MOTIVATION FACTORS OF SUCCESSFUL ACADEMIC RESEARCH COMMERCIALISATION AMONG MALAYSIAN TECHNICAL UNIVERSITIES

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ABSTRACT

The Malaysian government has been striving to provide an environment conducive to research commercialisation in the country. Despite the efforts, the targeted research commercialisation rate has yet to be achieved. As such, it is important to understand the motivation of the academic researchers who had successfully commercialised their research. Literature classifies motivation factors as extrinsic, intrinsic, and prosocial, which might exist independently or in a combination (mixed-motivation). Within the academic research commercialisation context, a considerable number of existing studies have discussed the role of extrinsic motivation factors, while the issues of intrinsic and prosocial factors have not been much studied. Thus, this study aimed to further understand the role of each motivation factor as well as the role of mixed-motivation factors among academic researchers who had successfully commercialised their research results. In achieving the study's objective, this study utilised the Self-Concordance Theory as the study's framework and applied a qualitative case study approach. The informants in the study were the academic researchers from four Malaysian technical universities. The research project was selected as the unit of analysis. The study revealed that academic researchers were highly motivated by the combination of all three motivation factors (mixed-motivation factors) in supporting their commercialisation activities. The recurring themes for all the successful research projects were passion and the personal traits of the academic researchers. The results of this study enrich the Self-Concordance Theory through highlighting the role of the mixed-motivation factors in explaining that the goals of academic researchers' commercialisation activities were closely linked to their personal goals.

Keywords: academic research commercialisation, extrinsic motivation factors, intrinsic motivation factors, prosocial motivation factors, Self- Concordance theory.

ABSTRAK

Kerajaan Malaysia telah berusaha untuk menyediakan persekitaran yang kondusif bagi pengkomersialan penyelidikan di negara ini. Walaupun pelbagai usaha telah dijalankan, kadar pengkomersialan yang disasarkan masih belum dicapai. Oleh itu, adalah penting untuk memahami motivasi penyelidik yang telah berjaya mengkomersialkan hasil penyelidikan mereka. Literatur telah mengklasifikasikan faktor-faktor motivasi sebagai ekstrinsik, intrinsik, dan prososial yang mungkin wujud secara bersendirian atau berkumpulan (motivasi bercampur). Dalam konteks pengkomersialan penyelidikan akademik, sebilangan besar kajian yang sedia ada telah membincangkan peranan faktor-faktor motivasi ekstrinsik, manakala faktor intrinsik dan prososial pula kurang dikaji. Oleh itu, kajian ini bertujuan untuk lebih memahami peranan setiap faktor motivasi serta peranan faktor motivasi bercampur di kalangan penyelidik yang telah berjaya mengkomersilkan hasil penyelidikan mereka. Dalam mencapai objektif kajian, kajian ini menggunakan *Self-Concordance Theory* sebagai rangka kerja kajian dan mengaplikasikan pendekatan kajian kes kualitatif. Informan-informan dalam kajian ini ialah para penyelidik daripada empat universiti teknikal di Malaysia yang telah berjaya mengkomersialkan hasil penyelidikan mereka. Projek penyelidikan telah dipilih sebagai unit analisis. Kajian ini mendedahkan bahawa penyelidik akademik didorong oleh gabungan ketiga-tiga faktor motivasi (faktor motivasi bercampur) dalam menyokong aktiviti pengkomersialan mereka. Elemen yang terdapat dalam kesemua projek penyelidikan yang berjaya adalah keghairahan dan sifat-sifat peribadi penyelidik. Hasil kajian ini memperkayakan *Self-Concordance Theory* dengan menonjolkan peranan faktor-faktor motivasi bercampur dalam menerangkan bahawa matlamat aktiviti pengkomersialan penyelidik selari dengan matlamat peribadi mereka sendiri.

Katakunci: pengkomersialan penyelidikan akademik, faktor-faktor motivasi ekstrinsik, faktor-faktor motivasi intrinsik, faktor-faktor motivasi prososial, *Self-Concordance Theory*.

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LIST OF ABBREVIATIONS

ATN	Australian Technology Network of Universities
AUTM	Association of University Technology Managers
CAQDAS	Computer-Aided Qualitative Data Analysis Software
CoE	Centre of Excellence
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
IBS	Industrialised Building System
KPI	Key Performance Index
MNCs	Multinational Companies
MOHE	Malaysian Ministry of Higher Education
MOSTI	Malaysian Ministry of Science, Technology and Innovation
MTDC	Malaysian Technical Development Corporation
MTUN	Malaysian Technical Universities Network
MUCET	MTUN Conference on Engineering and Technology
R&D	Research and Development
RMC-MOHE	Research Management Centre of MOHE
RSE	Researchers-Scientists-Engineers
RUs	Research Universities
SDT	Self-Determination Theory
S&T	Science and Technology
TNB	Tenaga Nasional Berhad
TTO	Technology Transfer Office
UMP	Universiti Malaysia Pahang
UniMAP	Universiti Malaysia Perlis
US	United States of America
UTeM	Universiti Teknikal Malaysia
UTHM	Universiti Tun Hussein Onn Malaysia

CHAPTER ONE: INTRODUCTION

1.1 Research Background

In the 1800s, universities were widely known as a place to gain tertiary education. They were also perceived as the major supplier of human capital. Then, research activities were introduced as a source of exploring new knowledge either for inventions or innovations. In 1900s, developed countries began to commercialise their research output in order to gain financial returns. Besides generating monetary returns, the commercialisation activity aimed to help the nation's economic growth by creating job opportunities as well as improving the quality of life of the citizens (AUTM, 2012). In 2000s, these research activities have become more important to drive higher economic performance and generate more funds to support the university operation (Philpott, Dooley, Reilly, Lupton, & O'Reilly, 2011; Rothaermel, Agung, & Jiang, 2007). The research activities also benefit the companies that have gained from the technology transfer and to the community that utilises the end products.

