perception of Support from Line Manager for Involvement in commercialisation activities**

Figure 4.3.26 shows that 44% of respondents stated agreement while 17% strongly agreed that their line managers are/would be supportive of them being involved in commercialisation. 11% disagreed while 6% strongly disagreed with the statement.

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**Figure 4.3.27: Perception of Line Manager Support Among Groups**

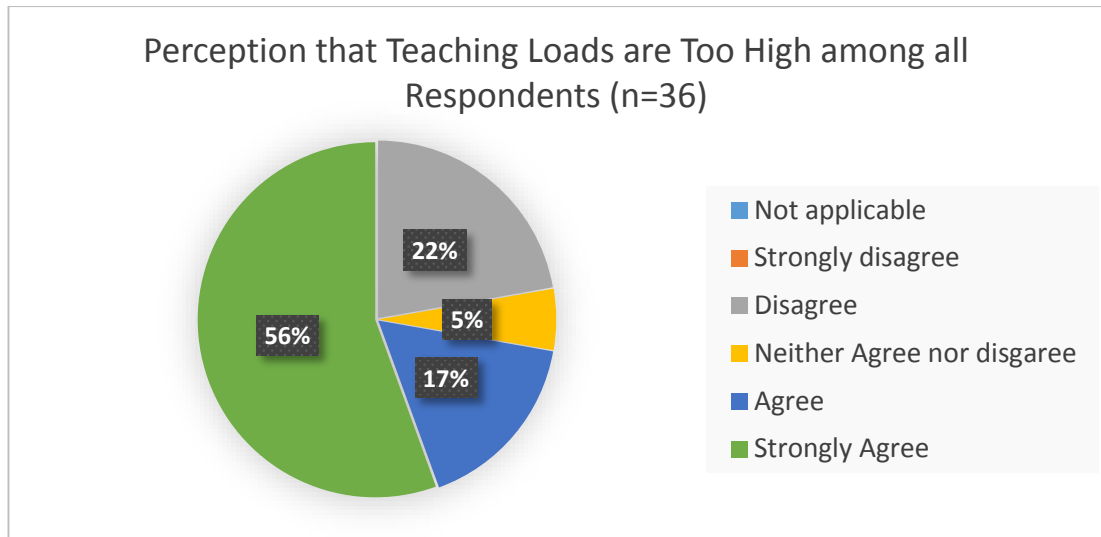
The response among groups was the same with the medians for both groups being equal (4.0) (see Appendix D).and the majority of both groups (> 40%) agreeing that there was line manager support (Figure 4.3.27). In conjunction with other management support results, inferential analysis will determine whether management support acts as an enabler or barrier at NMMU.

### *4.3.7.3 Question 7.2: Teaching loads are too high for researchers to be involved in commercialisation activities*

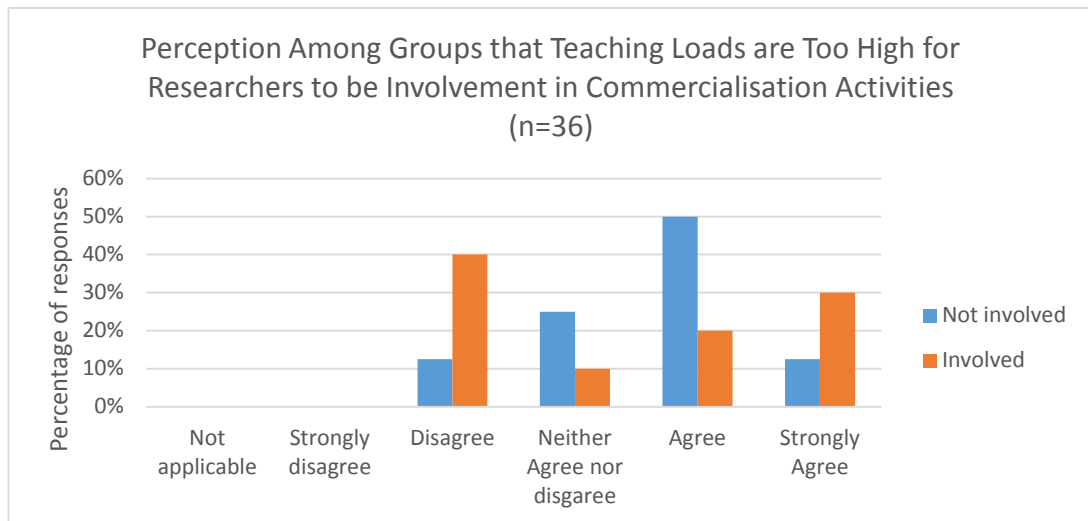
All respondents chose to answer this question with the majority agreeing and strongly agreeing (17% and 56% respectively) that teaching loads are too high for researchers to be involved in commercialisation activities (Figure 4.3.28). None of the respondents strongly disagreed with this statement but 22% disagreed.

While a core priority of the university is teaching, an intervention to accommodate researchers involved in commercialisation by providing teaching relief may be a consideration.

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**Figure 4.3.28: Perception Among all Respondents on Whether Teaching Loads are Too High for Researchers to be Involved in Commercialisation Activities**



**Figure 4.3.29: Perception Among Groups on Whether Teaching Loads are Too high for Researchers to be Involved in Commercialisation Activities**

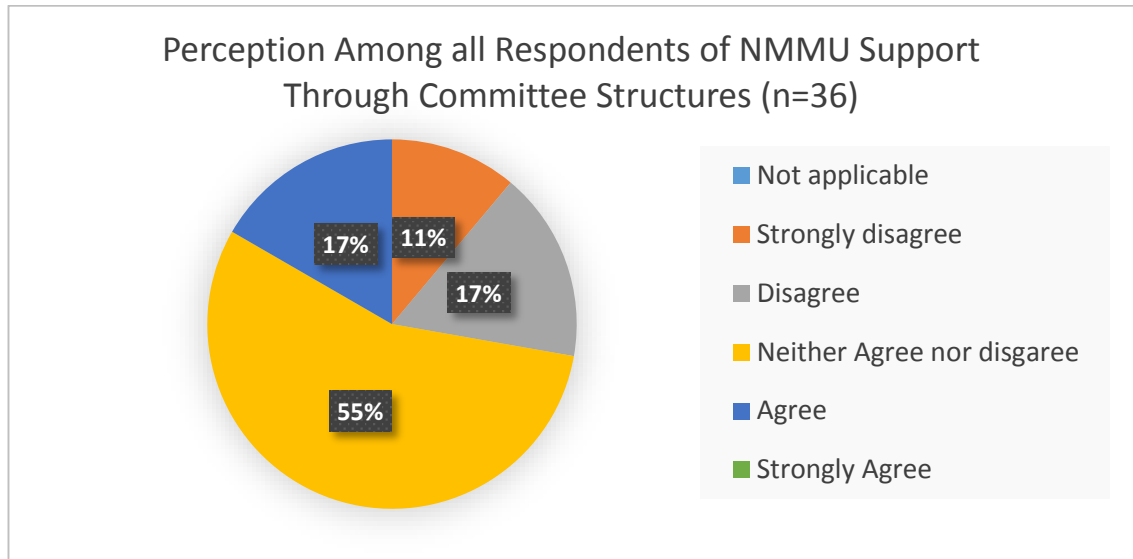
Figure 4.3.29 shows that 30% and 20% of involved researchers strongly agreed and agreed respectively with the statement while 40% disagreed with the statement and 10% were undecided. Compared to 50% of researchers not involved who agreed with the statement.

### 4.3.7.4 Question 7.3: NMMU support for involvement through committee structures

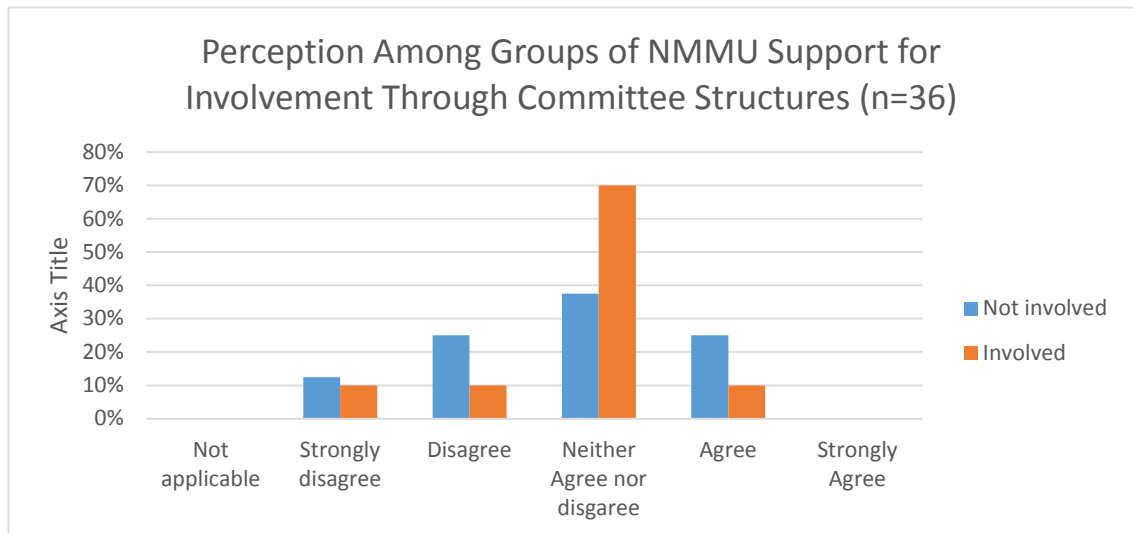
The majority of respondents were undecided (55%) while 17% agreed and 11% strongly disagreed (Figure 4.3.30). This result indicates that an intervention is necessary to

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assess existing committees, their role and how focus on driving commercialisation activities can be improved.



**Figure 4.3.30: perception among all respondents of whether NMMU supports involvement in commercialisation activities through committee structures**



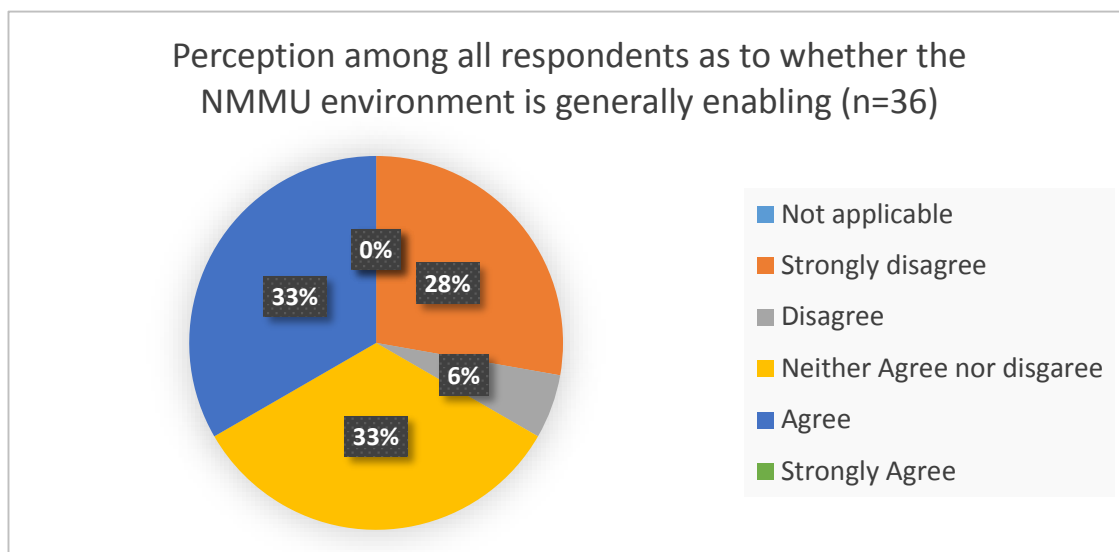
**Figure 4.3.31: Perception Among Groups of NMMU Support for Involvement in Commercialisation Activities through Committee Structures**

Involved researchers were mostly undecided (70%) on whether there is support for their involvement through the institution’s committee structures (Figure 4.3.31). This indicates that there is likely a need for greater awareness among involved researchers of existing committee structures and engagement on how these structures can be improved to provide further support.



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### 4.3.7.5 Question 7.4: NMMU environment is generally enabling for researcher involvement

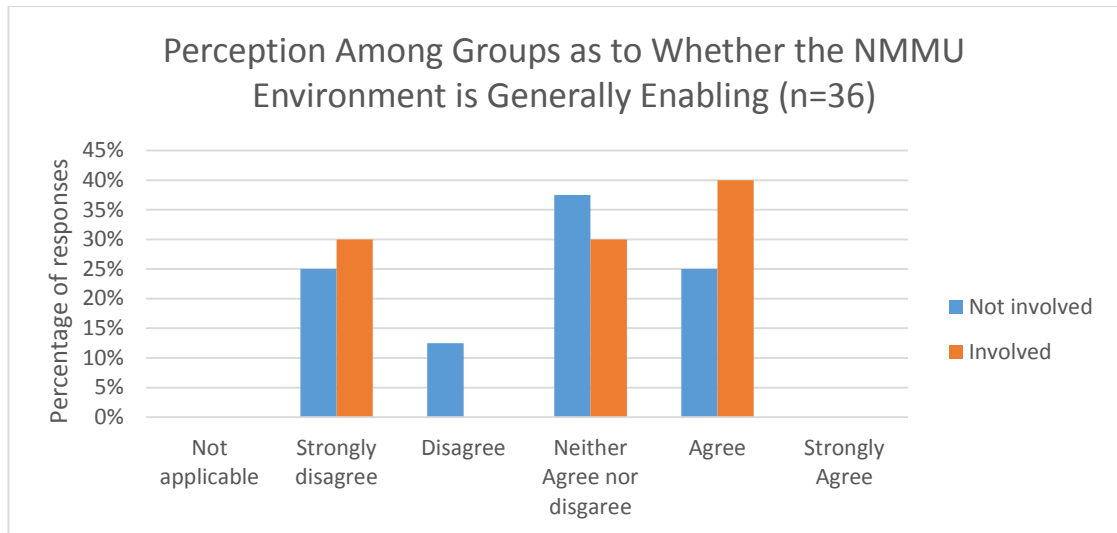


**Figure 4.3.32: Perception Among all Respondents as to Whether the NMMU Environment is Generally Enabling**

Figure 4.3.32 shows that 33% of all respondents agreed while another 33% were undecided. 28% strongly disagreed and 6% disagreed that the NMMU environment is generally enabling to promote involvement in commercialisation activities. This result shows that the institution needs to do more in general to support researchers and enable them to produce their best in terms of research and through their involvement in commercialisation activities. This result will be analysed further in conjunction with management support questions to provide a more meaningful result to determine whether institutional management support is a barrier for NMMU researchers.

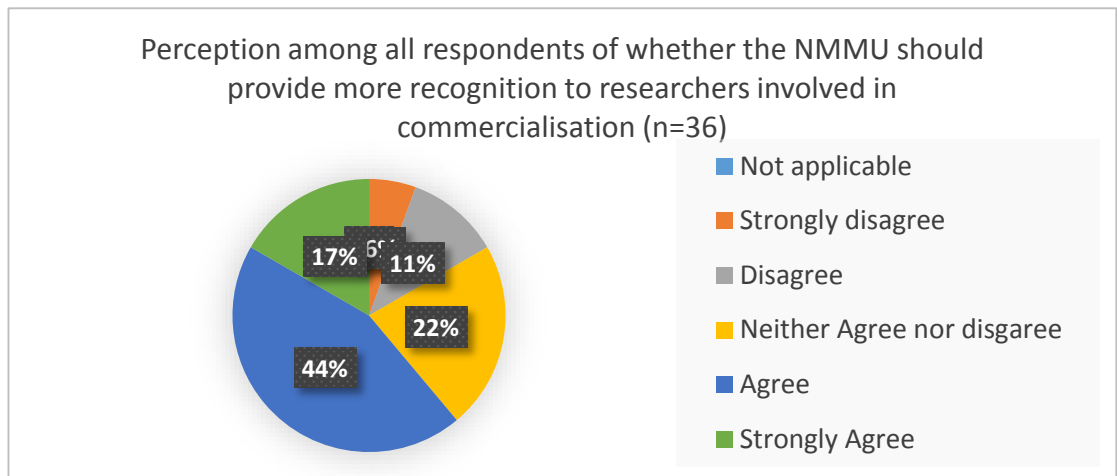
Figure 4.3.33 show that while 15% more involved researchers agreed with this statement than not involved researchers, 5% of involved researchers also strongly disagreed with the statement than researchers not involved. A large percentage of both groups were undecided. This provides a very unclear answer and will need to be examined along with other variables using the multivariate analysis.

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**Figure 4.3.33: Perception Among Groups as to Whether the NMMU Environment is Generally Enabling for Researcher Involvement in Commercialisation Activities**

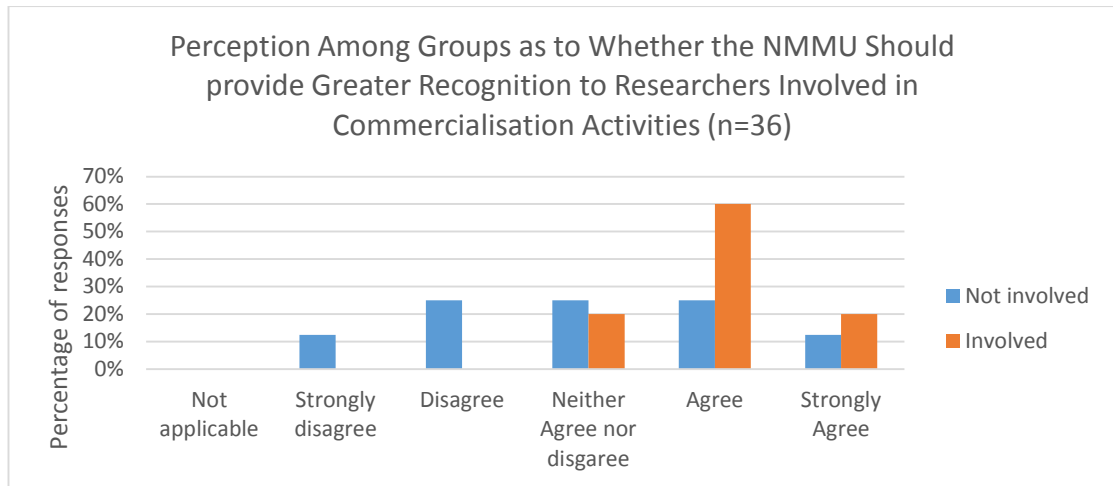
### 4.3.7.6 Question 7.5 Should the NMMU provide more recognition to involved researchers



**Figure 4.3.34: Perception Among all Respondents on Whether the NMMU should Provide more Recognition to Involved Researchers**

The majority of respondents either agreed (44%) or strongly agreed (17%). 22% were undecided and 11% disagreed while 6% strongly disagreed (Figure 4.3.34).

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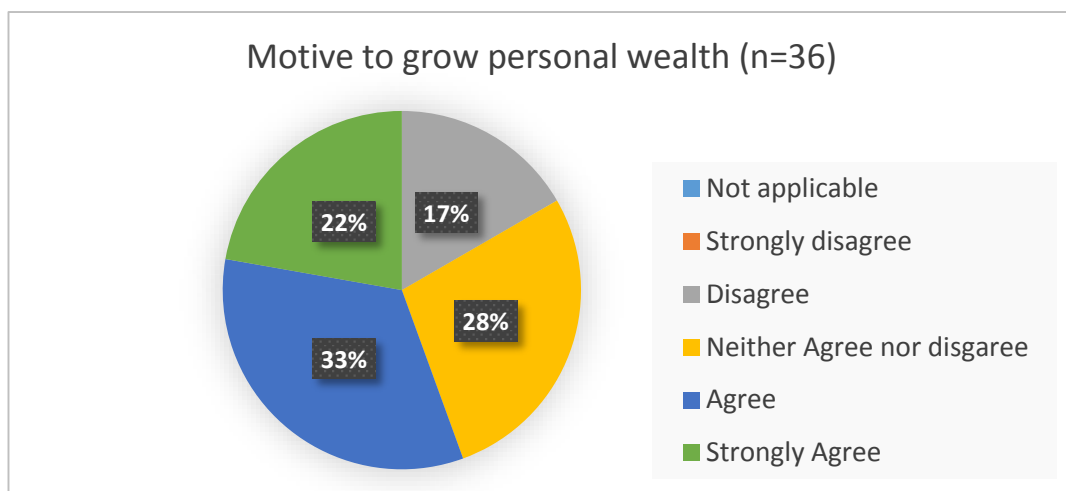


**Figure 4.3.35: Perception Among Groups of Whether the NMMU Should Provide Greater Recognition to Researchers Involved in Commercialisation activities**

Figure 4.3.35 shows that 80% of involved researchers agreed (60%) or strongly agreed (20%) that involved researchers should receive greater recognition for their involvement in commercialisation activities, while 20% were undecided. The NMMU has existing ways of recognising researchers for their involvement, however, this result indicates that additional recognition may serve as a non-monetary incentive to increase involvement.