Commercialisation of research outputs is now a concern of developing Asian countries such as Thailand (Rigg, Salamanca, & Parnwell, 2012; Wonglimpiyarat & Yuberk, 2005), Indonesia (Dhewanto & Umam, 2009; Lakitan, 2013), and Malaysia (Heng, Amran, & Aslan, 2012; Ismail, Senin, Mun, & Chen, 2012; Yaacob, Rasli, Senin, & Othman, 2011). Despite the benefits, various issues have emerged related to such initiatives which include barriers to commercialising research, facilitation of

local government efforts in commercialisation activities, as well as the role of academic researchers in research commercialisation activities.

1.1.1 Research Commercialisation in Malaysia

Malaysia is a developing country that aims to achieve a developed and high-income status by the year 2020. To achieve this, research and development (R&D) activities in the country's five-year development plans has been fundamentally emphasised; in fact, the first Science and Technology (S&T) Plan for the country has been implemented since 1986. The Ministry of Science, Technology and Innovation (MOSTI) defines research commercialisation activities as "taking an idea to an outcome – whether a product, service, process or organisational system to market by way of licensing, assignment, spin-off, or joint ventures" (MOSTI, 2009, p. 5). Within the university context, such commercialisation activities can directly generate income for the university concerned and serve as a platform for product delivery to end-users.

The country's research investment has grown bigger over the years although the amount is reportedly lower than other developing countries. The Gross Expenditure on Research and Development (GERD) in 2006 was RM3.6 billion, which was equal to 0.64% of the country's Gross Domestic Product (GDP) (OECD, 2013). The ratio of GERD to GDP is an important indicator to measure the intensity of R&D investment in a country. However, the GERD ratio declined to 0.21% in 2008, perhaps due to the global economic crisis.

In the same year of 2008, Malaysia began to implement a number of innovation blueprints, including the National Innovation Agenda and the New Economic Model (AIM, 2011; EPU, 2010). At that time, the government realised the need to leverage its level of research commercialisation in order to spur the planned innovation agenda accordingly. As a result, the GERD ratio escalated by 23.2% to 1.01% in 2009 (MASTIC, 2013). It was a major breakthrough in research investment by the country as the Tenth Malaysia Plan aimed to achieve a lower target of 1.0% of GERD by the year 2015 (EPU, 2006, 2010). This commitment shows that the Malaysian Government was serious in intensifying R&D activities in the country and hence reaping some returns on its investment, especially from the commercialised research university inventions.

The role of university in R&D activities is explicitly specified in the Malaysian Universities and University Colleges (Amendment) Act (AUKU) 2009. The Act defines that a university not only provide education at the preparatory, under-graduate, postgraduate or post-doctoral level, but also engage in research and educational development and commercialisation of such research and development. This definition emphasizes the importance of universities as agents of the Malaysian Government in research commercialisation activities (AUKU, 2009).

1.1.2 Research Commercialisation Ecosystem

The Innovative Malaysia is a concept developed in 2009 to boost the commercialisation activities by nurturing a creative and innovative culture in the country. The development of such concept is consistent with the Quadruple Helix

Model that depicts the collaboration of four important components in an innovation ecosystem, i.e. government, industry, ventures, and education (MOHE, 2010).

In the ecosystem, the government provides funding and develops policies to support a conducive research commercialisation environment, while the industry refers to private sector organizations, especially multinational companies (MNCs) and small and medium-sized enterprises (SMEs), that may benefit from a university research by either integrating the research result into their operation or developing them into final products or services. The venture component concerns with the entrepreneurial activities within the research commercialisation process, for example, the start-up or spin-off companies that serve as a platform for product or service commercialisation. Some scholars use the term 'academic entrepreneurs' to describe this component of the innovation ecosystem (Lam, 2011; Vanaelst *et al.*, 2006). Finally, the education component means the universities or institutions that supply the innovative human capital including academic researchers, scientists, engineers and entrepreneurs. This component serves as the bedrock of the ecosystem as the human capital is the initiator of a research project and the main actor in the research commercialisation activities (AIM, 2011; MOHE, 2010).

In Malaysia, there are 20 public universities that support the nation's research commercialisation aspiration. These universities are categorised into three types: (1) research universities, which focus on R&D activities, and receive most of the public research funds; (2) comprehensive universities, which offer all types of studies, ranging from medical to business studies, and from arts to Islamic studies; and (3) focused universities that focus on its niche area (see Table 1.1). Among the focused

universities, four of them are technical universities that form the Malaysian Technical Universities Network (MTUN).