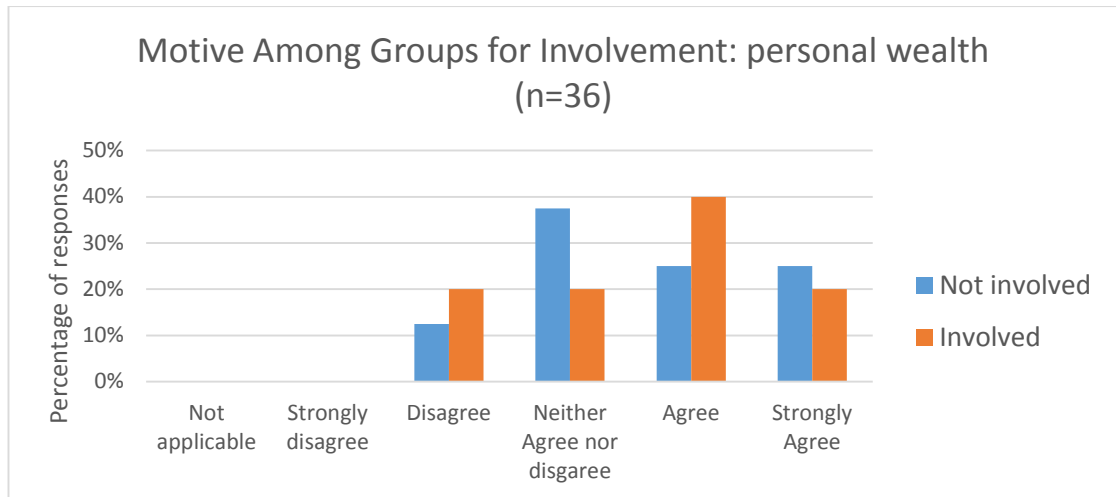
### 4.3.8 Section 8: Personal motives and incentives for involvement

#### 4.3.8.1 Question 8.1: Personal motive for involvement is to grow personal wealth



**Figure 4.3.36: Response from all respondents to whether growing personal wealth is a motive for involvement**

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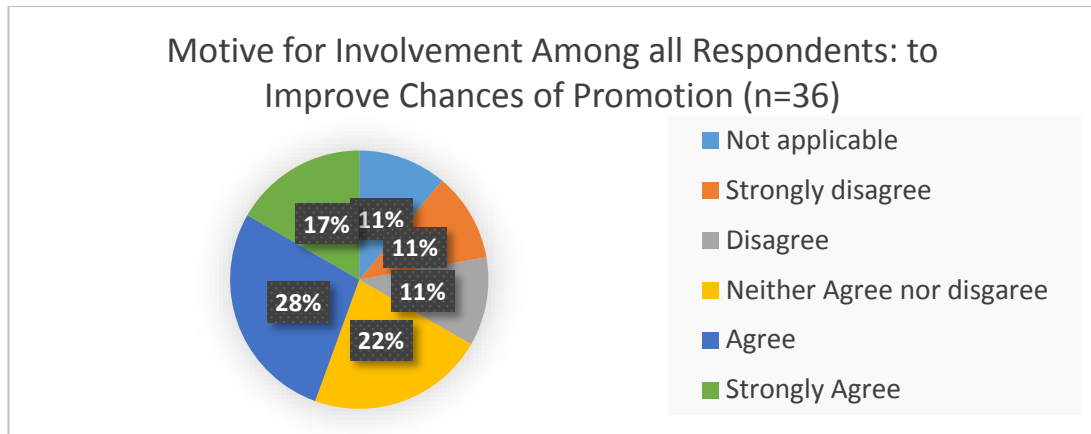
**Figure 4.3.37: Response among groups to whether growing personal wealth is a motive for involvement in commercialisation activities**

The majority of involved researchers either agreed (60%) or strongly agreed (20%) that growing their personal wealth was one of their motives for involvement in commercialisation activities. A minority of 20% disagreed and another 20% were undecided. Half of the researchers not involved either agreed (25%) or strongly agreed (25%) that this would be a motivating factor for them. The largest proportion of the researchers not involved (37%) were undecided and 13% disagreed (Figure 4.3.37). This motive will be analysed along with monetary incentives to determine a correlation.

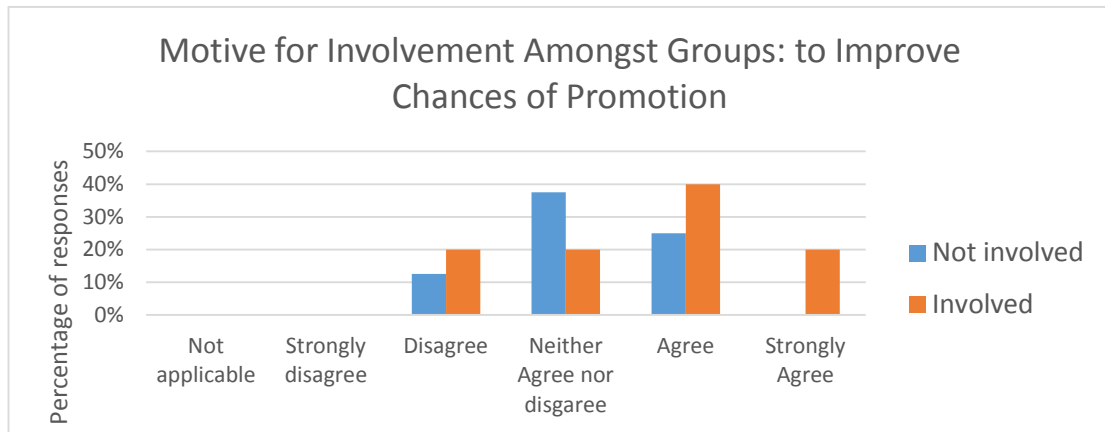
### 4.3.8.2 Question 8.2: Personal motive for involvement is an improved chance of promotion

Figure 4.3.38 shows that 28% of the sample agreed and 17% strongly agreed that improved chances of promotion were a motivating factor for involvement in commercialisation activities. 22% were undecided while 11% disagreed and another 11% strongly disagreed. This indicated that there is a disconnection between the performance management system and the activity of researchers in commercialisation activities.

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**Figure 4.3.38: Response from All Respondents to Whether Improved Chances of Promotion is a Motive for Involvement**

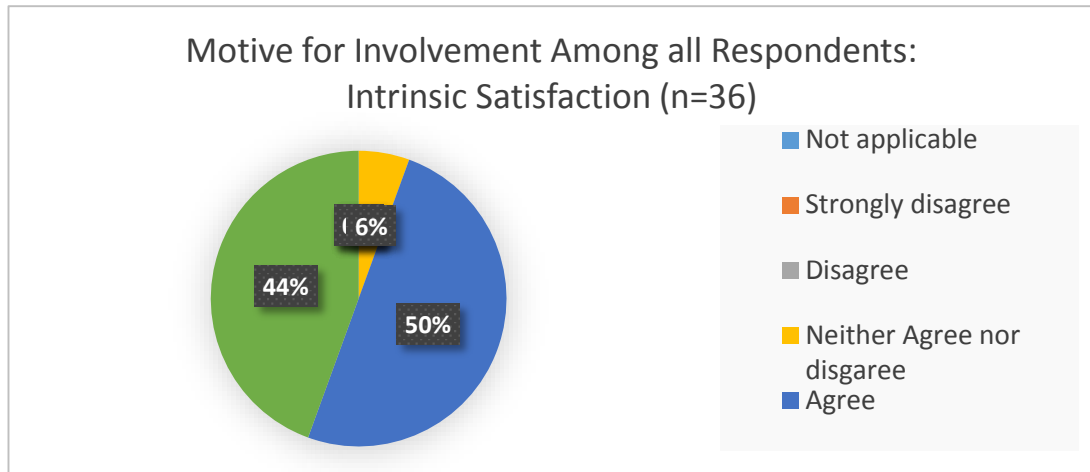


**Figure 4.3.39: Response Among Groups to 'Improved Chances of Promotion' being a Motive**

Figure 4.3.39 shows that 40% of involved researchers agreed and 20% strongly agreed indicating that this was a motivational factor for their involvement. The researcher not involved did not provide a clear response with most (37%) stating that they were undecided while only 25% agreed.

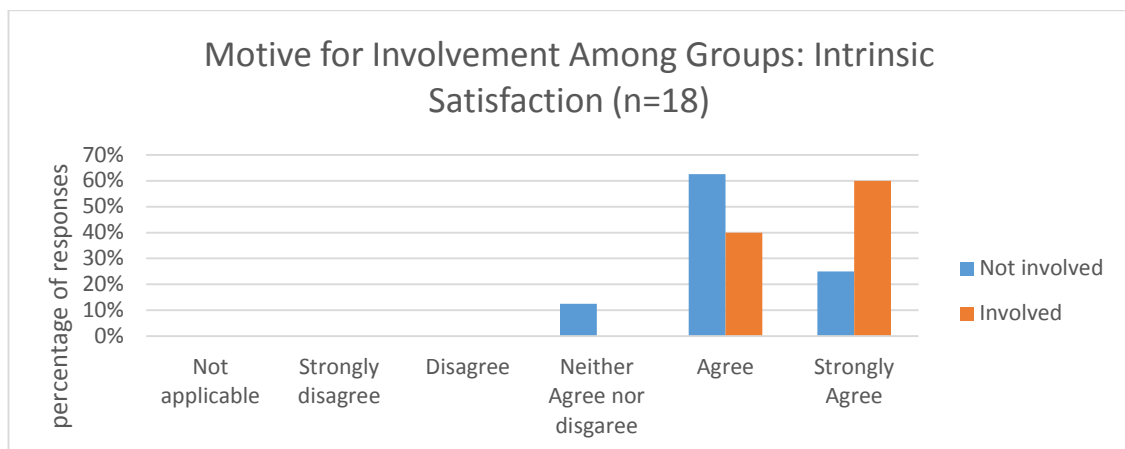
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## 4.3.8.3 Question 8.3: Intrinsic satisfaction is a personal motive for involvement



**Figure 4.3.40: Response Among all Respondents to Whether Intrinsic Satisfaction is an Incentive for Involvement**

An overwhelming 94% of respondents either agreed (50%) or strongly agreed (44%) that intrinsic satisfaction is motivating factor for involvement in commercialisation activities (Figure 4.3.40).

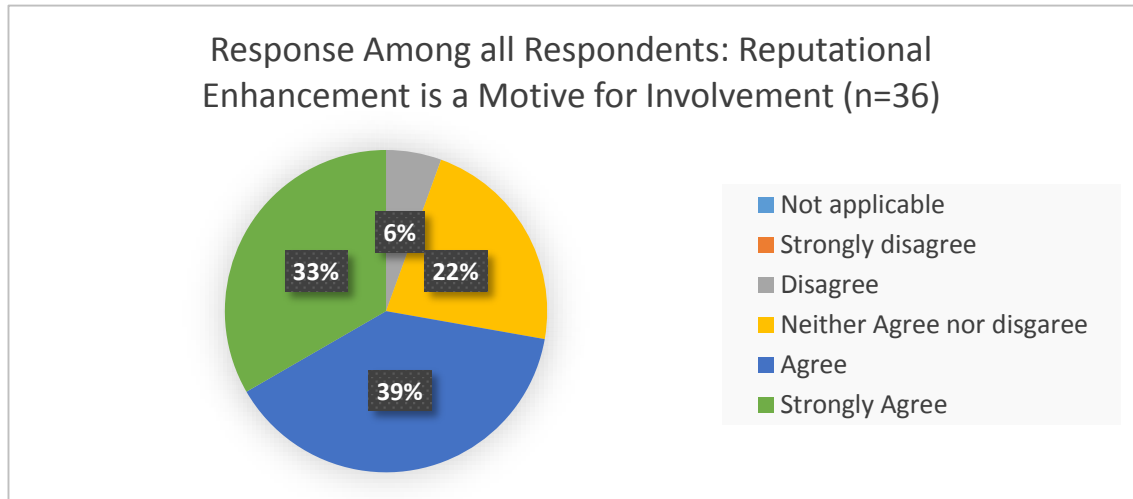


**Figure 4.3.41: Response among Groups as to Whether Intrinsic Satisfaction is a Motive for Involvement**

Figure 4.3.41 shows that the response among the groups was fairly similar with an overwhelming majority in both groups agreeing and strongly agreeing that intrinsic motivation is a motive for involvement. This result indicates that NMMU researchers are intrinsically motivated to perform and should their research be commercialised that intrinsic motivation is a strong motivating factor which drives their involvement.

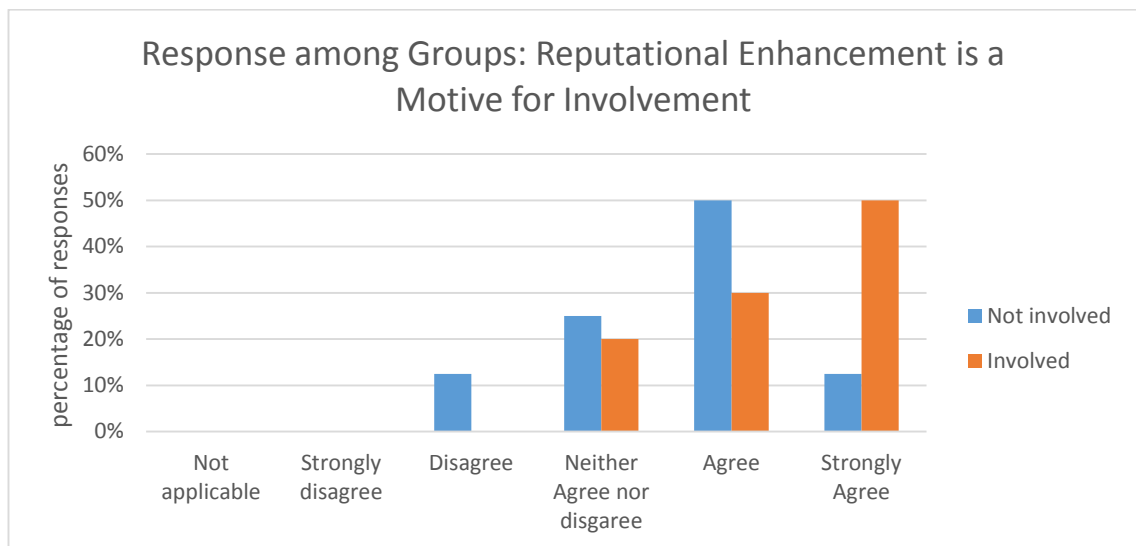
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## 4.3.8.4 Question 8.4: Reputational enhancement is a personal motive for involvement



**Figure 4.3.42: Response Among all Respondents to Whether 'Reputational Enhancement' is a Motive for Involvement**

Figure 4.3.42 shows that an overwhelming majority of respondents either agreed (39%) or strongly agreed (33%) that reputational enhancement is a motive for involvement. 22% were undecided and 6% disagreed.

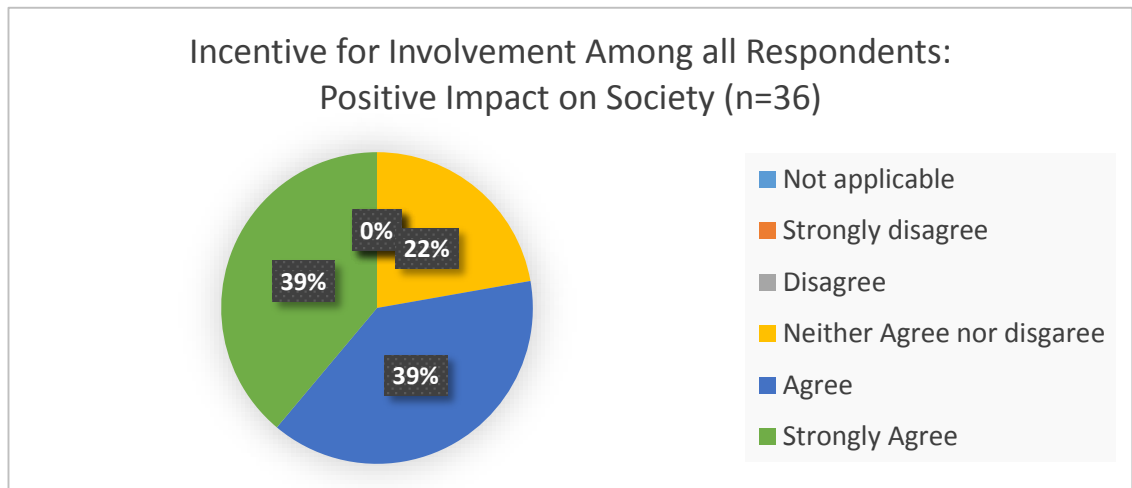


**Figure 4.3.43: Response Among Groups to Whether 'Reputational Enhancement' is a Motive for Involvement**

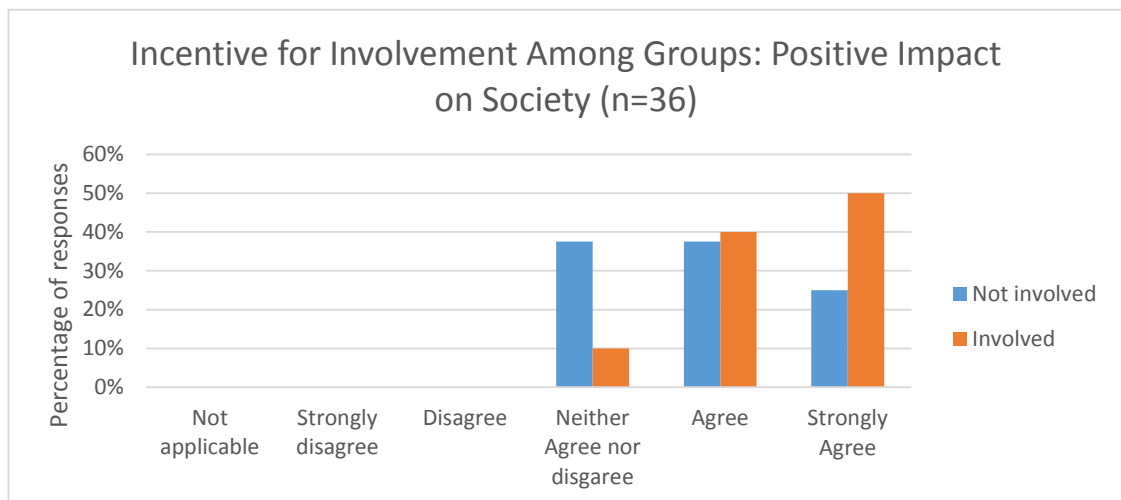
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There appeared to be a distinct difference in the responses between involved and not involved groups. Figure 4.3.43 shows that 50% of involved researchers appeared to agree more strongly than researchers not involved.

### 4.3.8.5 Question 8.5: Incentive for involvement is to make a positive impact on society



**Figure 4.3.44: Response Among all Respondents to Whether Making a Positive Impact on Society is a Motive for Involvement**



**Figure 4.3.45: Response Among Groups to Whether Making a Positive Impact on Society is a Motive for Involvement**

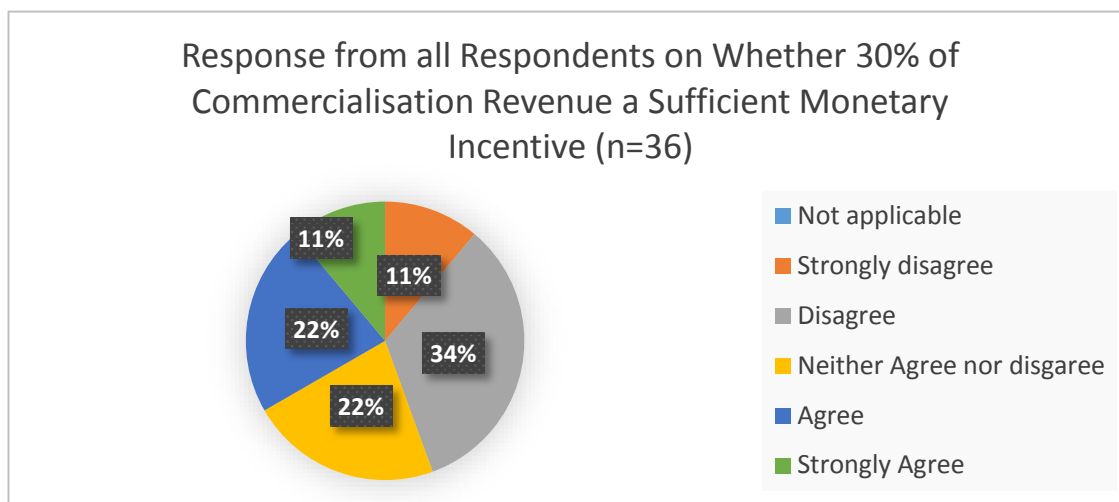
The majority of respondents either agreed (39%) or strongly agreed that making a positive impact on society is a motivating factor. The remaining 22% were undecided as shown in Figure 4.3.44.

Generally, involved researchers agreed more strongly with this statement and more researchers not involved were undecided Figure 4.3.45.



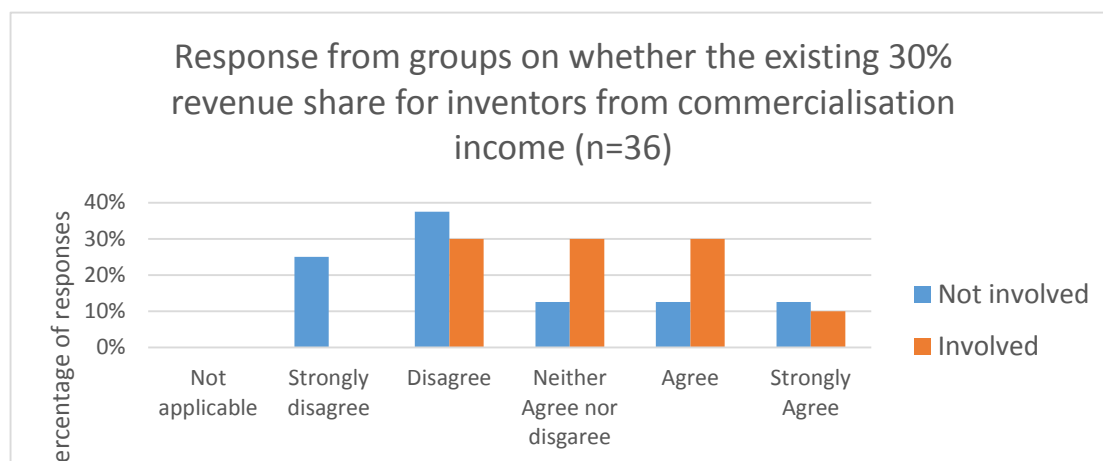
## Chapter 4

### 4.3.8.6 Question 8.6: NMMU commercialisation revenue share for inventors (30%) is sufficient incentive



**Figure 4.3.46: Response from all Respondents to Whether the Existing Monetary Incentive of 30% of net Commercialisation Revenue Received by the Institution is Sufficient Monetary Incentive for Inventors**

Figure 4.3.46 depicts a range of responses that were received with only 11% strongly agreeing and 22% agreeing (one third of all respondents) 34% disagreed and 22% were undecided as to whether 30% revenue share was sufficient.



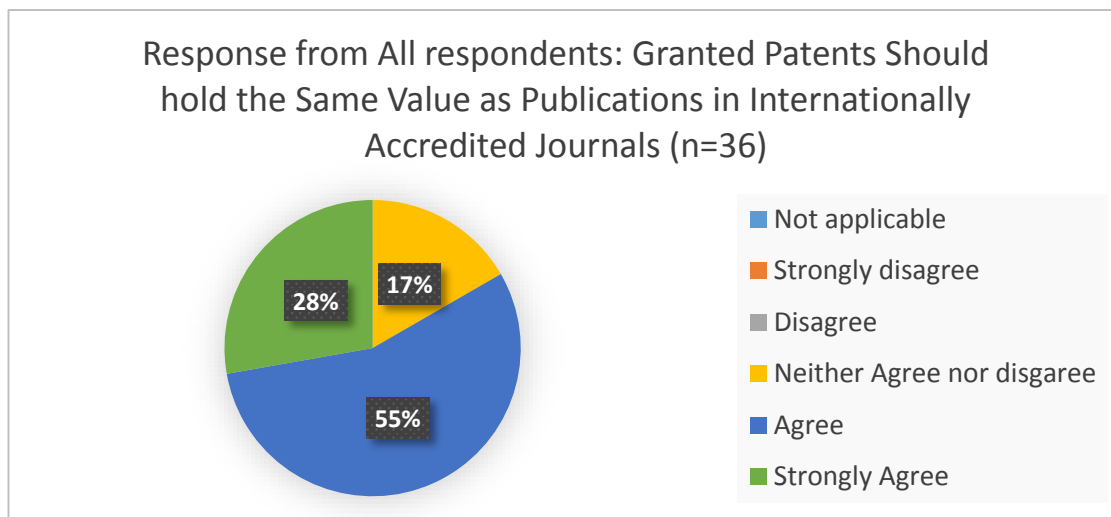
**Figure 4.3.47: Response among Groups to Whether the 30% Revenue Share for Inventors is Sufficient Monetary Incentive**

The highest response was received from researchers not involved who disagreed (37%) with this statement. A small percentage of involved researcher strongly agreed (10%) while 30% either agreed or were undecided. Further analysis is necessary to provide a meaningful result.

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### 4.3.9 Section 9: Interventions to improve involvement

4.3.9.1 Question 9.1: Patents granted in international territories should hold the same value as publications in internationally accredited journals during performance evaluation

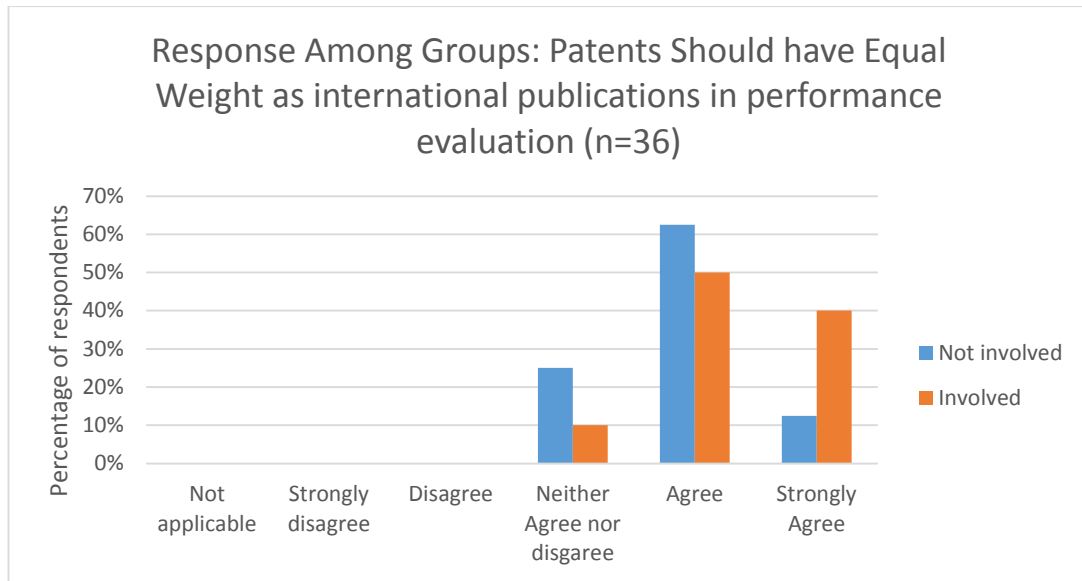


**Figure 4.3.48: Response Among all Respondents to Granted International Patents Holding Equal Weight to International Accredited Journal Publications during Performance Evaluation**

The majority of respondents agreed (55%) and strongly agreed (28%) that patents granted in foreign territories should hold an equal weight as journal publications in internationally accredited journals during performance valuation (Figure 4.3.48).

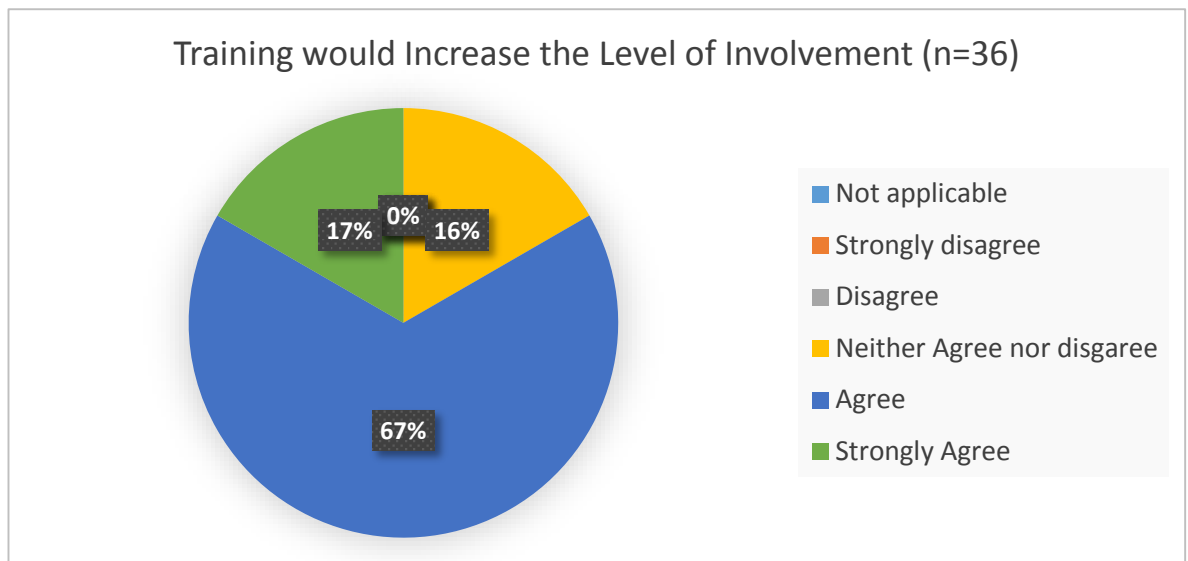
The responses among the groups appeared to be only slightly different with a greater percentage of involved researchers (40%) agreeing more strongly compared to researchers not involved (12%) (Figure 4.3.49).

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**Figure 4.3.49: Response Among Groups to Granted International Patents Holding Equals Weight to Internationally Accredited Journal Publications during Performance Evaluation**

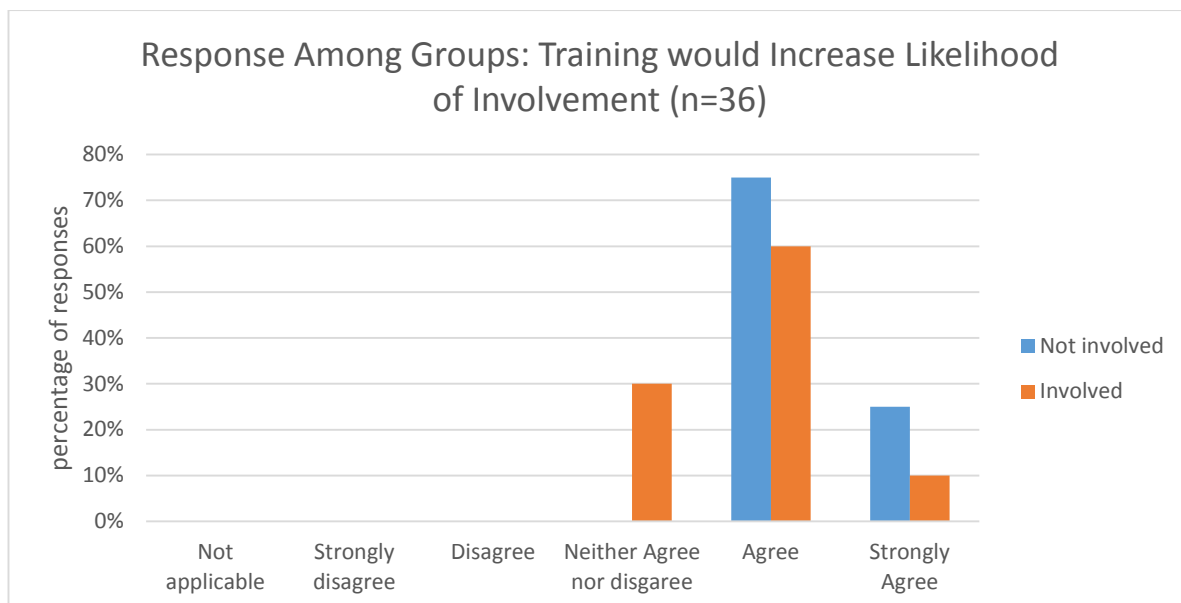
### 4.3.9.2 Question 9.2 Training would likely increase the involvement of researchers in commercialisation activities



**Figure 4.3.50: Response Among all Respondents to Whether Formal Training Opportunities would Increase the level of Researchers' Involvement**

The majority of all respondents agreed (67%) or strongly agreed (17%) that a training intervention would increase the involvement of researchers. 16% were undecided as to whether this would be a useful intervention Figure 4.3.51.

## Chapter 4



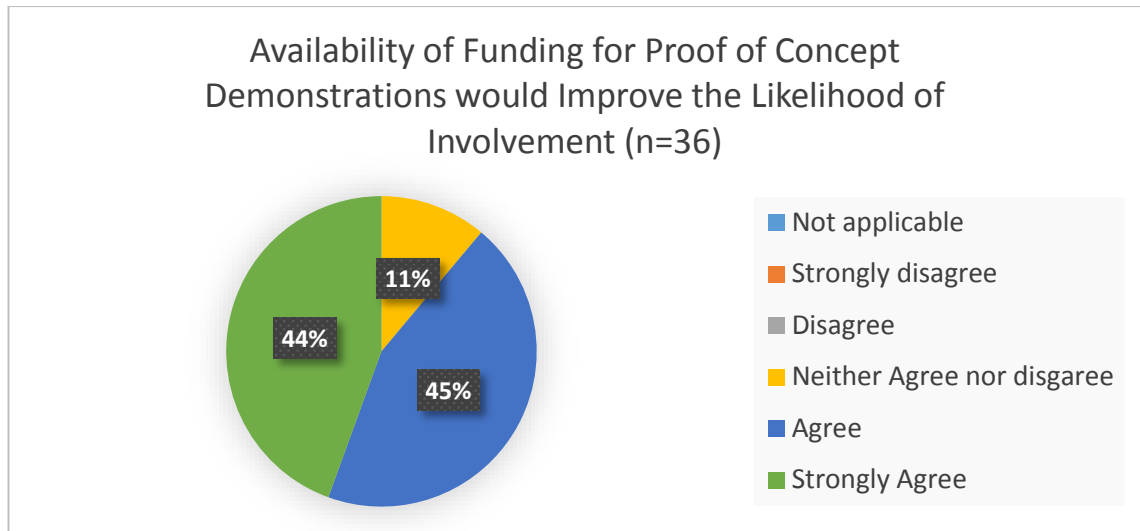
**Figure 4.3.51: Response Among Groups as to Whether Formal Training Opportunities would Increase the Level of Involvement**

Interestingly researchers not involved distinctly agreed with this statement while 30% of involved researchers were undecided. This could indicate that researchers not involved in commercialisation activities could feel disempowered through a lack of training in the implications of commercialisation of research. An intervention to provide formal training to researcher not involved in commercialisation activities will be discussed in Chapter Five.

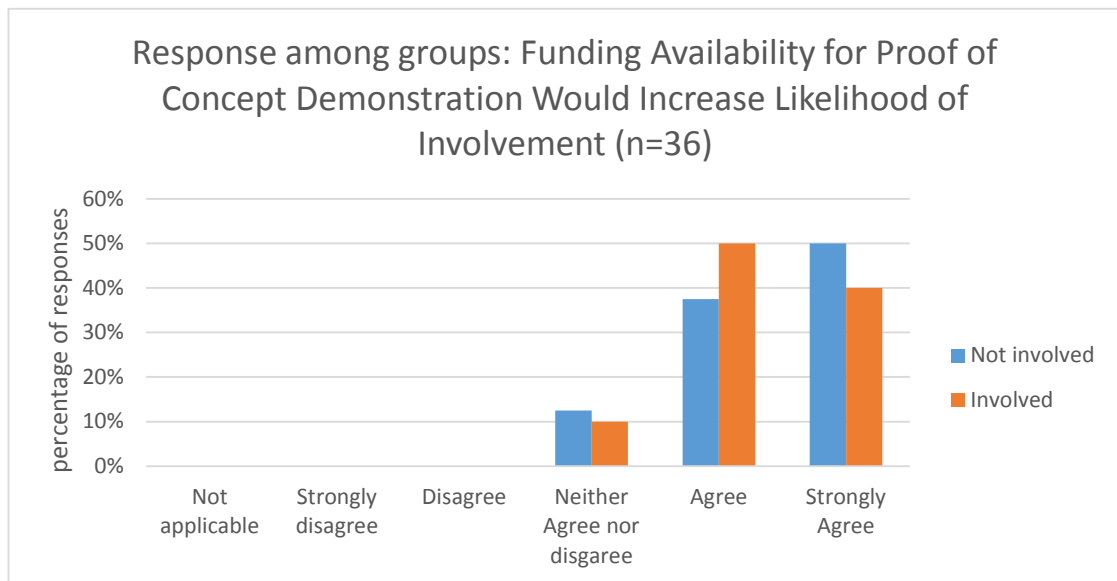
### *4.3.9.3 Question 9.3: Availability of funding for proof of concept demonstration would improve the likelihood of involvement*

An unsurprising 89% of all respondents agreed (45%) or strongly agreed (44%) that the availability of funding for proof of concept demonstration would increase the likelihood of involvement in commercialisation activities while 11% were undecided. This is not a surprising result as researchers are often short of funding for research involving proof of concepts developed at the late stages of basic research due to the lack of public funding available in this space.

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**Figure 4.3.52: Response Among all Respondents to Whether the Availability of Funding for Proof of Concept Demonstration Would Increase the Likelihood of Involvement**



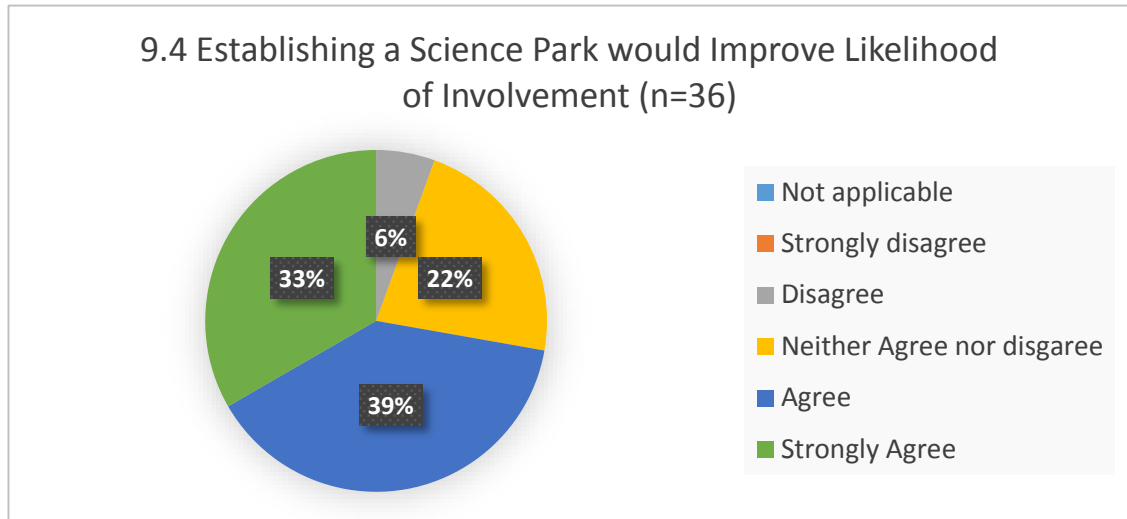
**Figure 4.3.53: Response Among Groups to Whether Availability of Funding for Proof of Concept Demonstration would Increase the Likelihood of Involvement**

The response among both the groups was relatively the same with researchers not involved agreeing more strongly (by 10%) than involved researchers (Figure 4.3.54).