Table 1.1
Public Universities in Malaysia and Its Classifications

RESEARCH UNIVERSITY	COMPREHENSIVE UNIVERSITY	FOCUSED UNIVERSITY (and its focus)
Universiti Sains Malaysia (USM)	Universiti Teknologi Mara (UiTM)	Universiti Malaysia Terengganu (UMT) – Marine technology
Universiti Malaya (UM)	Universiti Islam Antarabangsa Malaysia (UIAM)	Universiti Utara Malaysia (UUM) – Business and management
Universiti Kebangsaan Malaysia (UKM)	Universiti Malaysia Sabah (UMS)	Universiti Pendidikan Sultan Idris(UPSI) – School education
Universiti Putra Malaysia (UPM)	Universiti Malaysia Sarawak (UNIMAS)	Universiti Malaysia Kelantan (UMK) – Entrepreneurial/science
Universiti Teknologi Malaysia (UTM)		Universiti Pertahanan Nasional Malaysia (UPNM) – Defence/war technology and management
		Universiti Sains Islam Malaysia (USIM) – Islamic business and management
		Universiti Sultan Zainal Abidin(UniSZA) – Islamic science social studies
		Universiti Tun Hussein Onn Malaysia (UTHM) – Technical-focused
		Universiti Teknikal Malaysia Melaka (UTeM) – Technical-focused
		Universiti Malaysia Perlis (UniMAP) – Technical-focused
		Universiti Malaysia Pahang (UMP) – Technical-focused

Source: Ministry of Higher Education (MOHE, 2012).

1.1.3 Why Technical Universities?

Technical universities are universities that are technical-oriented. They focus on traditional research in engineering and machineries. They are expected to play a significant role in accelerating the country's commercialisation rate as technical courses taught in these universities have a big potential for supporting new product commercialisations. The nature of study focuses more on applied research rather than basic research (Audretsch & Lehmann, 2005a).

In Germany, technical universities are allocated more funds than other types of universities, such as comprehensive universities, to nurture and encourage spillovers from new technologies to firms as well as to support technology commercialisations into industries. For that reason, these technical universities have generally attracted more high-tech firms to be their industrial partners. The German government believes that these universities will generate and leverage the knowledge spillovers from university research better than other universities. Not only that, the technical universities also might help increase the country's performance in technology commercialisation and support its economic growth (Audretsch & Lehmann, 2005b).

Audretsch and Lehmann (2005a) compared the impact of technical universities in general on firm growth. They also studied the impact of a technical university on the firms that are located at the same vicinity as the university. Those firms exhibited a significantly greater propensity to apply for patents than the firms located at the vicinity of other types of universities. Fisch *et al.* (2014) compared and contrasted patenting performance of 300 universities worldwide. They utilised

technical universities as the control variable. They found that the highest patent output was in chemistry while the second highest was in engineering, which are the major courses in technical universities. They concluded that technical universities performed better in research commercialisation activities across countries and across different fields of study.

1.1.4 Malaysian Technical Universities Network (MTUN)

The Malaysian Technical Universities Network (MTUN) was established in 2006 with the vision of being a leading network in helping Malaysia to become a developed nation. This network aims to: (1) develop human capital with high competency; and (2) sustain the level of the country's competitiveness through establishing synergistic relationship between MTUN members and the industry. MTUN consists of four universities that focus on technical-based research. They are Universiti Malaysia Perlis (UniMAP), Universiti Malaysia Pahang (UMP), Universiti Teknikal Melaka (UTeM), and Universiti Tun Hussein Onn Malaysia (UTHM). These universities are young public universities (below 12 years of age) that have been upgraded from University College status in mid-2000 (MOHE, 2012).

The establishment of MTUN was inspired by the Australian Technology Network (ATN), which consists of five Australian universities: (1) Queensland University of Technology in Brisbane; (2) Curtin University in Perth; (3) RMIT University in Melbourne; (4) University of South Australia in Adelaide; and (5) University of Technology in Sydney. Besides being listed in the top 50 world-class ranking, ATN members collectively had 80% of their research at the world standard and had increased their world-class research groupings by 30% in 2012 (ATN,

2013). These accomplishments show the role of networking and collaboration within the network in support of their operations. By using ATN as its model, MTUN hopes to emulate ATN success and strengthen the university-industry networks among MTUN members (MUCET, 2012) for research commercialisation purposes.

The Malaysian Government has undertaken an initiative to boost innovation and commercialisation activities within MTUN universities by developing a dedicated Centre of Excellence (CoE) for Advanced Engineering and Applied Sciences. This centre is owned and governed by a consortium of MTUN members. The function of MTUN CoE is to synergistically combine the experts in all MTUN universities to facilitate the accomplishment of the national innovation agenda. In order to execute the MTUN CoE implementation, each member of MTUN develops a research cluster in its university on some niche areas. Members of the research cluster are specific area experts in MTUN universities. They decide whether to collaborate with each other either through cross-universities collaboration or through cross-disciplinary research project (MUCET, 2012).

The preliminary investigation at MTUN universities had revealed that they faced low commercialisation rate problem at the university level (A. Shaaban, personal communication, March 19, 2012; M. Khalil, personal communication, April 13, 2012). The researcher had interviewed two research management centre officers employed at the MTUN universities. From the interviews, the researcher found that there are many factors associated with the problem of commercialisation rate. These include university management, local government, TTO, and industry. There were also problems with the motives of academic researchers in commercialising their research results.

This study focused on academic researchers at MTUN universities to understand their motivation factors in commercialising their research results. By focusing on the academic researchers, this study acknowledges the importance of this group of people in research commercialisation ecosystem (Ismail, 2013), especially within MTUN universities that tend to receive lesser amount of research funding from the government, unlike research universities. In this context, it becomes more imperative to study their motivation in realising the government's R&D commercialisation objectives.