A public or internal university fund should be considered as an intervention to encourage proof of concept demonstration research. This will be discussed as an intervention in Chapter Five.

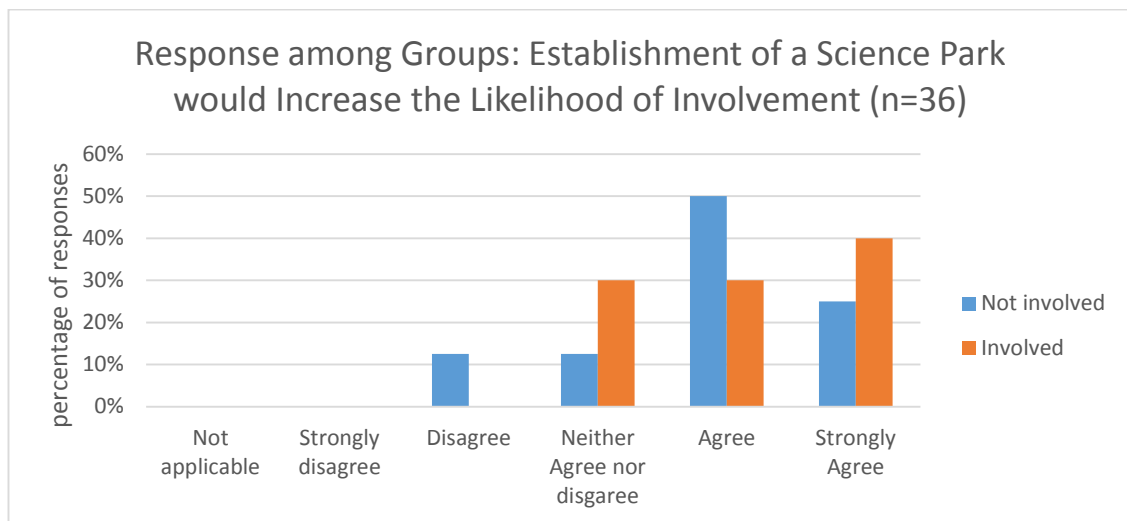
# Chapter 4

## 4.3.9.4 Question 9.4: The establishment of a Science Park would improve the likelihood of involvement in commercialisation among researchers



**Figure 4.3.54: Response Among all Respondents on Whether the Establishment of a Science Park would Increase the Likelihood of Involvement**

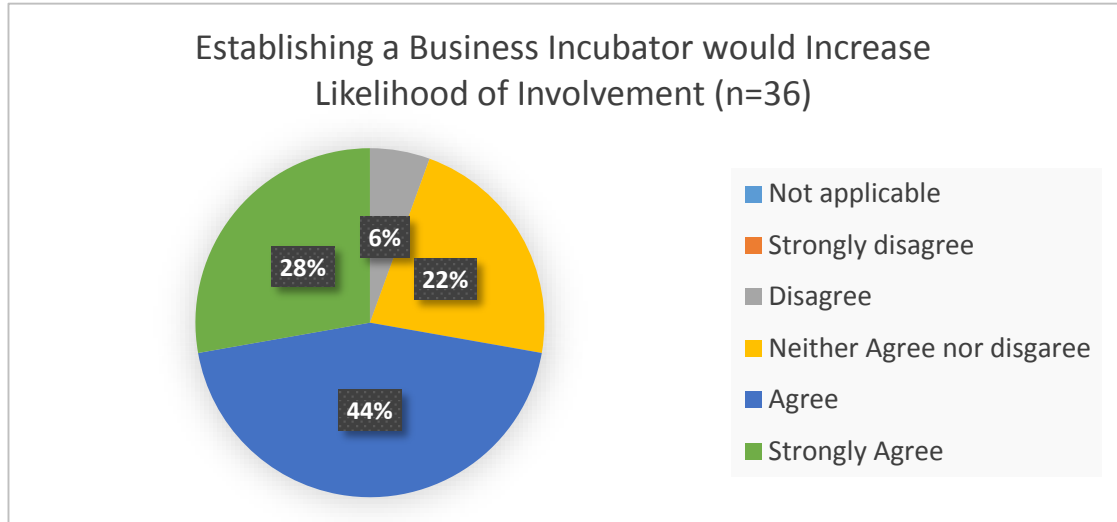
The majority of respondents (72%) agreed (39%) or strongly agreed (33%) that the establishment of a Science Park would improve the likelihood of involvement of researchers in commercialisation activities (Figure 4.3.48).



**Figure 4.3.55: Response among Groups to Whether a Science Park would Increase the Likelihood of Involvement**

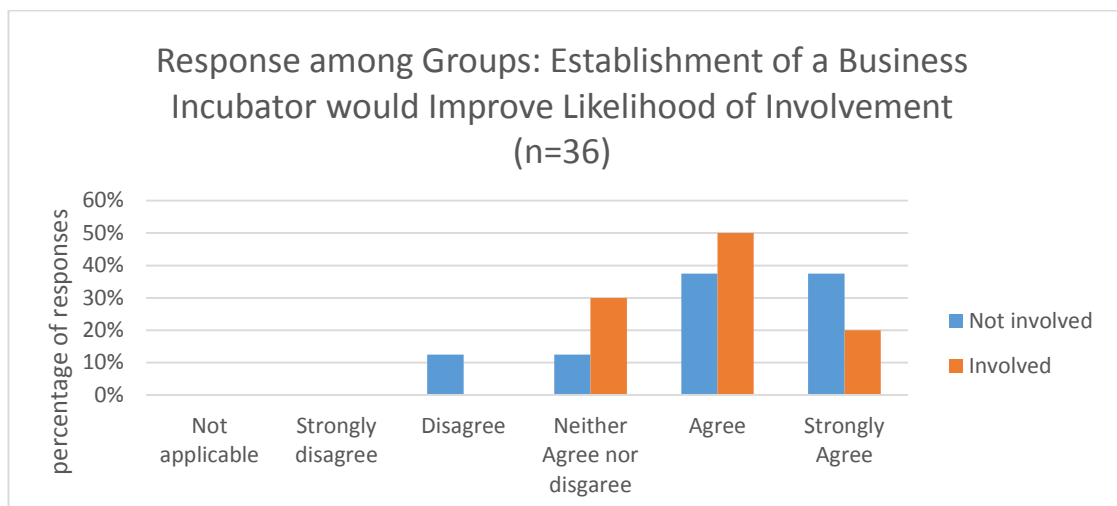
# Chapter 4

## 4.3.9.5 Question 9.5: The establishment of a business incubator would increase the likelihood of researcher involvement in commercialisation activities



**Figure 4.3.56: Response from all Respondents on Whether the Establishment of a business incubator would increase the likelihood of researcher involvement in commercialisation activities**

44% of all respondents agreed and 28% strongly agreed that the establishment of a business incubator would increase the likelihood of researcher involvement in commercialisation activities. 22% were undecided and 6% disagreed (Figure 4.3.56).



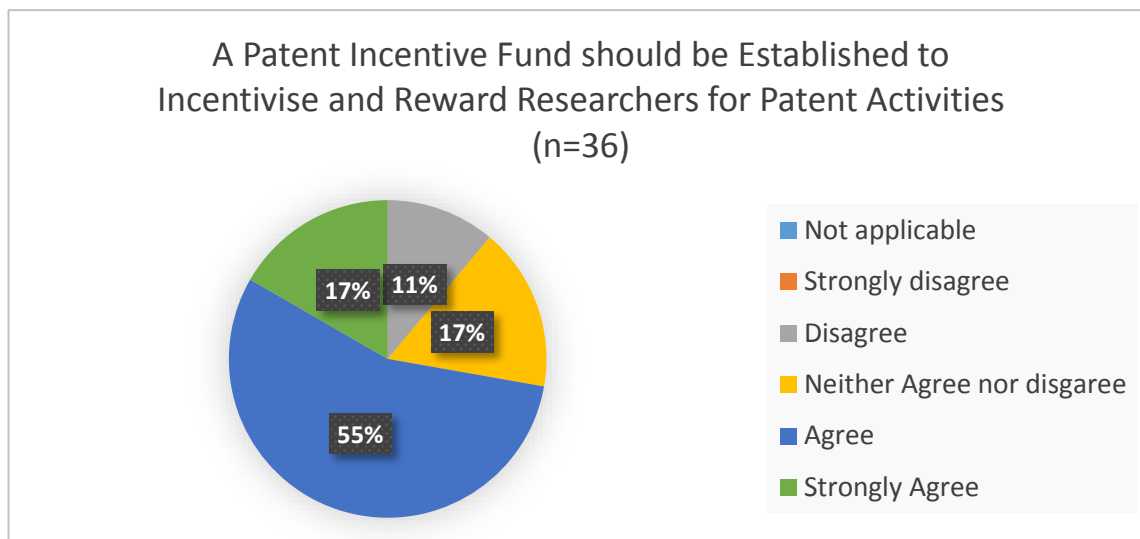
**Figure 4.3.57: Response among Groups on Whether the Establishment of a Business Incubator would Increase the Likelihood of Involvement**

There was a general response among both groups where researchers not involved agreed more strongly (38%) than involved researchers (20%) that a business incubator

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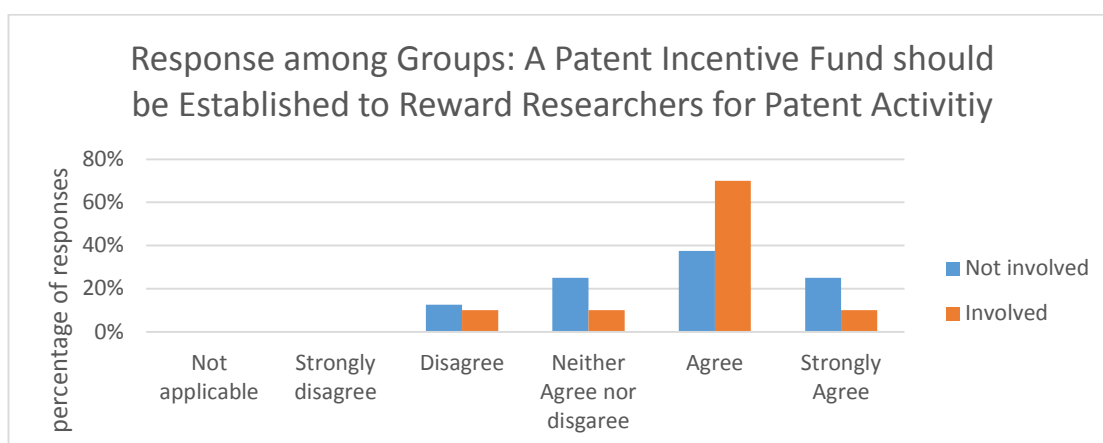
would act as an incentive to increase involvement of researchers (Figure 4.3.57). Only 12% of involved researchers disagreed that a business incubator would be an incentive.

### 4.3.9.6 Question 9.6: A patent incentive fund should be created to incentivise and reward researchers for patent activity



**Figure 4.3.58: Response from All Respondents to Whether a Patent Incentive Fund Should be Established**

While a variety of responses were received, the majority of respondents agreed (55%) that a patent incentive fund would be a useful incentive and reward intervention (Figure 4.3.58). While the largest response from both groups was to agree with the intervention, the outstanding response came from involved researchers (70%) (Figure 4.3.58).

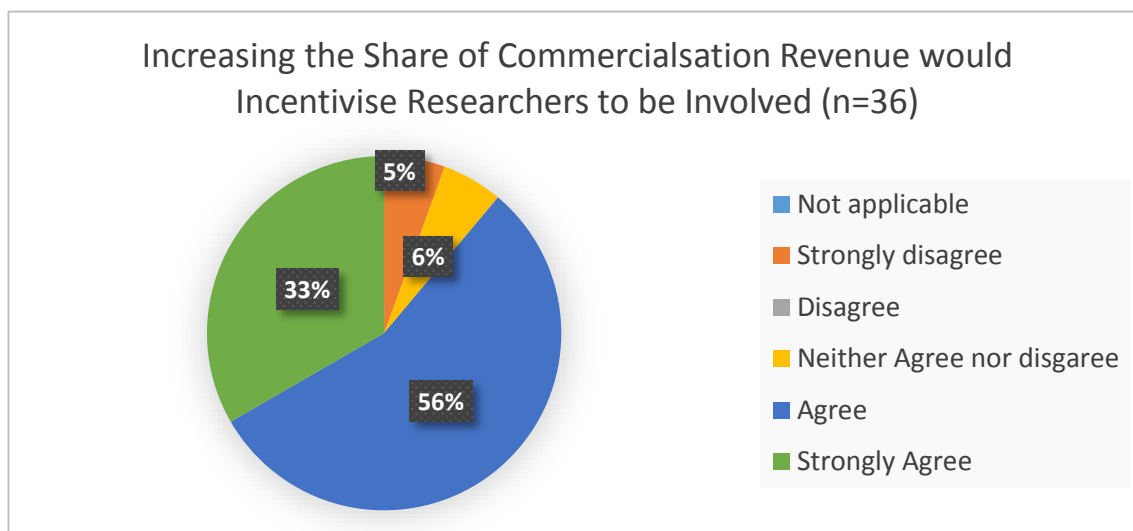


**Figure 4.3.59: Response among Groups to Whether a Patent Incentive Fund should be Established**



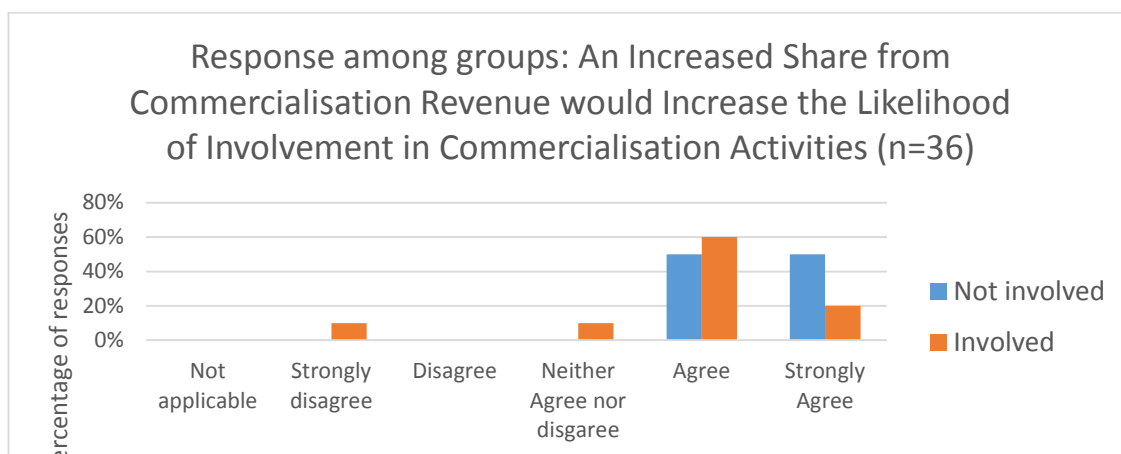
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### 4.3.9.7 Question 9.7: An increased share of commercialisation revenue would incentivise researchers to be involved in commercialisation activities



**Figure 4.3.60: Response among All Respondents to Whether Increasing the Existing Commercialisation Revenue share would Incentivise Researchers**

The overwhelming majority of respondents agreed (56%) and strongly agreed (33%) that an increased revenue share (more than 30% of net commercialisation revenue received) would incentivise involvement.

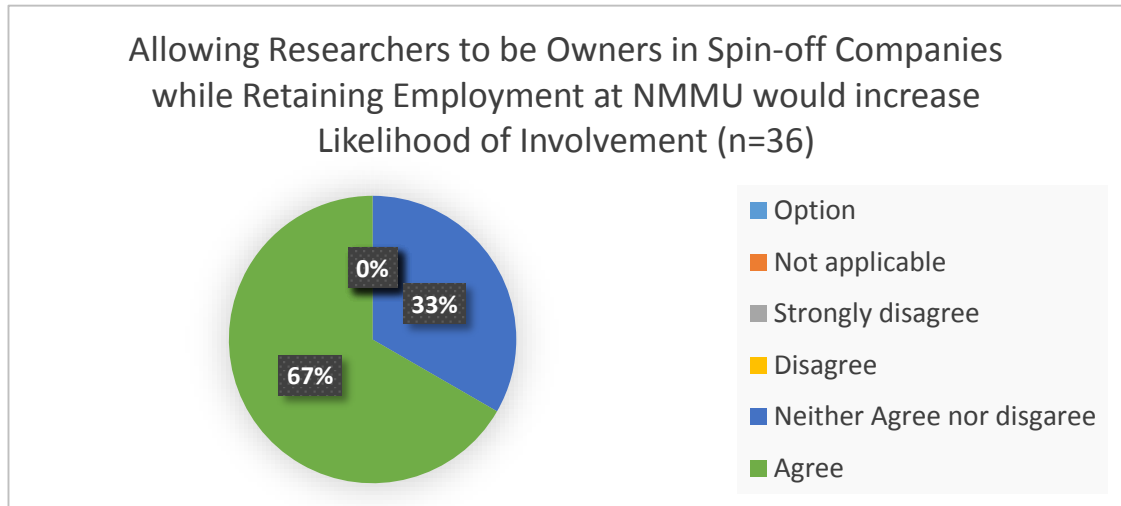


**Figure 4.3.61: Response among Groups to Whether Increasing the Commercialisation Revenue Share would Incentivise Researcher to be Involved**

Involved researchers provided a range of responses including strongly disagreeing (10%) and strongly agreeing (20%) with the intervention. Researchers not involved agreed (50%) or strongly agreed (50%) indicating that this would be a strong incentive to encourage involvement (Figure 4.3.61).

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4.3.9.8 Question 9.8: *Allowing researchers to be owners in spin-off companies while retaining NMMU employment would incentivise involvement in commercialisation activities*

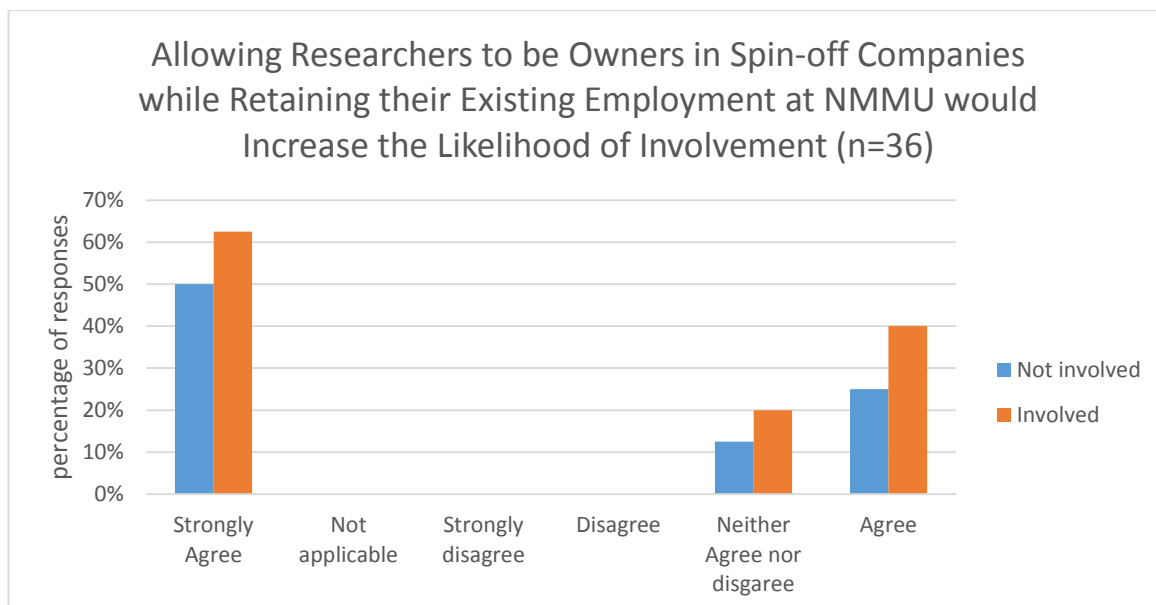


**Figure 4.3.62: Response among All Respondents to Whether Ownership in Spin-off Companies while Retaining Employment at NMMU would Increase the Likelihood of Involvement**

Figure 4.3.62 shows that 50% strongly agreed while 33% agreed and 17% were undecided. None of the respondents disagreed that the intervention would incentivise involvement indicating that not only would researchers want to be involved in the commercialisation of their research through a company but they would want to benefit through shareholding. The strong response indicates that this is a factor that should be considered when devising incentives strategies.