1.1.5 Academic Research Commercialisation

Academic research commercialisation activities focus on the research commercialisation activities at the individual level rather than at the university level. Academic researchers are the heart of a university's research commercialisation because they are the ones who embark on a research project until the research product is successfully commercialised. Research commercialisation is the final phase in the complex innovation or technology transfer process. The number of researchers involved in a research commercialisation project is usually more than one as it entails a lot of work leading to the invention phase. The intellectual property right of the invention is usually registered under the name of the institution in which the research works are carried out. As the inventor, the project leader and his or her team are entitled to get royalty for the research project they are involved in. The amount of royalty they receive is mutually agreed with the university.

The process of transferring a university's invention to the industry for further development and commercialisation is called technology transfer (AUTM, 2012).

The process starts with a scientific discovery and ends with commercialisation activities (e.g., licensing, start-up formations). Figure 1.2 shows the involvement of academic researchers at all stages of innovation process. The technology transfer office (TTO) intervenes only after they have disclosed their inventions. The synchronisation between both parties makes the research commercialisation activities possible and successful. The TTO searches a potential industrial partner, and the academic researchers will support the TTO in closing the deals with the firm. Conclusively, the academic researchers' role is important in a successful technology transfer project (Siegel, Waldman, Atwater, & Link, 2004).

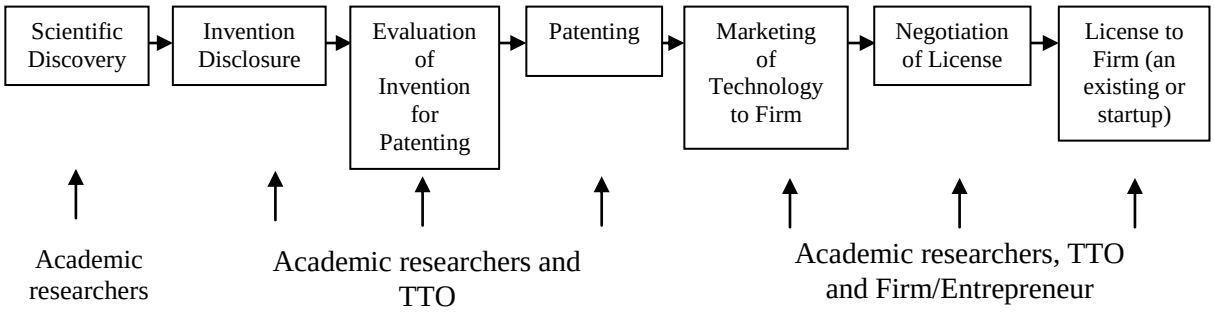


Figure 1.1
Technology Transfer Process and the Key Player(s)
Source: Siegel *et al.* (2003)

Vanaelst *et al.* (2006) emphasised that academic researchers as the 'key supplier' or the 'agent of research commercialisation'. It is crucial to conduct an in-depth study on the role of academic researchers as they are the ones who make the tactical decisions in commercialising their research results and in leading the directions of the research results (D'Este & Patel, 2007; Jensen, Thursby, & Thursby, 2003; Link, Scott, & Siegel, 2003; Siegel, Waldman, & Link, 2003).

1.2 Statement of the Problem

The Malaysian government has taken many initiatives to improve the research commercialisation rate in the country. In 2009, for example, they enacted the Intellectual Property Law as a notable step in facilitating academic researchers to protect their inventions from being imitated by others. The gazetted law also addresses the issues of wealth distribution for the inventors and the incentives for invention disclosures. The inventors might receive up to RM10,000 for each patent granted and a lucrative percentage out of the revenues garnered from an invention, which ranges from RM250,000 to RM5 million (MOSTI, 2009). The rewarding offers are worthwhile for those scientists as a payback for their years of hard work on their inventions. At the same time, the Ministry of Higher Education (MOHE) encourages university research commercialisation activities by tabling the National Higher Education Plan, which lists targeted outcomes on research commercialisation rate and other indicators, starting from 2007 (MOHE, 2007).

However, despite the various initiatives and incentives, the desired commercialisation performance is yet to be fully achieved. For example, the first phase of the MOHE's plan (2007–2010) had targeted a university research commercialisation rate of 5% by the year 2010. However, the actual rate reviewed was only 3%. The figure was alarming as the second phase target of the plan (2011-2015) is 8% (refer to Table 1.2). The actual rate suggests that academic researchers might not be motivated by only the external rewards but also other factors that have not been included in the Intellectual Property Policy.

Table 1.2
Targeted and Actual Research Commercialisation Rate based on Malaysia Plan

Malaysia Plan	Targeted Rate	Actual Rate
Ninth Malaysia Plan (2006–2010)	5%	3%
Tenth Malaysia Plan (2011–2015)	8%	?

Source: Malaysian Economic Planning Unit (2011)

Literature on academic research commercialisation indicates various factors that motivate commercialisation. These factors are external, internal, and prosocial. Prosocial motivation is defined as doing things for others. It is a crucial component in research commercialisation activities because the research outputs should benefit the society, whose taxes paid are generally used to fund a research project (Grant & Berry, 2011; Grant, 2008; Lam, 2011; Lindenberg, 2001) (refer to Table 2.1, page 52, to see the trends in the literature). However, literatures point out that that previous studies tended to give more focus on extrinsic motivation factors (Baldini, Grimaldi, & Sobrero, 2007; Göktepe-Hulten & Mahagaonkar, 2010) but less on intrinsic motivation factors and even lesser on prosocial motivation. Hence, focusing on different types of motivation seems to be a good avenue for research (Lam, 2011).