Both groups provided a similar response profile with none of the respondent from either group disagreeing (Figure 4.3.63).

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**Figure 4.3.63: Response among Groups to Whether Allowing Ownership in Spin-off Companies while Retaining Employment at NMMU would Increase the Likelihood of Involvement in Commercialisation Activities**

### 4.3.10 Summary of univariate analysis

#### 4.3.10.1 Summary of Sections 1-3

The data from sections 1, 2 and 3 of the questionnaire were synthesised in to understand the extent of involvement of researchers in commercialisation activities (RQ<sub>5</sub>). The specific activities which respondents stated they were involved in were used to categorically rank the level of involvement among the group of involved researchers as depicted in Table 4.5. Further to this, the faculty within which they worked and an understanding of the type of research they conduct was probed. It is noted from Table 4.5 that of the researchers involved in commercialisation activities, the respondents most involved (medium and high involvement) in both faculties undertake applied research. Six of nine involved respondents were from the faculty of Science, and five of nine involved respondents were from the faculty of EBEIT.

Table 4.5 allows us to make some assumptions about the population of researchers within the EBEIT and Science faculties. Since the faculty samples are considered to be representative of the population, one may assume based on this data that up to 12% of the total population of Science and EBEIT researchers have a high involvement in

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commercialisation activities; 23% have a medium involvement and 23% have a low involvement. The remainder (44%) are not involved in commercialisation activities.

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**Table 4.5: Summary of data reported in sections 1,2 and 3 of the questionnaire**

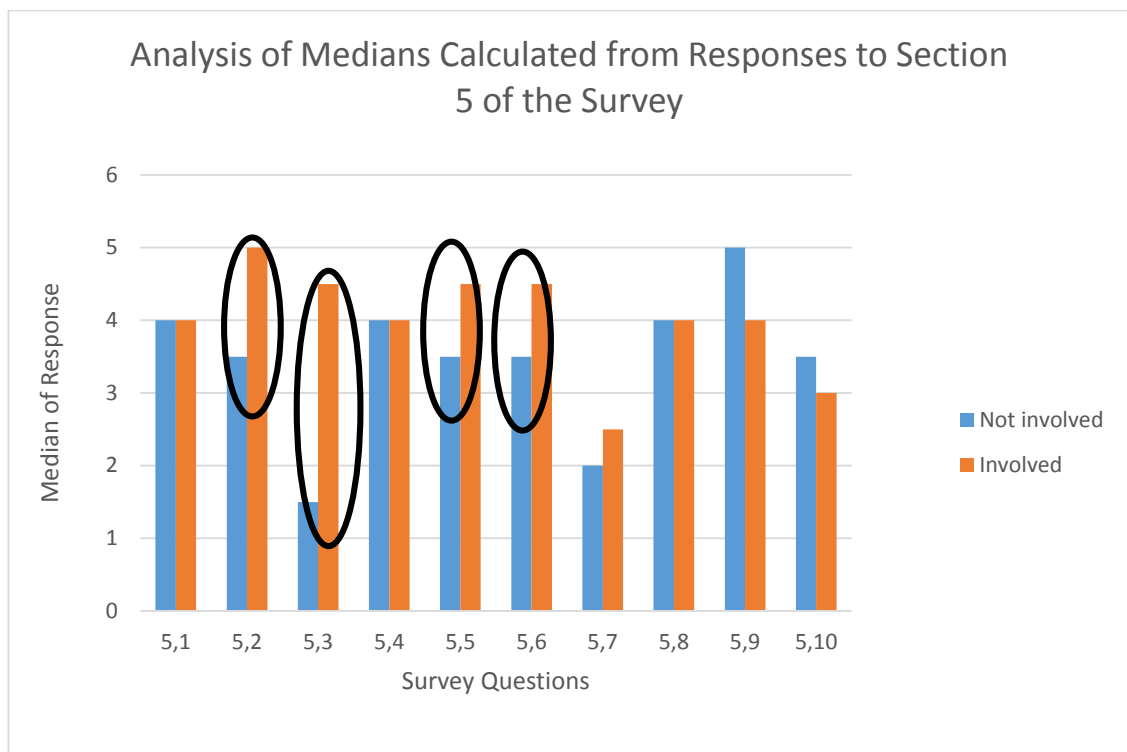
Samples	Involvement in Commercialisation Activities	Response		Level of Involvement	Total per faculty		Extent of involvement per faculty							
		#	% of Total		EBEIT	SCI	EBEIT				SCI			
							Basic	Applied Research	User-inspired research	User-inspired & Applied Research	Basic	Applied Research	User-inspired research	User-inspired & Applied Research
Group 1: NOT involved	Not involved in Commercialisation Activities	16	44%	No involvement	9	7	6	3	0	0	4	3	0	0
Group 2: involved in commercialisation activities	Involved in Disclosure	2	6%	Low	2	0	0	2	0	0	0	0	0	0
	Involved in patenting	6	17%		2	4	2	0	0	0	0	0	2	2
	Involved in Disclosure and patenting	6	17%	Medium	0	6	0	0	0	0	0	6	0	0
	Involved in disclosure and spinoff	2	6%		1	1	0	1	0	0	0	1	0	0
	Involved in patenting, design registration or trademark filing, licencing deal	2	6%	High	2	0	0	2	0	0	0	0	0	0
	Involved in disclosure, patenting design registration, trade mark application, spinoff company and licensing deal	2	6%		2	0	0	2	0	0	0	0	0	0

#### 4.3.10.2 Summary of Section 4

The analysis of responses to questions 4.1 – 4.5 showed the involved researchers were substantially more aware of the individual services offered by the TTO than their colleague who were not involved.

#### 4.3.10.3 Summary of Section 5

An analysis of the medians of the responses was conducted to assess if there were distinct differences.



**Figure 4.3.64: Comparison of Medians among Groups' Responses to all Questions in Section 5**

Three observations are relevant from Figure 4.3.64. Most notably is the difference between medians among the groups in response to question 5.3 on whether involvement in commercialisation activities adds value to research activity. Researchers not involved in commercialisation activities felt that involvement did not add value to research activities while involved researchers felt strongly that involvement did add value.

The second most notable difference is the response to question 5.2, however due to a large proportion of researchers not involved choosing the 'not applicable' option the response was skewed (See Appendix D for skewness calculation).

The third observation is the differences between medians for questions 5.5. and 5.6. Involved researchers distinctly felt it was more important to disclose to the TTO compared to researchers not involved. Researchers involved in commercialisation activities felt more strongly that involvement leads to a greater number of research collaborations compared to those not involved.

#### *4.3.10.4 Summary of Section 6*

Researchers both involved and not involved (from those who chose to respond) agreed that the TTO provides sufficient support. It was evident however that researchers not involved felt that there was insufficient information made available by the TTO on the process of commercialisation. Researchers generally felt that the TTO works closely with involved researchers to progress their innovations. This is an indication of the working relationship held with the TTO and can be interpreted as a positive enabler to move innovation forward. Researchers perceived that it was useful to have a dedicated TTO at the NMMU. This confirms that the existence of the TTO acts an enabler to satisfy the commercialisation needs of the NMMU.

#### *4.3.10.5 Summary of Section 7*

Researchers stated that line managers are generally supportive of involvement in commercialisation activities but that teaching loads were too heavy when considering involvement in commercialisation. The managerial support is further investigated in the multivariate analysis. Committee structures to enable involvement in commercialisation and progress innovation were perceived to be less productive than expected. The NMMU environment as a work environment was also perceived as not fully conducive to encouraging commercialisation activity. While this was a general question, the specific elements of the environment can be a topic of future investigation. Researchers also stated that the institution can do more to recognise the contributions of researchers to innovation. Recommendations on additional recognition will be provided in Chapter Five.

#### *4.3.10.6 Summary of Section 8*

It was important to gain an understanding of the personal motives researchers held for involvement so that these align with the recommendations to enhance enablers and lower barriers to involvement. Less than half of the respondents stated that a promotion would be a motive. Of all the motives, the most overwhelming response was received for intrinsic satisfaction. It can be interpreted that involvement in commercialisation provides or would provide a sense of achievement to researchers. Involved researchers stated

more strongly than those not involved that reputational enhancement is a strong motivation in addition to making an impact on society.

At least half of the respondents stated that personal wealth creation is a motivating factor that influence their decision to be involved. When compared to the question on whether the inventor's share of 30% from commercialisation revenue, only one third of respondents agreed and over 40% disagreed. This indicates that monetary incentives are definitively important to enabling involvement but at the same time indicates two things: a) researchers perceive that technology transfer can make a lot of money on a single transaction and b) that there is insufficient understanding of the how small a chance there is that a technology will make money in the short to medium term. A popular example of this is the Google search engine. Developed at Stanford university by a couple of students in the early 90's, they did not start making money from the search engine until they got their business model right to involve advertising in the right ways in the early 2000s. Technology is never an overnight success, especially when it starts at a university. Even after the company started to make money, the company needed to reach a certain size where it became sustainable and profitable to give back to its *alma mata* (which Sergei Brin and Larry Page did voluntarily).

#### 4.3.10.7 Summary of Section 9

Section 9 probed the researcher's perception of potential interventions which would act as enablers to involvement. While only 45% stated that gaining a promotion would motivate them to be involved, 88% agreed that patents granted in foreign territories should be equally weighted with internationally accredited journal publications during performance reviews. This finding shows that researchers would mostly likely support an intervention where the performance management system at NMMU is adjusted to accommodate patent activity.

When asked whether training would likely increase researchers' level of involvement, there was an overwhelming response among both groups that it would be acceptable and supported. Researchers also supported the notions that the establishment of a business incubator and a science park would enable involvement further.

There was general support for the notions of providing funding for proof of concept demonstration would encourage involvement. The establishment of a patent incentive fund would also prove enabling. This would be a national incentive. An increased share of commercialisation revenue and relaxing the policy on conflict of interest to allow



ownership in spin-off companies would also enable researchers to be involved to a greater extent.

#### 4.4 MULTIVARIATE ANALYSIS

In order to test the hypotheses, the involved and not involved researchers represented the groups of the sample, group 1 and group 2. The following illustrates the data from the questions which were used to test for significant relationships in a multivariate analysis using the Kruskal-Wallis test.

Hypotheses	Sample	Questions
H1: There is a significant difference between the perceptions held by researchers involved versus those not involved in commercialisation activities with respect to institutional support provided to enable involvement in commercialisation activities	Involved versus not involved	5.4, 7.3,7.4
H2: Researchers perceive that there is a significant correlation between institutional non-monetary incentives and involvement in commercialisation activities.	Involved	6.4;7.5;9.1
H3: Researchers perceive that there is a significant correlation between management support and involvement in commercialisation activities.	Involved versus not involved	5.4;7.1
H4: Researchers perceive that there is significant correlation between TTO support and involvement in commercialisation activities.	Involved versus not involved	6.1;6.2;6.3
H5: There is a significant correlation between researchers' individual monetary motives and institutional monetary incentives for involvement in commercialisation activities.	Not involved	8.1;8.6;9.7

**Figure 4.4: Data Tested against Hypotheses to Determine Significant Relationships**

##### 4.4.1 Hypothesis testing: $H_1$

The responses to questions 5.4 (Involvement supported by faculty); 7.3 (involvement supported by committee structures) and 7.4 (involvement supported by institution's enabling environment) were analysed among both involved researchers and not involved researchers as six independent samples.

$H_0$ : There is no significant correlation between the perceptions held by involved researchers and not involved researchers with respect to institutional support provided to enable involvement in commercialisation activities at NMMU.

**H<sub>1</sub>:** There is a significant correlation between the perceptions held by involved researchers and not involved researchers with respect to institutional support provided to enable involvement in commercialisation activities at NMMU.

**Table 4.6: Hypothesis testing H1**

H1	All			Not involved			Involved		
	5.4	7.3	7.4	5.4	7.3	7.4	5.4	7.3	7.4
Median	4.00	3.00	3.00	4	3.00	3.00	4	3.00	3.00
Std Dev	1.01	0.85346	1.19283	0.60	0.85	1.19	1.17	0.75	1.25
Variance	1.02778	0.7284	1.42284						
Skewness	-1.4396	-0.63109	-0.43443	0.05	-0.31	-0.32	-1.15	-1.09	-0.54

<b>H:</b>	18.581
<b>d.f.:</b>	5
<b>P value:</b>	0.0023

**Decision:** Reject H<sub>0</sub> since p < 0.05

**Management conclusion:** The data provides insufficient evidence, at  $\alpha = 0.05$ , to conclude that at least 2 of the 6 probability distributions differ in location. There is a significant correlation between the perceptions held by involved researchers and not involved researchers with respect to institutional support provided to enable involvement in commercialisation activities at NMMU.

The above test validates findings from the descriptive statistics (See sections 4.3.5.4 – p84; 4.3.7.4 - p97 and 4.3.7.6 - p100.). Institutional support is perceived to be low among both involved and not involved researchers and is therefore identified as a barrier to involvement. Recommendations to lower this barrier will be put forward in Chapter Five.

#### 4.4.2 Hypothesis Testing: H<sub>2</sub>

The responses to questions 6.4 (existence of a TTO); 7.5 (recognition as an incentive) and 9.1 (performance evaluation should count granted patents as publications) were analysed among involved researchers as 3 independent samples.

**H<sub>0</sub>:** Researchers perceive that there is no significant correlation between institutional non-monetary incentives and involvement in commercialisation activities.

**H<sub>2</sub>:** Researchers perceive that there is a significant correlation between institutional non-monetary incentives and involvement in commercialisation activities.

**Table 4.7: Hypothesis testing H2**

H2	All			Not involved			Involved		
	6.4	7.5	9.1	6.4	7.5	9.1	6.4	7.5	9.1
Median	4	4	4	3.5	3	4	4.5	4	4
Std Dev	1.62	1.07	0.66	2.11763	1.22	0.6	0.84261	0.63	0.64
Variance	2.63194	1.1358	0.4321						
Skewness	1.11	-0.7	-0.12	-0.29247	0	0.05	-1.11323	-0.54197	-0.37

H:	3.138
d.f.:	2
P value:	0.208

**Decision:** Fail to reject  $H_0$  since p-value > 0.05

**Management conclusion:** The data provides sufficient evidence, at  $\alpha = 0.05$ , to conclude that at least 2 of the 3 probability distributions differ in location. Thus there is no significant correlation between perceptions held by researchers involved in commercialisation activities and non-monetary incentives at NMMU.

The results from the above test that researchers at NMMU do not perceive that non-monetary incentives alone are sufficient to enable their involvement in commercialisation activities. This confirms previous research that a combination of incentives both monetary and non-monetary are necessary to enable and promote involvement in commercialisation activities as found by Walter et al. (2013). A combination of incentives is likely necessary as will be put forward in Chapter Five.

#### **4.4.3 Hypothesis testing: $H_3$**

The responses to questions 5.4 (faculty support), 7.1 (line management support) and 7.3 (committee structures) were compared among researchers involved and not involved as 6 sample groups.

**$H_0$ :** Researchers both involved and not involved perceive that there is no significant correlation between management support and involvement in commercialisation activities.

**$H_3$ :** Researchers both involved and not involved perceive that there is a significant correlation between management support and involvement in commercialisation activities.

**Table 4.8: Hypothesis testing H3**

H3	All			Not involved			Involved		
Question	5.4	7.1	7.3	5.4	7.1	7.3	5.4	7.1	7.3
Median	4.00	4	3.00	4	4	3.00	4	4	3.00
Std Dev	1.01	1.07	0.85346	0.60	0.33	0.85	1.17	1.2	0.75
Variance	1.02778	-0.7	0.7284						
Skewness	-1.4396	1.1358	-0.63109	0.05	-2.27	-0.31	-1.15	-0.69	-1.09

The following H-statistic was calculated

H:	20.069
d.f.:	5
P value:	0.001213

**Decision:** Reject  $H_0$  since  $p < 0.05$

**Management conclusion:** The data provides sufficient evidence, at  $\alpha = 0.05$ , to conclude that at least 2 of the 6 probability distributions differ in location. Researchers both involved and not involved perceive that there is a significant correlation between management support and involvement in commercialisation activities.

As reported by (Bercovitz and Feldman, 2008) researchers may be reluctant to be involved in commercialisation activities even though line managers may encourage it. The data in this study proved the same as the perceptions of support by line management among both involved and not involved researcher groups was more or less the same. Other factors such as research field and research relevance may be factors to consider which significantly influence involvement and are areas noted where further research is needed.

#### **4.4.4 Hypothesis Testing: $H_4$**

The responses to questions 6.1 (TTO provides sufficient support); 6.2 (TTO provides adequate information) and 6.3 (TTO works closely with researchers) were analysed among both involved researchers and not involved researchers as 6 independent samples.

**$H_0$ :** Researchers perceive that there is no significant correlation between TTO support and involvement in commercialisation activities.

**$H_4$ :** Researchers perceive that there is significant correlation between TTO support and involvement in commercialisation activities.

**Table 4.9: Hypothesis testing H4**

H4	All			Not involved			Involved		
Question	6.1	6.2	6.3	6.1	6.2	6.3	6.1	6.2	6.3
Median	4	4	4	4	2.5	1.5	4	4	4
Std Dev	1.5684	1.62233	1.81812	1.93649	1.76334	1.89984	0.53852	0.65383	0.8124
Variance	2.45988	2.63194	3.30556						
Skewness	-1.52229	-1.11001	-0.91362	-0.5164	-0.19022	0.07007	0.07684	-0.16368	-0.93997

<b>H:</b>	35.821
<b>d.f.:</b>	5
<b>P value:</b>	0.000001031

**Decision:** Reject  $H_0$

**Management conclusion:** The data provides sufficient evidence, at  $\alpha = 0.05$ , to conclude that at least 2 of the 6 probability distributions differ in location. Researchers both involved and not involved perceive that there is a significant correlation between TTO support and involvement in commercialisation activities.

This result is supported by previous studies on the impact of a dedicated TTO on the progression of commercial initiatives at an institution. Baldini et al. (2007) and Siegel et al. (2003) previously pointed out that the TTO is not the only non-monetary incentive which is useful to propel commercialisation activity but they also found that the TTO significantly reduces the cost of the faculty in terms of time spent on IP administration.

#### **4.4.5 Hypothesis testing: $H_5$**

The responses to questions 8.1 (motive is personal wealth creation); 8.6 (30% of commercialisation revenue to inventors) and 9.7 (allowing ownership in spin-off companies) were analysed among both involved researchers and not involved researchers as 6 independent samples.

**$H_0$ :** There is a significant correlation between researchers' individual monetary motives and institutional monetary incentives for involvement in commercialisation activities.

**$H_5$ :** There is a significant correlation between researchers' individual monetary motives and institutional monetary incentives for involvement in commercialisation activities.

**Table 4.10: Hypothesis testing H5**

H5	All			Not involved			Involved		
Question	8.1	8.6	9.7	8.1	8.6	9.7	8.1	8.6	9.7
Median	4	3	4	3.5	2	4.5	4	3	4
Std Dev	1.00769	1.1967	0.93624	0.99216	1.32288	0.5	1.0198	0.9798	1.07703
Variance	1.01543	1.4321	0.87654						
Skewness	-0.1421	0.21451	-1.84703	0.036	0.64794	0	-0.27155	0.22964	-1.51758

H:	25.115
d.f.:	5
P value:	0.000132

**Decision:** Therefore Reject  $H_0$

**Management conclusion:** The data provides sufficient evidence, at  $\alpha = 0.05$ , to conclude that at least two of the six probability distributions differ in location. There is a significant correlation between researchers' individual monetary motives and institutional monetary incentives for involvement in commercialisation activities.

Monetary incentives were identified as enablers to involvement in commercialisation activities consistent with findings by Lach and Schankerman (2008). Since the monetary motives of researchers involved and not involved in commercialisation activities proved significant, recommendations will be put forward on monetary incentives which speak to those motives.

#### 4.5 CONCLUSION

This chapter has addressed objective RO<sub>4</sub>: *To conduct a structured survey to be completed by researchers at NMMU* and provided answers to the following research questions: RQ<sub>5</sub>: *To what extent are NMMU researchers involved in commercialisation activities?* RQ<sub>6</sub>: *What is the perception of researchers on involvement in commercialisation activities?* and RQ<sub>7</sub>: *What is the general perception held by NMMU researchers on the existing enablers and barriers to involvement in commercialisation activities?*

The chapter has provided an analysis of the data received from the questionnaire distributed to researchers of the Science and EBEIT faculties at NMMU and summarised the findings from the data.