In the context of Malaysia, particularly MTUN universities, a question can be raised: 'What motivates academic researchers to commercialise their research results? Specifically, what has motivated academic researchers to successfully commercialise their research projects?' By giving focus on this group of researchers, this study can give an insight to policy makers on what has made some academic researchers successful in commercialising their research results, and recommend appropriate strategies on how to encourage research commercialisation activities.

1.3 Research Questions

In line with the problem statement, this study attempts to answer the following research questions:

1) How did the motivation factors encourage the successful academic researchers to commercialise their research results?

   (a) How were they extrinsically motivated?

   (b) How were they intrinsically motivated?

   (c) How were they prosocially motivated?

2) How did the mixed-motivation factors influence the successful academic researchers to commercialise their research results?

3) What were the motivating factors that boosted the successful academic researchers to commercialise their research results?

1.4 Research Objectives

In order to answer the research questions, the research aims:

1) To understand how the motivation factors encourage the successful academic researchers in commercialising their research results.

   (a) To understand the extrinsic motivation of those researchers in depth.

   (b) To understand the intrinsic motivation of those researchers in depth.

(c) To understand the prosocial motivation of those researchers in depth.

2) To investigate the mixed-motivation factors in motivating successful academic researchers to commercialise their research results.

3) To explore the motivating factors that boost up the research commercialisation activities.

1.5 Scope of Study

The aim of this research is to identify the motivation factors of academic researchers who have successfully commercialised their research results. The motivation factors considered in this study were extrinsic, intrinsic, and prosocial or a combination of these factors, called mixed-motivation factors. Academic researchers in the Malaysian technical universities in UTeM, UTHM, UMP, and UniMAP (namely the MTUN members) were studied. A research project typically involves team work. Some of the cases discussed involved more than one researcher in a team, while some cases had only one researcher (the project leader/inventor). Academic researchers in this study include university staff members employed by the university as well as students of the universities.

13 successful research projects from these universities were selected as cases for study. The data collection started in the beginning of October 2013 until January 2014. 'Successful research projects' in this study referred to the research projects that had successfully completed all the phases of the commercialisation process, from the scientific discovery phase to the product launching phase. In addition, the

commercialised research had generated some sort of monetary benefits to the university. The cases selected were based on data from the MOHE publication and the Research Management Centre of the universities.

This study did not cover the level of success of the products in the market or the success of the business involving the commercialised products. Also, other forms of impacts, other than the monetary benefit from the research commercialisation, including the impact of the research products on the university or the society, were beyond the scope of this study.

1.6 Definition of Key Terms

Technology transfer process

It is a long process that starts from scientific discovery until research publications and commercialisation process. In this process, the technology can be transferred using several means including paper publications, consultation, and commercialisation of the research results (Nelson, 2012). The process is considered successful when the technology is transferred from the technology provider to the recipient.

Research commercialisation process

A research commercialisation process is a part of the technology transfer process. It starts with the initial ideas to invent to the product until it successfully generates income for the university and benefit the target market. This process does not include paper publications, consultation, and contract research. The intellectual

property registered is considered a part of the process but not an end of the process as the registration does not generate money yet to the university. A research commercialisation process is a term is used to emphasise the commercial value of the process more in contrast to the term 'technology transfer process', which is more general and is not necessarily for profit making for the university.

Research commercialisation activities

Research commercialisation activities are defined as "taking an idea to an outcome – whether a product, service, process or organisational system to market by way of licensing, assignment, spin-off, or joint ventures" (MOSTI, 2009). These activities directly generate income for the university. Patenting is not considered a research commercialisation activity because it is only an indicator of intention to commercialise. Patenting does not promise commercialisation as not all patented products will be commercialised; some are kept in the shelves. Interestingly, the Malaysian Government provides monetary incentives with different amount to academic researchers who disclose their inventions, apply for and are granted with patents for their research products (MOHE, 2009).

Academic research commercialisation

The term 'academic research commercialisation' is used instead of 'university research commercialisation' to show that the study focuses on the people factor and not on the institutional factor. Moreover, the study did not intend to compare and contrast interuniversity or interpersonal research commercialisation performance.

Successful academic researchers

Successful academic researchers were the researchers who had their research results successfully commercialised. That is, the academic research projects have completed all phases in the research commercialisation process (Tornatzky & Fleischer, 1990), have been launched in the market, and have generated monetary return to the university from the commercialisation exercise. According to MOSTI (2009), a research product is commercialised once the income has been generated or the money goes into university's pocket.

Research results

Research results are the researchers' inventions or outputs from R&D activities, including the product, service, process, and organisational system. The invention ownership belongs to the university, regardless whether the research is funded by the government or private entities, which is in line with the Malaysia's National Intellectual Property Law 2009 (MOSTI, 2009).

Motivation factors

Motivation factors are the motives or goals or reasons academic researchers commercialise their research results. There were three types of motivation factors examined in this study, i.e. extrinsic, intrinsic, and prosocial motivation. This study did not cover other motivation factors unless it emerged after the data collection phase.

Mixed-motivation factors

The term mixed-motivation is used to depict the collective relationship between extrinsic, intrinsic, and prosocial motivations (Benedetti, 2012). It can be the mix of

any two factors or the mix of all three factors. The occurrence of the factors could be simultaneous or subsequent one after another.