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## CHAPTER FIVE: FINDINGS, RECOMMENDATIONS AND CONCLUSION

### 5.1 INTRODUCTION

The previous chapter reported the results of the measuring instrument (the survey) used to test the perceptions of researchers involved and not involved in commercialisation activities at the NMMU. An analysis and interpretation of the results was reported and discussed. This chapter isolates the key findings from the study and provides a set of recommendations for further research and interventions which may be used to reduce barriers and enhance enablers to encourage involvement of researchers in commercialisation activities at NMMU.

The involvement of researchers in commercialisation activities is considered entrepreneurial -within the higher education and research environment and thus while reference is made to commercialisation activities, the phenomenon of researcher involvement in such activities is considered entrepreneurial (Markman et al., 2005; Mars and Rios-Aguilar, 2010; Trencher et al., 2014). In order for a university to respond to the need to affect economic and social needs it is therefore important to understand the factors which enable and those that create a barrier to researcher involvement in commercialisation activities.

This Chapter seeks to achieve **RO<sub>5</sub>**: *Use the outcome of the survey to provide informed recommendations to improve researcher involvement in commercialisation activities.* The objective will be achieved by addressing **RQ<sub>8</sub>**: *How can barriers be lowered and enablers enhanced to encourage involvement in commercialisation activities?*

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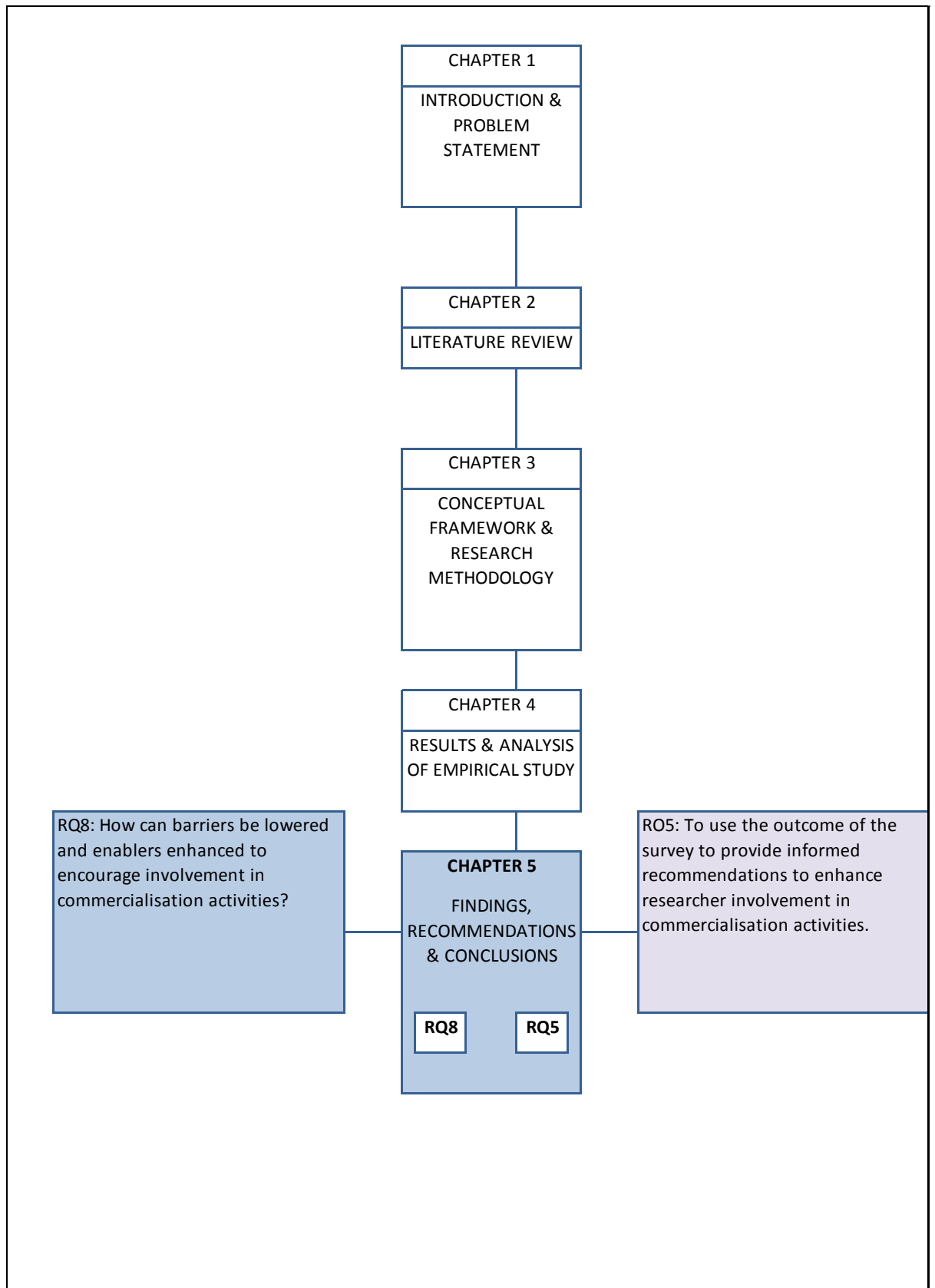


Figure 5.1: Overview of Chapter Five



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## 5.2 SUMMARY OF RESEARCH OBJECTIVES AND QUESTIONS

The **main research objective (RO<sub>M</sub>)** of this study was to *understand the enablers and barriers to involvement in commercialisation activities at Nelson Mandela Metropolitan University*. In order to address the main research objective the following research objectives were developed:

**RO<sub>1</sub>:** *Perform a literature review to define the enablers and barriers to involvement in commercialisation activities and to define commercialisation activities within the context of technology transfer.* A literature study was performed in Chapter Two to understand the key constructs of the commercialisation activities in a university environment and identify the enablers and barriers to researcher involvement. The key constructs defined were innovation, technology transfer, the entrepreneurial university, industry collaboration and academic entrepreneurship. The broad role of the university in society and the pressure to create value through transferred technologies was described. An overview of the research environment in South Africa was explained using the legislative parameters and how the IPR FFR&D Act affects researchers. The role of the Technology Transfer Office was emphasized as a key office of the institution responsible for driving the progress of commercialisation of research outputs and creating an environment which enables involvement of researchers. Enablers were classified according to monetary and non-monetary incentives.

**RO<sub>2</sub>:** *Define the importance of researcher involvement in commercialisation activities.* **Chapter Two** further elaborated on the importance of researcher involvement by defining the role of the university in society and the benefits which involvement presents to research through industry collaborations and economic development.

**RO<sub>3</sub>:** *Explain the research methodology used for this research study with sufficient detail to allow it to be reproduced in future.* **Chapter Three** provided a detailed description of the research design using a quantitative approach.

**RO<sub>4</sub>:** *Conduct a structured survey to be completed by researchers at the NMMU.* A questionnaire was designed and reviewed by a professional in the technology transfer space. The questionnaire was passed by the NMMU REC-H committee and distributed electronically to researchers in the Science and EBEIT faculties at NMMU. Thirty two respondents completed the survey, the data from which was used in this study. See Appendix B and Appendix C.

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To address the main research objective of this study the following research questions were raised:

**RQ<sub>M</sub>: Are researchers at the NMMU optimally involved in commercialisation activities?**

In order to analyse the above main research problem, the following research questions based on the secondary research objectives, were answered:

**RQ<sub>1</sub>: What are commercialisation activities at a university?** Commercialisation activities were defined in **Chapter Two** and limited to interaction with the TTO from the disclosure of new inventions to the commercialisation of inventions through to formation of spin-off companies.

**RQ<sub>2</sub>: What are the enablers to researcher involvement in commercialisation activities on a global, national, regional and institutional level?** A list of identified enablers both monetary and non-monetary at global, national and local level was provided in **Chapter Two**. National and institutional enablers were focussed on.

**RQ<sub>3</sub>: What are the barriers to researcher involvement in commercialisation activities on a global, national, regional and local level?** A list of identified barriers at global, national and local level was provided in Chapter Two. The focus was on National and institutional barriers.

**RQ<sub>4</sub>: How can a detailed description of the research methodology be provided in order to understand and reproduce this research study in future?** The research design and methodology was addressed in **Chapter Three**.

**RQ<sub>5</sub>: To what extent are NMMU researchers involved in commercialisation activities?** In **Chapter Four** each level of involvement was defined according to the type of activity and the amount of time spent by researchers. Using the data from the survey, it was found that 12% are highly involved; 23% have medium involvement 23% have low involvement and the remaining 44% are not involved.

**RQ<sub>6</sub>: What is the perception of researchers on involvement in commercialisation activities?** Understanding whether researchers perceived that involvement was important was the first step to be addressed in **Chapter Four**. Assessing the perception of the value of involvement on various aspects of their professional activities and

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personally was an important part of this process. It was discovered that involved researchers perceived a great value attributed to their research and reputational enhancement for themselves and their research groups, than researchers not involved.

**RQ<sub>7</sub>:** *What are the general perceptions held by NMMU researchers on the existing enablers and barriers to involvement in commercialisation activities?* Enablers and barriers identified from literature in **Chapter Two** were used to firstly determine whether they were in fact enablers or barriers at NMMU. A questionnaire was designed to understand the perceptions of researchers in the Science and EBEIT faculties of NMMU. Secondly, the extent to which those enablers or barriers affect the decision of researchers to become involved in commercialisation activities was probed.

A summary of the analysis of the data showed that researchers perceived that the NMMU committee structures can be improved to provide greater enablement. Faculty management support was found to be consistently medium to high for both involved and not involved groups. The improvement of monetary incentives at an institutional level was identified as important to providing greater enablement for researchers to become involved. Funding mechanisms to reward researchers on a national level and to progress innovative concepts towards proof of concept demonstration were important factors identified as monetary incentives. Non-monetary incentives such as recognition and including patent counts on an equal basis to internationally accredited publications during performance review were also identified as important to encouraging researchers. These findings were discussed in greater detail in **Chapter Four**.

### 5.3 AREAS IDENTIFIED FOR FURTHER RESEARCH

The following areas were identified as future areas of research:

- i. The opinion of researchers on faculty rewards for innovation and commercialisation involvement/activity.
- ii. Researchers at NMMU strongly perceived that there is insufficient faculty management support for involvement.
- iii. Factors which affect the decision to be involved in commercialisation activities.
- iv. Does involvement in commercialisation activity depend on the research field and research relevance?

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- v. What do South African researchers think about the value of commercialisation activity?
- vi. Researchers noted that they did not perceive that the NMMU committee structures enabled the involvement of researchers in commercialisation activities. The composition, structure and reporting lines of committee structures at NMMU in enabling involvement in commercialisation activity can be investigated further to understand how the perception can be improved.

### 5.4 LIMITATIONS OF RESEARCH

Collis and Hussey (2009) describe a weakness in research as a limitation. The following have been identified as limitations of this study:

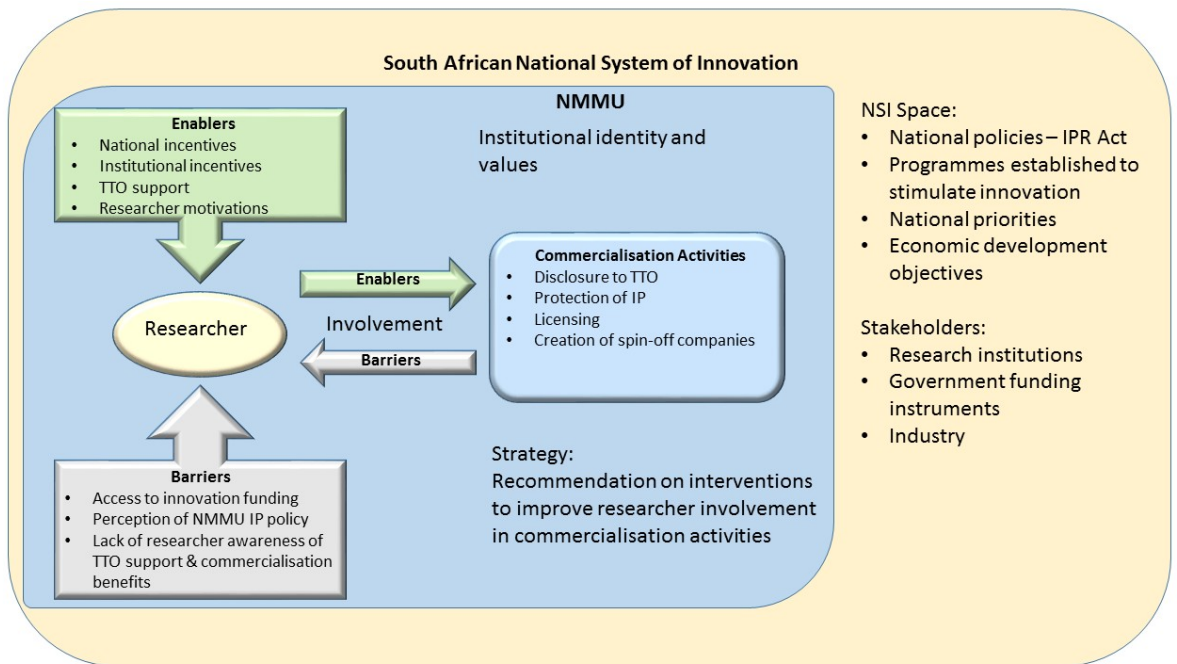
- i. Only researchers of the faculties of Science and EBEIT were targeted since these are the faculties which utilise the TTO services the most and also the most likely fields which give rise to innovation. Expanding the survey to other Faculties such as Health Sciences may be advisable in future.
- ii. Positivistic and quantitative research are limited to the questions posed in the survey. The approach lacks the ability to probe further as to reasons for certain responses.
- iii. Only a limited number of questions could be asked in the survey in order to ensure that it did not take up too much of the respondents' time.

### 5.5 SUMMARY OF KEY FINDINGS

#### 5.5.1 *Enablers of Involvement in Commercialisation Activities*

In **Chapter Three**, the enablers were identified from the descriptive statistics derived from the response to the questionnaire. Here a summary of the researchers' perceptions of enablers are put forward. The univariate analysis allowed for the comparison of survey data against findings from literature. The following were identified as enablers (monetary and non-monetary incentives) from the perceptions held by researchers. These findings will be used to support recommendations for enhancement in Chapter Five. A schematic representation of the study to this point is illustrated in Figure 5 2

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**Figure 5 2: Schematic Representation of Enablers and Barriers to Researcher Involvement in Commercialisation Activities at NMMU**

## 5.5.1.1 Monetary incentives:

- i. Once off payment for granted payments – a patent incentive fund

Researchers generally agreed that a patent incentive fund would increase the likelihood of involvement in commercialisation activities. It is more likely that this should take place at a national level rather than at an institutional level as the use of government funding is restricted to operations with little room to create additional incentives.

- ii. Percentages of commercial revenue paid to inventors

The majority of researchers agreed that the current state of 30% of commercialisation revenues paid to the inventors should be increased.

## 5.5.1.2 Non-monetary incentives:

- i. Management support

Management support was investigated in two ways – at a line manager level (question 7.1; Section 4.3.7.195) and at a faculty level (question 5.4; Section 4.3.5.4, p84). Management support proved to be an enabler in encouraging involvement in commercialisation activities.

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### ii. Recognition

Researchers at NMMU perceived that there is insufficient recognition given to researchers involved in commercialisation activities (See question 7.5; Section 4.3.7.6, p100). They generally felt that while involvement adds value to the likelihood of successful research, one of the benefits which they can leverage is the advantage of reputational enhancement (See question 8.4; Section 4.3.8.4; p105). Recognition of research groups for their contribution and involvement in commercialisation activities would also prove useful to sustaining research groups.

### iii. TTO support and efficiency

The support received from the TTO by involved researchers appeared to be sufficient while researchers not involved felt that there was insufficient information on the process of commercialisation provided by the TTO (See questions 6.1-6.3; Sections 4.3.6.1-4.3.6.3; p90-92).

### iv. Self-motivation and intrinsic satisfaction

Researchers felt that they had strong personal motives including career progression, wealth creation and reputational enhancement for being involved in commercialisation.

### v. A strong motive for involvement among involved researchers was to sustain their research groups.

While it is known that none of the research entities have received commercial income from commercialised inventions significant enough to sustain partial operations of entities, the reputational enhancement for the entity as a result of commercially relevant research may prove beneficial to attract industry related contract research projects (See question 5.8; section 4.3.5.8; p87) and grant funding from public funders. This is a potential area which future research can explore.

### **5.5.2 Barriers to Involvement in Commercialisation Activities**

In Chapter Three, the barriers were identified from the descriptive statistics derived from the response to the questionnaire. Here, a summary of the researchers' perceptions of barriers are put forward. The univariate analysis allowed for the comparison of survey

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data against findings from literature. The following were identified as barriers to involvement in commercialisation activities from the perceptions held by researchers.

iii. Low perception of importance of involvement

Researchers not involved in commercialisation activities did not perceive that involvement was of importance. The linkage between successful research and involvement was not a factor which was applicable to them.

iv. Lack of TTO awareness

It was clear from the response to questions 4.1-4.5 that researchers not involved in commercialisation activities were not aware of the full spectrum of support services offered by the TTO. This represents one of the more significant barriers according to Siegel and Phan (2005) and in **Chapter Five**, recommendations will be put forward to address how to lower the impact of this barrier.

v. Perception of insufficient institutional support

Researchers perceived that the NMMU committee structures were not supportive at enabling involvement (See question 7.3 Section 4.3.7.4, p97). The TTO is an NMMU office established to provide support to encourage involvement in commercialisation activities and progress innovation. The TTO is required to champion the Innovation agenda and needs of the research community within the NMMU. Involved researchers generally agreed that the TTO provides sufficient support to enable involvement (see questions 6.1-6.3). Investigating the specific aspects through a qualitative study would prove useful to identifying specifically why researchers perceive that there is insufficient support and what can be done to improve their perception.

### **5.6 RECOMMENDATIONS FOR INTERVENTIONS TO IMPROVE RESEARCHER INVOLVEMENT IN COMMERCIALISATION ACTIVITIES AT NMMU**

The following presents a set of recommendations to improve researcher involvement in commercialisation activities at a national level and at an institutional level as developed specifically for the NMMU.

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## 5.6.1 *National enablers*

### 5.6.1.1 *Patent incentive fund*

As mentioned in **Chapter Two**, a national patent incentive fund which operates on an equal basis as the publication incentive fund should be re-established to reward and incentivise researchers for patents granted in foreign territories. South Africa is not a patent examining territory and therefore should not be included as a territory. The research publication incentive operated by the National Research Foundation pays approximately R90 000 per article published in an internationally accredited journal to the institution ([www.nrf.gov](http://www.nrf.gov)). Most of this (at least two thirds) is channelled towards the research fund for the individual researchers. There is a discrimination placed on authors such that the first author receives a greater percentage of the split than the remaining authors on co-publications.

A patent incentive fund can be operated through the National Intellectual Property Management Office to incentivise researchers to patent findings before publication. This in no way compromises the publication process since the priority date of the patent is the most important aspect of the filing. If the fund operated on an equal basis to the publication incentive fund and is administrated by the TTO, the TTO is likely going to hand over the full amount to the researchers since the aim would be to incentivise patenting.

### 5.6.1.2 *Technology showcase events*

In 2015, the Department of Science and Technology hosted its inaugural event called Innovation Bridge, which enabled universities to showcase innovative technologies which are deemed as fit for transfer or commercialisation. The event brought together private investors, government funders and departments and key role players to be witness to the innovations arising from publicly funded research. The event subsidised the costs of building and improving prototypes, technology marketing and travel for representatives of the TTO and researchers as deemed appropriate.

It was the first event of its kind which shed a national spotlight on the state of innovation and the contribution of Universities to creating and developing world class innovations. Events such as these provide recognition to institutions for their innovative outputs by highlighting the innovative capabilities within specific research fields to the attention of large industries.



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### *5.6.1.3 National innovation awards & competitions*

Recognising innovators and institutions on a national stage for their contribution to innovation in the country is important. At the moment, there is no single means by which this recognition is given. Individual universities through their websites and local publications attempt to highlight the innovative achievements and the impact innovation makes on society. The prestige of national innovation awards would play an important role in not only giving local recognition but international recognition. There are various ways in which the impact of innovation is measured but in South Africa, the measurement of innovation impact should be aligned with current national priorities. Buy in from major publication houses such as the Mail & Guardian, Time Magazine, Financial Mail and Engineering News would be critical to promoting the innovative contribution South Africa makes to the world and within its borders.

There are various competitions which industry sectors fund in order to not only assess the competitive space but to also recognise the contributions made toward the sector. In its own way the higher education innovation space is a sector and as such funders should collaborate to bring technologies developed at HEIs to the forefront of industry attention. The Technology Innovation Agency in collaboration with NIPMO and the Industrial Development Corporation would be ideally placed to fund and operate such a competition which can take place annually. The competition would not only provide recognition but also funding and networks to enable the progression of innovations to be practiced.

### **5.6.2 *Enhancing Institutional Enablers and Lowering Barriers to Involvement in Commercialisation Activities***

At an institutional level a combination of monetary and non-monetary incentives are necessary to enable involvement in commercialisation activities. The following recommendations are based on the needs of the NMMU highlighted by this study.

#### *5.6.2.1 Monetary incentives*

- i. Increasing the commercialisation revenue share from 30%

NMMU researchers generally agreed that the percentage of revenue allocated to inventors which currently stands at 30% should be increased. The policy has been in place since 2011 and precedents have been set in terms of how commercialisation

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revenue is managed. The NMMU IP Policy (NMMU, 2013b) should be revised following a process of stakeholder engagement. A benchmarking exercise should be undertaken to establish which universities offer a greater percentage than the legislatively prescribed minimum of 30%. The database of inventors (pre-commercialisation) should be interviewed in a structured manner to understand their concerns. Understanding the perspective of the faculties should also be undertaken as not all faculties at the NMMU would produce a proliferation of inventions that can be commercialised when compared to the Faculties of Science and EBEIT.

Striking a balance between the needs of inventors, faculties and the university would be difficult but perhaps the response from researchers indicates the need for more research funding. As many of the involved researchers stated that a motive for their involvement is to sustain their research groups, this should be investigated further as part of the exercise. Particularly in the case of research groups collaborating with industry and conducting user-inspired and applied research. This study has shown that innovations are most likely to arise from researchers that have a high involvement in commercialisation activities. Perhaps the university should consider treating the faculties in which these researchers reside differently for their contribution to innovation which impacts local economic development through and an incentive of increased percentage of commercialisation revenue.

### *5.6.2.2 Non-monetary incentives*

#### *5.6.2.2.1 Institutional culture & management support*

Management support is critical to enabling the involvement of researchers in commercialisation activities as identified in **Chapter Two**. The majority of respondents stated that management generally supported and encouraged their involvement in commercialisation activities. This is an enabling factor which needs to be sustained. The TTO is in a position to encourage management support through highlighting the innovative achievements of individual researchers and research groups at institutional management committee meetings such as the Innovation Committee, the Research, Technology and Innovation committee and Faculty board meetings. Further to this the role of the TTO personnel at entity board level is important to not only highlight achievements and advise on intellectual property management issues but to also encourage innovation collaboration and advise on innovation strategy.

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### *5.6.2.2.2 Committee structures*

Respondents stated that they do not perceive the committee structures at NMMU to be effective in enabling researcher involvement in commercialisation activities. Further research through engagement with researchers is necessary to understand their specific issues of discontent. However, issues such as frequency of meeting, composition of committees and committee responsibility versus researcher's responsibility, and committee reporting lines are a few issues which can be investigated to improve the perception of researchers. A general awareness of how the Innovation Committee operates, is composed and reports may also improve this perception.

### *5.6.2.2.3 Recognition*

#### *i. Innovators Events*

Researchers perceived that the NMMU can do more to recognise the achievements and contributions of researchers to innovation. The NMMU presents an Award at the Research and Engagement awards ceremony held each year to recognise and award researchers for their contribution. In September 2015 the Innovation Office held its first 'Innovator's Evening' which invited all inventors (researchers listed on patents) and innovators (those who contributed towards the progression of innovations and or are associated with design registrations and trademark filings) to an evening event to honour them for their contributions to innovation. The head of NIPMO attended as an honoured guest to applaud innovators for their contribution and encourage them further. Innovators were presented with an 'Innovator' or 'Inventor' coffee mug as well as a certificate of recognition. The Deputy Vice Chancellor for Research and Engagement, the Head of NIPMO and the Director of the Innovation Office presented each of the innovators and inventors with these tokens of recognition. The photographs from event was publicised widely within the University through internal publications and the local "Herald" newspaper. Innovators were celebrated within their departments and faculties for their contribution.

The Innovators' Evening can be moulded to host Innovation Café-type events where South African innovators can be invited to present their stories and engage with local researchers and entrepreneurs, the aim of which would be to foster creativity and innovation at the University and progress the innovation conversation.

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### 5.6.2.2.4 Training

Involved researchers stated that a formal training programme would be an enabler to encourage greater involvement among researchers. The Innovation Office, through its collaboration with SARIMA (Southern African Research and Innovation Managers Association) currently provides access to *IP WISE™*, a one day short course designed to improve researchers' understanding of IP and its role in research. The senior staff of the Innovation Office have provided this training to other universities in South Africa as usually a senior staff member of another university presents at an institution. A recommendation stemming from this would be that the TTO is more flexible to providing other training in addition to *IP WISE™*. A programme of local and international speakers can be devised and planned to match the needs of researchers. Perhaps in combination with an Innovators' Evening where researchers from other universities in a specific field are hosted to present their stories of failure and success and most importantly the lessons learnt.

The NMMU Innovation Office holds good relations with the TTOs of Virginia Commonwealth University in the United States and Uppsala University in Sweden. Both of these universities have implemented structured training programmes for researchers held after hours for researchers who have started to become involved and those who have been involved in the technologies. Generally their technologies have matured toward business incubation or spin-off from the university. The staff of the TTO provide this training themselves and this not only places them in contact with researchers on a regular basis but enables researchers to ask questions within a learning environment among their peers. An investigation of the training programmes offered by VCU and Uppsala University should be considered when planning training programmes.

### 5.6.2.2.5 TTO Outreach & Awareness campaigns

The TTO conducts several outreach activities to engage the various stakeholders and to spread the awareness of the importance of IP and its value to research. Researchers not involved in commercialisation activities held a substantially lower awareness of TTO services compared to involved researchers. Thus the Innovation Office needs to provide additional material on the operations and services carried out by the office to researchers, particularly those not involved. The existing information on the intranet is clearly not effective in raising awareness and therefore marketing material and engaging with departments of faculties will be the most likely approach to be effective in promoting this awareness.

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Appointing an 'Innovation Champion' within each department may also prove effective in disseminating information about 'innovation at NMMU'. Ensuring the understanding of at least one staff member of a department, preferably one that is involved may ensure that the messages from the TTO on events, awareness campaigns and recognition of researchers reaches the departments in a more accurate or informed manner. The Innovation Champion can also be trained to a greater extent in identification of IP and so act as a link to the department to encourage disclosure of innovations. This may also be effective in overcoming the perception that inventors are not adequately rewarded or recognised for their innovative contributions.

### *5.6.2.2.6 Establishment of a Science Park or Business Incubator*

Researchers perceived that the establishment of both facilities would enable involvement. The NMMU recently (July 2015) launched Propella Business Incubator and Accelerator, a joint venture between the university and Engeli Enterprises, a private company which specialises in enterprise development. Propella is not exclusive to NMMU-related projects and invites industry players to contribute towards small enterprise development through tax exempt contributions. A few NMMU spin-off companies are based here and are already in a programme designed for companies to become sustainable and profitable in the short term.

These spin-off companies have relationships with NMMU researchers and units which still depend on research input for technology development, scaling and application. This is not uncommon for new technology spin-offs and is in fact encouraged. Researchers are invited to play technical advisory roles as well as have membership on the boards of companies.

## **5.7 CONCLUSION**

This Chapter has addressed the objective RO<sub>5</sub>: *To use the outcome of the survey to provide informed recommendations to enhance researcher involvement in commercialisation activities* by providing an answer to the research question RQ<sub>8</sub>: *How can barriers be lowered and enablers enhanced to encourage involvement in commercialisation activities?*

A summary of key findings from the analysis of the survey results has been provided in the chapter together with a set of identified areas for further research. This is followed

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by recommendations for interventions to lower barriers and enhance enablers to improve researcher involvement in commercialisation activities at NMMU.

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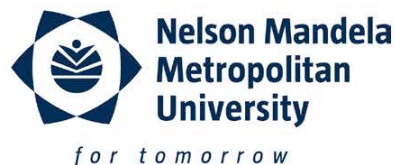
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## APPENDIX A: ETHICS APPROVAL



• PO Box 77000 • Nelson Mandela Metropolitan University  
• Port Elizabeth • 6031 • South Africa • [www.nmmu.ac.za](http://www.nmmu.ac.za)

Chairperson: Research Ethics Committee (Human)  
Tel: +27 (0)41 504-2235

Ref: [H15-BES-BUS-028 /Approval]

Contact person: Mrs U Spies

4 September 2015

Prof M Cullen  
Faculty: BES  
Department: Business School  
2<sup>nd</sup> Avenue Campus

Dear Prof Cullen

### A STRATEGY FOR THE ENHANCEMENT OF ACADEMIC ENTREPRENEURSHIP AT THE NELSON MANDELA METROPOLITAN UNIVERSITY

PRP: Prof M Cullen  
PI: Ms M Chetty

Your above-entitled application served at Research Ethics Committee (Human) for approval.

The ethics clearance reference number is **H15-BES-BUS-028** and is valid for three years. Please inform the REC-H, via your faculty representative, if any changes (particularly in the methodology) occur during this time. An annual affirmation to the effect that the protocols in use are still those for which approval was granted, will be required from you. You will be reminded timeously of this responsibility, and will receive the necessary documentation well in advance of any deadline.

We wish you well with the project. Please inform your co-investigators of the outcome, and convey our best wishes.

Yours sincerely

A handwritten signature in cursive script, appearing to read "C Cilliers".

Prof C Cilliers  
Chairperson: Research Ethics Committee (Human)

cc: Department of Research Capacity Development  
Faculty Officer: BES

# APPENDIX B: QUESTIONNAIRE

11/21/2015

NMMU Web Survey - edit questionnaire



## Involvement in Commercialisation Activities

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Page No: 1

This questionnaire is designed to probe the researcher's opinion of support for commercialisation activities at the NMMU. The data gathered from this questionnaire will be kept STRICTLY CONFIDENTIAL. To complete this questionnaire, you must be a researcher at the NMMU. By completing this questionnaire you are consenting to the use of this data for research purposes. Before you begin please make sure that you have about 10-12 minutes to complete this questionnaire.

### 1. Respondent profile

Please provide information which most closely describes your career and tenure at NMMU by answering the following questions.

- 1.1 Faculty in which respondent reports (Select one of the following): \*  
 Faculty of Science information technology  Faculty of engineering, built environment and information technology
- 1.2 I am \_\_\_\_\_ years old \*  
 (value between 20 and 90)
- 1.3 Gender \*  
 Male  Female
- 1.4 What is your home language? \*  
 Afrikaans  English  Other  Xhosa  Zulu
- 1.5 Race \*  
 Asian  Black  Caucasian  Indian  Other
- 1.6 Have you ever been employed in a for-profit company on a full-time basis for a period of at least one year? \*  
 Yes  No
- 1.7 How many years of work experience do you have in the research environment ? \*  
 (value between 1 and 60)
- 1.8 For how many years have you been employed by the NMMU? \*  
 (value between 1 and 50)

<http://websurvey.nmmu.ac.za/q.asp?designmode=yes&sid=579&k=lazrodzlnw>

1/2

- 1.9 Select which of the following describes your current employment status at the NMMU:

Full time, permanent staff  
  Full time, contract staff  
  Part time  
  Other

**[add new question](#)**

## **2. Research Activity**

Definitions according to Abreu (2012):

Basic research is defined as research that has no direct application or is purely for the purpose of adding to the body of knowledge; user-inspired research is basic research that is inspired by considerations of use; and applied research is that which is directed towards an individual, group or societal need or use.

- 2.1 If you are involved in research, select which of the following describes the type of research you conduct for most of your time (select one only):

Basic Research  
 User-inspired research  
 Applied Research

- 2.2 Which of the following are you involved in (tick all that apply):

Teaching  
 Supervising Postgraduates  
 Research  
 Academic administration (department, school or faculty-level)

- 2.3 Select which of the following best describes the relevance of your research to external organisations

My research holds no relevance for external organisations  
  My research can be applied in a commercial context  
  My research may be of general commercial interest to industry  
  My research is relevant to government, state-funded institutions and/or non-profit organisations  
  My research is applied in a commercial context

**[add new question](#)**

**[add new category](#)**

If you have not selected 'Research' as one of the activities you are involved in in 2.2, please do not continue with this questionnaire.



## Involvement in Commercialisation Activities

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Page No: 2

If commercialisation activities are defined as any of the following: a) Discussion of innovative research findings with the Technology Transfer Office (TTO)- typically called disclosure (at the NMMU, the TTO is the Department of Innovation Support and Technology Transfer), b) Protection of intellectual property through patenting of inventions, registration of functional and aesthetic designs, and filing of trade marks c) Involvement in the formation of a university spin-off company d) Licensing of research outputs to external organisations, then please answer the following questions with this frame of reference.

### 3. Involvement in commercialisation activities

Please answer the following questions to describe your involvement in commercialisation activities.

- 3.1 Have you been involved in any commercialisation activities at the NMMU or at another university or research institution in the last 5 years? \*  Yes  No
- 3.2 Are you currently involved in any commercialisation activities at the NMMU? \*  Yes  No
- 3.3 If the answer to 3.1 or 3.2 is Yes: of the time that you spend on research, how much do you estimate you spend on commercialisation activities as defined above? \*  1-25%  26-50%  51-75%  76-100%  Not applicable
- 3.4 Do you think you will be involved in any commercialisation activities at the NMMU in the next 5 years? \*  Yes  No  Don't know
- 3.5 If your answer to Question 3.2 or 3.4 is Yes, select one or more of the following which you have been involved in at the NMMU or \*  I have not been involved in commercialisation activities  
 Disclosure to, or discussions with, the NMMUs or other institutions Technology Transfer Office regarding innovative research findings  
 Patenting an invention

another university or  
research institution:

- Filing a design registration or trade mark  
 The start of a spin-off company  
 Licensing of research outputs

**[add new question](#)**

#### **4. Awareness of TTO support**

Are you aware that the NMMU's Technology Transfer Office offers support for the following:

- 4.1 Filing of formal protection  
\* of intellectual property  
(such as patents, design  
registrations and trade  
marks)  Yes  No
- 4.2 Funding the building and  
\* marketing of prototypes  Yes  No
- 4.3 Commercialisation of  
\* research outputs through  
new company formation  Yes  No
- 4.4 Commercialisation of  
\* research outputs through  
licensing to external  
organisations  Yes  No
- 4.5 Negotiation of  
\* commercialisation contracts  Yes  No

**[add new question](#)**

**[add new category](#)**



## Involvement in Commercialisation Activities

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The following questions are designed to understand the researcher's opinion on the importance of involvement in commercialisation activities.

### 5. Importance of commercialisation activities

State whether you agree or disagree with these statements:

- 5.1 \* It is generally important for researchers to be involved in commercialisation activities
- Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 5.2 \* Involvement in commercialisation activities adds value to my research
- Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 5.3 \* I am involved in commercialisation activities because I want to sustain my research group
- Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly agree
- 5.4 \* Involvement in commercialisation activities is generally supported by my faculty
- Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly agree
- 5.5 \* It is important to disclose innovative research findings to the TTO
- Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 5.6 \* Involvement in commercialisation activities can improve the likelihood of successful research activities
- Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 5.7 \* Involvement in commercialisation activities does not affect other traditional research activities
- Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 5.8 Involvement in

11/21/2015

NMMU Web Survey - edit questionnaire

\* commercialisation activities can increase the number of research collaborations with external organisations

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

5.9 \* The extent of involvement of researchers in commercialisation activities depends on their research field

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

5.10 \* The process of obtaining statutory protection for innovative research outputs can lead to missed publication opportunities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

**[add new question](#)**  
**[add new category](#)**



## Involvement in Commercialisation Activities

[Preview Page](#) | [Re-order Page Numbers](#) | [Re-order Category Numbers by Page](#) | [Survey Summary](#) | [Survey List](#) | [User Guide](#)

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The following questions are designed to gain an understanding of researchers' opinions on the value of the support provided by the NMMU Technology Transfer Office (Department of Innovation Support and Technology Transfer)

### 6. Value of Technology Transfer Office support

State whether you agree or disagree with these statements. If you have NOT engaged with NMMU's TTO in the last 5 years, please select 'not applicable'.

- 6.1 The NMMU's TTO provides sufficient support to researchers for commercialisation activities  
\*  Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly agree
- 6.2 The NMMU's TTO provides adequate information on the process of commercialisation  
\*  Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 6.3 The NMMU's TTO works closely with researchers to support their involvement in commercialisation activities  
\*  Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 6.4 It is useful to have a TTO dedicated to supporting only the NMMU's technology transfer needs  
\*  Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

[add new question](#)

### 7. Institutional support

The following questions are designed to gain an understanding of the researchers' opinions on the institutional support provided by the NMMU for involvement in commercialisation activities. Please state whether you agree or disagree with these statements.

- 7.1 My line manager is/would be supportive of my involvement in commercialisation activities  
\*  Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

7.2 Teaching loads are too high  
\* for researchers to be  
involved in  
commercialisation activities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

7.3 The NMMU supports  
\* commercialisation activities  
through its committee  
structures

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

7.4 The NMMUs institutional  
\* environment is generally  
enabling for researcher  
involvement in  
commercialisation activities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

7.5 The NMMU should provide  
\* greater recognition to  
researchers involved in  
commercialisation activities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

**[add new question](#)**  
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## Involvement in Commercialisation Activities

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The following questions are designed to gain an understanding of researchers opinions of different incentives for involvement in commercialisation activities.

### **8. Personal incentives for involvement**

State whether you agree or disagree with these statements:

- 8.1 I am/would like to be involved in commercialisation activities to grow my personal wealth \*  
 Not applicable disagree  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 8.2 I am/would like to be involved in commercialisation activities to improve my chances of promotion \*  
 Not applicable disagree  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 8.3 Involvement in commercialisation activities is/would be intrinsically satisfying for me \*  
 Not applicable disagree  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 8.4 Involvement in commercialisation activities can lead to enhancement of my reputation \*  
 Not applicable disagree  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 8.5 I am motivated to be involved in commercialisation activities because I believe it can lead to a positive impact on society \*  
 Not applicable disagree  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree
- 8.6 The NMMU's policy of distributing 30% of commercialisation revenue to inventors or creators provides sufficient financial incentive for involvement in \*  
 Not applicable disagree  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

commercialisation activities**[add new question](#)****9. Interventions to improve involvement**

The following questions are designed to gain an understanding of researchers' opinions on different interventions which may be used to enhance researcher involvement in commercialisation activities. State whether you agree or disagree with these statements.