Motivating factors

Motivating factors are factors that assist research commercialisation activities, such as the government roles, TTO intervention, and peer effects. Other factors are internally driving research commercialisation are socio-demographies and personal traits.

1.7 Significance of Research

This study is significant theoretically and practically. From the theoretical view, this study enriches the literature particularly on prosocial motivation on academic research commercialisation. Unlike extrinsic and intrinsic motivation factors in the academic research commercialisation literature, prosocial motivation is not well understood because it has been largely ignored in this realm. In addition, the study contributes to the literature by considering the role of mixed-motivation factors in encouraging academic research commercialisation, especially in the context of MTUN universities

In addition, this study applies qualitative case study method, which differs from the previous quantitative method in this field. Qualitative method is used to investigate in-depth a complex phenomenon such as the motivation factors of academic research commercialisation. In essence, this research is a good platform to 'listen' to the voice of the academic researchers with regards to what had motivated them to commercialise their academic research through face-to-face interviews. Only

by understanding their voices that policy makers will be able to get some useful insight into what needs to be done to boost academic research commercialisation, which will subsequently benefit not only the industry but also the whole society.

1.8 Organisation of the Thesis

Chapter One of this thesis presents the background of the study, including the research commercialisation phases in the global context as well as in Malaysia. It also details out the statement of problems, research questions and objectives, definition of key terms, and significance of research. Next, Chapter Two starts with an overview of a university's research commercialisation activities, the importance of people factor in academic research commercialisation activities, the researchers' motivation factors, the underpinning theory, and the proposed conceptual framework in the study.

Then, Chapter Three discusses the research questions and strategies, data collection procedures, and data analysis. Subsequently, Chapter Four presents the research findings, and Chapter Five wraps up the study with a discussion, recommendations, and avenues for further studies. The final section is the conclusion of the whole study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents an overview of issues in research commercialisation. Then, it discusses different motivation factors in research commercialisation. The motivation factors include extrinsic, intrinsic, and prosocial. Finally, the underpinning theory used to explain motivation and behaviour is explained and a conceptual framework is proposed at the end of the chapter.

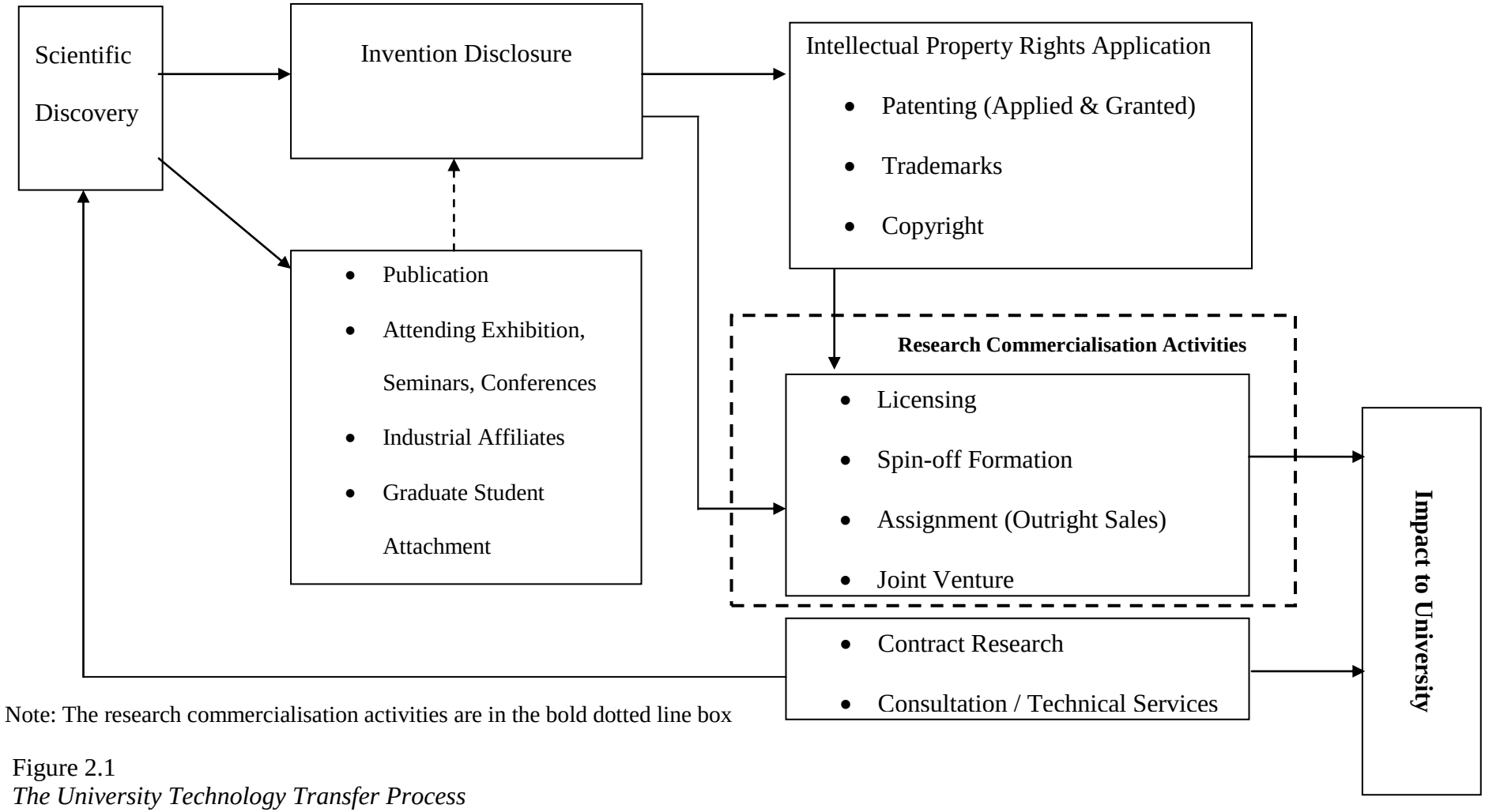
2.2 University Research Commercialisation