9.1 The NMMUs performance

\* evaluation system should ascribe the same value to patents granted in foreign territories as they do to publications in internationally accredited journals

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

9.2 Formal relevant training

\* opportunities for researchers involved in commercialisation activities would increase the level of involvement in these activities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

9.3 The availability of funds for

\* proof of concept and demonstration prototypes would improve the likelihood of involvement in commercialisation activities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

9.4 The establishment of a

\* Science Park at the NMMU would improve the likelihood of researcher involvement in commercialisation activities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

9.5 The establishment of a

\* Business Incubator at the NMMU would improve the likelihood of researcher involvement in commercialisation activities

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

9.6 A patent incentive fund (a

\* reward similar to existing publication incentives) should be established to reward innovative researchers for patenting inventions

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree

9.7 Increasing the share of

\* commercialisation revenue to inventors or creators would increase the likelihood of involvement in

Not applicable  Strongly disagree  Disagree  Neither agree nor disagree  Agree  Strongly Agree



commercialisation activities

9.8 Allowing researchers to be  
\* owners of spin-off  
companies while retaining  
their existing employment  
at the NMMU would  
increase the likelihood of  
involvement in  
commercialisation activities

- Not applicable    Strongly disagree    Disagree    Neither agree nor  
disagree    Agree    Strongly Agree

***add new question***  
***add new category***

## APPENDIX C: RAW DATA AND STATISTICS

Basic descriptive statistics summarised from raw data

**Table C 1: Section 1**

Q			Count	Percentage	Average	Median
1.1	Faculty	Engineering, Built Environment and Information Technology	18			
		Science	18			
1.2	Age	25-34 years old	5	14%	44.64	44.5
		35- 44 years	13	36%		
		45-54 years	16	44%		
		>55 years	2	6%		
1.3	Gender	Male	25	69%		
		Female	11	31%		
1.4	Language	English	24	67%		
		Afrikaans	12	33%		
1.5	Race	Other	14	39%		
		Caucasian	22	61%		
1.6	Previous industry employment for more than 1 year	Yes	22	61%		
		No	14	39%		
1.7	Work Experience in research environment	</=14 years	17	47%	14	14
		>14 years	19	53%		
1.8	Employed at NMMU	<10 years	16	44%	13	15
		>10 years	20	56%		
1.9	Type of employment	Full Time Permanent	28	78%		
		Other	2	6%		
		Full Time Contract	6	17%		

**Table C 2: Response to question 2.1**

<b>Q2-1 If you are involved in research, select which of the following describes the type of research you conduct for most of your time (select one only):</b>		
<b>Type of research</b>	<b>Responses</b>	<b>Percentage</b>
User Inspired research	2	6%
Basic Research	12	33%
Applied research	20	56%
User inspired & applied research	2	6%

**Table C 3: Response to question 2.2**

<b>Q2-2 Which of the following are you involved in (tick all that apply):</b>		
<b>Activity</b>	<b>Number of Responses</b>	
Teaching	32	
Supervising postgraduate students	26	
Research	36	
Academic administration	24	
<b>Summary of selections</b>		
<b>Activity combinations selected by respondents</b>	<b>Number of Responses</b>	<b>Percentage</b>
Research	4	11%
Teaching & Research	2	6%
Teaching, supervising Postgraduates & research	6	17%
Teaching, Research & academic administration	4	11%
Teaching, supervising Postgraduates, research & Academic administration	20	56%

**Table C 4: Response to question 2.3**

<b>Q2-3 Select which of the following best describes the relevance of your research to external organisations</b>		
<b>Activity</b>	<b>Number of Responses</b>	<b>Percentage</b>
No Relevance	4	11%
Can be applied commercially	16	44%
General commercial interest	4	11%
Government	6	17%
Is applied commercially	6	17%

**Table C 5: Response to question 3.1**

<b>Q3-1 Have you been involved in any commercialisation activities at the NMMU or at another university or research institution in the last 5 years?</b>		
<b>Option</b>	<b>Response</b>	<b>%</b>
Yes	20	56%
No	16	44%
Don't Know	0	0%

**Table C 6: Response to question 3.2**

<b>Q3-2 Are you currently involved in any commercialisation activities at the NMMU?</b>		
<b>Option</b>	<b>Responses</b>	<b>%</b>
Yes	20	56%
No	16	44%

**Table C 7: Response to question 3.3**

<b>Q3-3 If the answer to 3.1 or 3.2 is Yes: of the time that you spend on research, how much do you estimate you spend on commercialisation activities as defined above?</b>		
<b>Option</b>	<b>Responses</b>	<b>%</b>
0%	16	44%
up to 25% of research time	14	39%
up to 50% of research time	2	6%
up to 75% of research time	2	6%
up to 100% of research time	2	6%

**Table C 8: Response to question 3.4**

<b>Q3-4 Do you think you will be involved in any commercialisation activities at the NMMU in the next 5 years?</b>		
<b>Option</b>	<b>Response</b>	<b>%</b>
Yes	22	61%
No	4	11%
Don't know	10	28%

**Table C 9: Response to question 3.5**

<b>Q3-5 If your answer to Question 3.2 or 3.4 is Yes, select one or more of the following which you have been involved in at the NMMU or another university or research institution:</b>		
<b>Option</b>	<b>Response</b>	<b>%</b>
NotInvCA	16	44%
Disclosure	2	6%
Patenting	6	17%
Disclosure,Patenting	6	17%
Disclosure,Spinoff	2	6%
Patenting,DesignTM,LicenseRO	2	6%
Disclosure,Patenting,DesignTM,Spinoff,LicenseRO	2	6%

**Table C 10: response to questions 4.1-4.5**

Sample	Options	Q4-1 Filing of formal protection of intellectual property (such as patents, design registrations and trade marks)	Q4-2 Funding the building and marketing of prototypes	Q4-3 Commercialisation of research outputs through new company formation	Q4-4 Commercialisation of research outputs through licensing to external organisations	Q4-5 Negotiation of commercialisation contracts	Mean %	Std Dev
All	Y	26	24	26	24	28	71%	1.496663
	N	10	12	10	12	8	29%	1.496663
Not involved	Y	6	4	8	6	10	43%	2.039608
	N	10	12	8	10	6	58%	2.039608
Involved	Y	20	20	18	18	18	94%	0.979796
	N	0	0	2	2	2	6%	0.979796

Table C 11: Response to questions 5.1-5.5

Sample	Option	Q5-1 It is generally important for researchers to be involved in commercialisation activities		Q5-2 Involvement in commercialisation activities adds value to my research		Q5-3 I am involved in commercialisation activities because I want to sustain my research group		Q5-4 Involvement in commercialisation activities is generally supported by my faculty		Q5-5 It is important to disclose innovative research findings to the TTO	
		#Responses	%	#Responses	%	#Responses	%	#Responses	%	#Responses	%
All	Not applicable	0	0%	2	6%	6	17%	0	0%	0	0%
	Strongly disagree	2	6%	0	0%	2	6%	4	11%	0	0%
	Disagree	6	17%	2	6%	4	11%	0	0%	4	11%
	Neither Agree nor disagree	4	11%	6	17%	8	22%	8	22%	8	22%
	Agree	20	56%	14	39%	6	17%	22	61%	12	33%
	Strongly Agree	4	11%	12	33%	10	28%	2	6%	12	33%
Not involved	Not applicable	0	0%	2	13%	6	38%	0	0%	0	0%
	Strongly disagree	0	0%	0	0%	2	13%	0	0%	0	0%
	Disagree	2	13%	0	0%	2	13%	0	0%	2	13%
	Neither Agree nor disagree	2	13%	6	38%	6	38%	4	25%	6	38%
	Agree	12	75%	8	50%	0	0%	10	63%	6	38%
	Strongly Agree	0	0%	0	0%	0	0%	2	13%	2	13%
Involved	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	2	10%	0	0%	0	0%	4	20%	0	0%
	Disagree	4	20%	2	10%	2	10%	0	0%	2	10%
	Neither Agree nor disagree	2	10%	0	0%	2	10%	4	20%	2	10%
	Agree	8	40%	6	30%	6	30%	12	60%	6	30%
	Strongly Agree	4	20%	12	60%	10	50%	0	0%	10	50%
Basic Statistics	Median All	4.00		4.00		3.00		4.00		4.00	
	Median Uninvolved	4.00		3.50		1.50		4.00		3.50	
	Median Involved	4.00		5.00		4.50		4.00		4.50	
	Std Dev All	1.07		1.26		1.76		1.01		0.99	
	Std Dev Uninvolved	0.70		1.27		1.32		0.60		0.87	
	Std Dev Involved	1.28		0.92		0.98		1.17		0.98	

**Table C 12: Response to questions 5.6-5.10**

Sample	Option	Q5-6 Involvement in commercialisation activities can improve the likelihood of successful research activities		Q5-7 Involvement in commercialisation activities does not affect other traditional research activities		Q5-8 Involvement in commercialisation activities can increase the number of research collaborations with external organisations		Q5-9 The extent of involvement of researchers in commercialisation activities depends on their research field		Q5-10 The process of obtaining statutory protection for innovative research outputs can lead to missed publication opportunities	
		#Responses	%	#Responses	%	#Responses	%	#Responses	%	#Responses	%
All	Not applicable	0	0%	0	0%	0	0%	0	0%	2	6%
	Strongly disagree	0	0%	6	17%	0	0%	0	0%	4	11%
	Disagree	4	11%	14	39%	4	11%	2	6%	4	11%
	Neither Agree nor disagree	8	22%	6	17%	4	11%	0	0%	10	28%
	Agree	12	33%	8	22%	16	44%	16	44%	12	33%
	Strongly Agree	12	33%	2	6%	12	33%	18	50%	4	11%
Not involved	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	2	13%	0	0%	0	0%	2	13%
	Disagree	2	13%	8	50%	2	13%	2	13%	0	0%
	Neither Agree nor disagree	6	38%	2	13%	0	0%	0	0%	6	38%
	Agree	6	38%	4	25%	8	50%	4	25%	8	50%
	Strongly Agree	2	13%	0	0%	6	38%	10	63%	0	0%
Involved	Not applicable	0	0%	0	0%	0	0%	0	0%	2	10%
	Strongly disagree	0	0%	4	20%	0	0%	0	0%	2	10%
	Disagree	2	10%	6	30%	2	10%	0	0%	4	20%
	Neither Agree nor disagree	2	10%	4	20%	4	20%	0	0%	4	20%
	Agree	6	30%	4	20%	8	40%	12	60%	4	20%
	Strongly Agree	10	50%	2	10%	6	30%	8	40%	4	20%
Basic Statistics	Median All	4.00		2.00		4.00		4.50		3.00	
	Median Uninvolved	3.50		2.00		4.00		5.00		3.50	
	Median Involved	4.50		2.50		4.00		4.00		3.00	
	Std Dev All	0.99		1.16		0.94		0.76		1.35	
	Std Dev Uninvolved	0.87		1.00		0.93		0.99		0.97	
	Std Dev Involved	0.98		1.27		0.94		0.49		1.58	

**Table C 13: Response to questions 6.1-6.2**

Sample	Option	Q6-1 The NMMU's TTO provides sufficient support to researchers for commercialisation activities		Q6-2 The NMMUs TTO provides adequate information on the process of commercialisation		Q6-3 The NMMUs TTO works closely with researchers to support their involvement in commercialisation activities		Q6-4 It is useful to have a TTO dedicated to supporting only the NMMUs technology transfer needs	
		#Responses	%	#Responses	%	#Responses	%	#Responses	%
All	Not applicable	6	17%	6	17%	8	22%	6	17%
	Strongly disagree	0	0%	0	0%	0	0%	0	0%
	Disagree	0	0%	2	6%	1	3%	1	3%
	Neither Agree nor disagree	2	6%	5	14%	4	11%	4	11%
	Agree	24	67%	17	47%	15	42%	11	31%
	Strongly Agree	4	11%	6	17%	8	22%	14	39%
Not involved	Not applicable	6	38%	6	38%	8	50%	6	38%
	Strongly disagree	0	0%	0	0%	0	0%	0	0%
	Disagree	0	0%	2	13%	0	0%	0	0%
	Neither Agree nor disagree	0	0%	2	13%	2	13%	2	13%
	Agree	10	63%	6	38%	6	38%	4	25%
	Strongly Agree	0	0%	0	0%	0	0%	4	25%
Involved	Not applicable	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	0	0%	0	0%	0	0%
	Disagree	0	0%	0	0%	1	5%	1	5%
	Neither Agree nor disagree	2	10%	3	15%	2	10%	2	10%
	Agree	14	70%	11	55%	9	45%	7	35%
	Strongly Agree	4	20%	6	30%	8	40%	10	50%
Basic statistics	Median All	4.00		4.00		4.00		4.00	
	Median Uninvolved	4.00		2.50		1.50		3.50	
	Median Involved	4.00		4.00		4.00		4.50	
	Std Dev All	1.57		1.62		1.82		1.76	
	Std Dev Uninvolved	1.94		1.76		1.90		2.12	
	Std Dev Involved	0.54		0.65		0.81		0.84	



Table C 14: Response to questions 7.1-7.5

Sample	Option	Q7-1 My line manager is/would be supportive of my involvement in commercialisation activities		Q7-2 Teaching loads are too high for researchers to be involved in commercialisation activities		Q7-3 The NMMU supports commercialisation activities through its committee structures		Q7-4 The NMMUs institutional environment is generally enabling for researcher involvement in commercialisation activities		Q7-5 The NMMU should provide greater recognition to researchers involved in commercialisation activities	
		#Responses	%	#Responses	%	#Responses	%	#Responses	%	#Responses	%
All	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	2	6%	0	0%	4	11%	10	28%	2	6%
	Disagree	4	11%	8	22%	6	17%	2	6%	4	11%
	Neither Agree nor disagree	8	22%	2	6%	20	56%	12	33%	8	22%
	Agree	16	44%	6	17%	6	17%	12	33%	16	44%
	Strongly Agree	6	17%	20	56%	0	0%	0	0%	6	17%
Not involved	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	0	0%	2	13%	4	25%	2	13%
	Disagree	2	13%	0	0%	4	25%	2	13%	4	25%
	Neither Agree nor disagree	4	25%	0	0%	6	38%	6	38%	4	25%
	Agree	8	50%	2	13%	4	25%	4	25%	4	25%
Strongly Agree	2	13%	14	88%	0	0%	0	0%	2	13%	
Involved	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	2	10%	0	0%	2	10%	6	30%	0	0%
	Disagree	2	10%	8	40%	2	10%	0	0%	0	0%
	Neither Agree nor disagree	4	20%	2	10%	14	70%	6	30%	4	20%
	Agree	8	40%	4	20%	2	10%	8	40%	12	60%
	Strongly Agree	4	20%	6	30%	0	0%	0	0%	4	20%
Basic Statistics	Median All	4.00		5.00		3.00		3.00		4.00	
	Median Uninvolved	4.00		5.00		3.00		3.00		3.00	
	Median Involved	4.00		3.50		3.00		3.00		4.00	
	Std Dev All	1.07		1.22		0.85		1.19		1.07	
	Std Dev Uninvolved	0.86		0.33		0.97		1.11		1.22	
	Std Dev Involved	1.20		1.28		0.75		1.25		0.63	

**Table C 15: Responses to questions 8.1-8.6**

Sample	Option	Q8-1 I am/would like to be involved in commercialisation activities to grow my personal wealth		Q8-2 I am/would like to be involved in commercialisation activities to improve my chances of promotion		Q8-3 Involvement in commercialisation activities is/would be intrinsically satisfying for me		Q8-4 Involvement in commercialisation activities can lead to enhancement of my reputation		Q8-5 I am motivated to be involved in commercialisation activities because I believe it can lead to a positive impact on society		Q8-6 The NMMU's policy of distributing 30% of commercialisation revenue to inventors or creators provides sufficient financial incentive for involvement in commercialisation activities	
		#Responses	%	#Responses	%	#Responses	%	#Responses	%	#Responses	%	#Responses	%
All	Not applicable	0	0%	4	11%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	4	11%	0	0%	0	0%	0	0%	4	11%
	Disagree	6	17%	4	11%	0	0%	2	6%	0	0%	12	33%
	Neither Agree nor disagree	10	28%	8	22%	2	6%	8	22%	8	22%	8	22%
	Agree	12	33%	10	28%	18	50%	14	39%	14	39%	8	22%
	Strongly Agree	8	22%	6	17%	16	44%	12	33%	14	39%	4	11%
Not involved	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	2	13%	0	0%	0	0%	0	0%	4	25%
	Disagree	2	13%	0	0%	0	0%	2	13%	0	0%	6	38%
	Neither Agree nor disagree	6	38%	4	25%	2	13%	4	25%	6	38%	2	13%
	Agree	4	25%	6	38%	10	63%	8	50%	6	38%	2	13%
Strongly Agree	4	25%	4	25%	4	25%	2	13%	4	25%	2	13%	
Involved	Not applicable	0	0%	4	20%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	2	10%	0	0%	0	0%	0	0%	0	0%
	Disagree	4	20%	4	20%	0	0%	0	0%	0	0%	6	30%
	Neither Agree nor disagree	4	20%	4	20%	0	0%	4	20%	2	10%	6	30%
	Agree	8	40%	4	20%	8	40%	6	30%	8	40%	6	30%
	Strongly Agree	4	20%	2	10%	12	60%	10	50%	10	50%	2	10%
Basic statistics	Median All	3.00		4.00		4.00		4.00		3.00		4.00	
	Median Uninvolved	4.00		4.00		4.00		4.00		2.00		4.00	
	Median Involved	2.50		5.00		4.50		4.50		3.00		4.00	
	Std Dev All	1.58		0.59		0.88		0.76		1.20		0.66	
	Std Dev Uninvolved	1.22		0.60		0.86		0.78		1.32		0.60	
	Std Dev Involved	1.62		0.49		0.78		0.66		0.98		0.64	

**Table C 16: responses to questions 9.1-9.5**

		Q9-1 The NMMUs performance evaluation system should ascribe the same value to patents granted in foreign territories as they do to publications in internationally accredited journals		Q9-2 Formal relevant training opportunities for researchers involved in commercialisation activities would increase the level of involvement in these activities		Q9-3 The availability of funds for proof of concept and demonstration prototypes would improve the likelihood of involvement in commercialisation activities		Q9-4 The establishment of a Science Park at the NMMU would improve the likelihood of researcher involvement in commercialisation activities		Q9-5 The establishment of a Business Incubator at the NMMU would improve the likelihood of researcher involvement in commercialisation activities	
Sample	Option	#Responses	%	#Responses	%	#Responses	%	#Responses	%	#Responses	%
All	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	0	0%	0	0%	0	0%	0	0%
	Disagree	0	0%	0	0%	0	0%	2	6%	2	6%
	Neither Agree nor disagree	6	17%	6	17%	4	11%	8	22%	8	22%
	Agree	20	56%	24	67%	16	44%	14	39%	16	44%
	Strongly Agree	10	28%	6	17%	16	44%	12	33%	10	28%
Not involved	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	0	0%	0	0%	0	0%	0	0%
	Disagree	0	0%	0	0%	0	0%	2	13%	2	13%
	Neither Agree nor disagree	4	25%	0	0%	2	13%	2	13%	2	13%
	Agree	10	63%	12	75%	6	38%	8	50%	6	38%
	Strongly Agree	2	13%	4	25%	8	50%	4	25%	6	38%
Involved	Not applicable	0	0%	0	0%	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	0	0%	0	0%	0	0%	0	0%
	Disagree	0	0%	0	0%	0	0%	0	0%	0	0%
	Neither Agree nor disagree	2	10%	6	30%	2	10%	6	30%	6	30%
	Agree	10	50%	12	60%	10	50%	6	30%	10	50%
	Strongly Agree	8	40%	2	10%	8	40%	8	40%	4	20%
Basic statistics	Median All	4.00		4.00		4.00		4.00		4.00	
	Median Uninvolved	4.00		4.00		4.50		4.00		4.00	
	Median Involved	4.00		4.00		4.00		4.00		4.00	
	Std Dev All	0.66		0.58		0.67		0.88		0.85	
	Std Dev Uninvolved	0.60		0.43		0.70		0.93		1.00	
	Std Dev Involved	0.64		0.60		0.64		0.83		0.70	

**Table C 17: Responses to questions 9.6 - 9.8**

		Q9-6 A patent incentive fund (a reward similar to existing publication incentives) should be established to reward innovative researchers for patenting inventions		Q9-7 Increasing the share of commercialisation revenue to inventors or creators would increase the likelihood of involvement in commercialisation activities		Q9-8 Allowing researchers to be owners of spin-off companies while retaining their existing employment at the NMMU would increase the likelihood of involvement in commercialisation activities	
Sample	Option	#Responses	%	#Responses	%	#Responses	%
<b>All</b>	Not applicable	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	2	6%	0	0%
	Disagree	4	11%	0	0%	0	0%
	Neither Agree nor disagree	6	17%	2	6%	6	17%
	Agree	20	56%	20	56%	12	33%
	Strongly Agree	6	17%	12	33%	18	50%
<b>Not involved</b>	Not applicable	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	0	0%	0	0%
	Disagree	2	13%	0	0%	0	0%
	Neither Agree nor disagree	4	25%	0	0%	2	13%
	Agree	6	38%	8	50%	4	25%
	Strongly Agree	4	25%	8	50%	10	63%
<b>Involved</b>	Not applicable	0	0%	0	0%	0	0%
	Strongly disagree	0	0%	2	10%	0	0%
	Disagree	2	10%	0	0%	0	0%
	Neither Agree nor disagree	2	10%	2	10%	4	20%
	Agree	14	70%	12	60%	8	40%
	Strongly Agree	2	10%	4	20%	8	40%
<b>Basic statistics</b>	Median All	4.00		4.00		4.50	
	Median Uninvolved	4.00		4.50		5.00	
	Median Involved	4.00		4.00		4.00	
	Std Dev All	0.85		0.94		0.75	
	Std Dev Uninvolved	0.97		0.50		0.71	
	Std Dev Involved	0.75		1.08		0.75	

# APPENDIX D: TURNITIN REPORT

1/10/2016

Turnitin

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