Decades earlier, scientists were not concerned with selling or protecting their inventions but they were keen to share them with their fellow scientists. Then, the best reward for them was recognition from the scientific communities, and not monetary reward. Later, the attitude began to change. The success of technology used during the Cold War and the wars on diseases prompted the US government to turn to inventions of university scientists as a way to survive in a globalised economy. This was the starting point in which universities began to indirectly commercialise their research results (Merton, 1957; Slaughter & Rhoades, 1996; Walsh & Hong, 2009).

In the USA, in particular, the Bayh-Dole Act was enacted in December 1980 to facilitate universities in retaining intellectual property and granting exclusive licenses of federally funded inventions to private firms. The act also provides

guidelines in giving incentives and facilitates academic commercialisation in transferring university technology to the industry partners. The act also specifies that universities are to give licensing preference to small businesses (Audretsch & Aldridge, 2009; Mowery, Nelson, Sampat, & Ziedonis, 2001). Since then, other countries including Japan, Italy and some in Europe, started to enact Bayh-Dole-like acts to speed up commercialisation rate of university's inventions in their countries (Grimaldi, Kenney, Siegel, & Wright, 2011).

Research commercialisation activity is a part of a comprehensive technology transfer process (refer to Figure 2.1). Agrawal and Henderson (2002), Nelson (2012), and Yaacob (2011) emphasised the inclusion of myriad technology transfer channels rather than focusing only on patenting, licensing, and spin-off formations such as publication activities, networking sessions (exhibition, seminars, and conferences), graduate student attachment, public lectures, consultations, and contract researches. While these activities are vital routes for research commercialisation, this study defines research commercialisation as "taking an idea to an outcome – whether a product, service, process or organisational system to market by way of licensing, assignment, spin-off, or joint ventures" (MOSTI, 2009). In a layman's term, it is an activity that generates a monetary return from each ringgit the government has spent for a research project.



Note: The research commercialisation activities are in the bold dotted line box

Figure 2.1
The University Technology Transfer Process
Source: Compiled by the author from several articles.

2.2.1 The Advantages of Research Commercialisation Activity

Since university researchers are already occupied with diverse responsibilities of teaching, research, and publication, some begin to question whether commercialisation of research results will add to the existing workload. However, there is evidence that research commercialisation activity offers additional benefit to them. Previous researches showed that research commercialisation did not substitute but complement the academic activities already done by academics (Crespi, Este, Fontana, Geuna, & D'Este, 2011; Larsen, 2011; Perkmann *et al.*, 2013; Van Looy, Callaert, & Debackere, 2006). Commercialising researchers also tended to publish more than their colleagues and admitted that the patenting activity helps them to improve the quality of their future research works (Perkmann *et al.*, 2013). Zucker and Darby (1996) referred to extraordinarily productive scientists who have discovered more than 40 genetic sequences or written more than 20 articles on genetic sequences discoveries as "star scientists". Star scientists also tend to be involved actively in commercialisation activities. In general, commercialisation activities enable researchers to enhance their work and hence career (Crespi *et al.*, 2011; Geuna & Muscio, 2009; Larsen, 2011).

Commercialisation activities also benefit other stakeholders than the academic researchers themselves. Instead of relying on government fund, revenues that are generated from a research commercialisation activity can be used to finance future academic research works. The revenue is also a testimony that the university is giving back to the society by offering better products and services as well as generating job

opportunities and wealth (Carayol, 2003; Markman, Siegel, & Wright, 2008; Owen-Smith & Powell, 2003; Van Looy *et al.*, 2006).

There are many commercialised university technologies that are benefit the public. AUTM, which is headquartered in the US, publishes *The Better World Report* to deliver the message that university research has succeeded in benefiting people around the globe. From agriculture to software and veterinary science, from the Internet to nicotine-patch, AUTM has shown that the government money spent on academic research was a wise investment (AUTM, 2008). In 2012, AUTM reported that the US universities gained income from licensing activities, which amounted to USD 1.8 billion of 57 reporting institutions. The number of patents issued to the institutions rose by 7%, i.e. to 4,296 from 4,018, and the number of start-up companies that emerged from their research products increased to 617 companies as compared to 613 companies (AUTM, 2012).

2.2.2 The Disadvantages of Research Commercialisation Activity

Although commercialisation activities seem to produce positive consequences, they are not without drawbacks. One of the drawback pertains to scientific secrecy (Larsen, 2011; Perkmann *et al.*, 2013; Walsh & Hong, 2009). As more discoveries are made, more scientists begin to engage in scientific secrecy. Scientists nowadays are more secretive in what they do and share less information with other people. This may be because they are concerned that someone may steal their ideas to commercialise them first. Take the case of Paul Chu, a Chinese-American physicist who altered his own scientific formula in his article and then sent it to a journal publisher in 1980 for a

possible submission. He did this because he thought that the journal reviewers could also be his potential competitors. However, Chu submitted the correct formula in his final submission of the article (Gleick, 1987).

Some scholars are reportedly reluctant to disclose their research findings before they are published. Some even refuse accessibility to their original data, or refuse to share useful materials (i.e., the instruments used) for other scholars' reference (Larsen, 2011). Such actions have several negative implications. If the same research topic is pursued by two or three different teams, this leads to a waste of resources. Such behaviour also discourages collaborative learning and knowledge sharing. As a result, the dissemination of the knowledge will be limited thus causing the sluggish "progress of science as a collective effort" (Walsh & Hong, 2009). Such secretive behaviour also may cause some publication delay problems as the industry partner will ask the researchers to delay publications concerning to patenting issues (Walsh & Hong, 2009).

The secrecy issue is very much related to scientific competition (Stephan, 2008; Walsh & Hong, 2009). Scientists compete with each other for prestige, funding, as well as positions. For these recognitions, a competitive culture and environment may ensue. Scientific competition is not only at the individual level, but also at the institutional level. For example, in Malaysia, a university competes with other universities to get more funding from the Ministry of Education. In a developing country like Malaysia, researchers are required to fulfil individual Key Performance Indicators (KPIs). To increase their publication targets, unethical behaviours may be resorted to. Some may request their names to be included in a publication even if they

do not make substantial contribution to the academic work. The term "ghost riders/free riders" is appropriate for such people (Vikneswaran, 2011).

Research commercialisation also suffers from academic freedom. Some research works are dictated by industrial partners and market demands. When this happens, they are no longer neutral in their academic stance. Such collaboration may also limit their ability to commercialise their research results because they have to fulfil the demand of the potential licensee of the technology (Tartari & Breschi, 2012). According to Behrens and Gray (2001), there are two types of academic freedom that researchers have to deal with. The first is freedom in communicating research, and second is freedom in conducting research. The first type of academic freedom is almost the same with the secrecy issue, while the second one concerns with the selection of types of research, either basic or applied research. A research commercialisation activity may create a tendency for academic researchers to engage in applied researches (Behrens & Gray, 2001; Davis, Larsen, & Lotz, 2009; Lee, 1996). Moreover, they tend to publish in application-oriented journals rather than scientific-oriented ones (Van Looy *et al.*, 2006). Even though applied research works generate income for the university, they do not contribute much towards the academic culture as compared to basic research, which involves inventing or discovering new knowledge. Unlike basic research, applied research focuses on solving current problems (Walsh & Hong, 2009).

Finally, a growing research commercialisation activity might lead to a decline in patent's quality. The patenting policy (i.e., Bayh-Dole act) has led to a paradox; even though there has been an increase in patenting activities, there has also been a decline in the patents' quality. The quality of a patent can be measured by the number

of citations. When patenting activity becomes one of the key performance indicators for academic researchers, they will patent their products regardless of whether they are of quality or have questionable values (Jensen *et al.*, 2003; Link *et al.*, 2003). Inexperienced researchers will create unimportant inventions for the sake of funding (Czarnitzki, Hussinger, & Schneider, 2011; Lissoni, 2012).

2.3 Research Commercialisation Ecosystem in Malaysia

Malaysia aims to achieve a developed country and high-income status by 2020. The Malaysian government has seriously engaged in research and development (R&D) activities since the launching of the first Science and Technology Plan in 1986. Since then, annual new development plans along with their allocated budgets are announced. The Plan also talks about commercialisation activities, as way for the country to generate income. To boost the commercialisation rate in the country, cooperation between all parties in the country is needed.

Professor Asma Ismail, a prominent researcher who has successfully commercialised her research product to be sold around the world, noted that Malaysia is going toward an innovation-led economy (Ismail, 2013; MOHE, 2010). To achieve this objective, an innovative society should be nurtured by considering four important elements as specified in the Quadruple Helix Model (QHM). This model depicts the collaboration between four important components in the ecosystem. They are government, industry, ventures, and education. The result of such collaboration is an innovative society, i.e. the overlap of the components (refer to Figure 2.2).

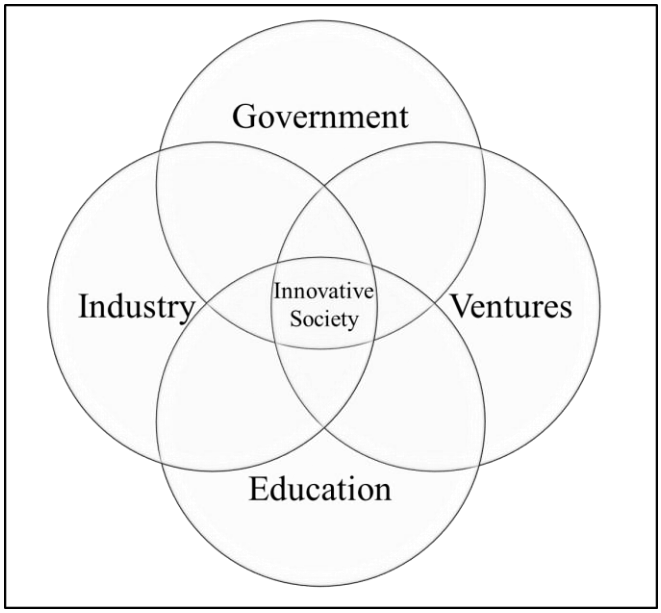


Figure 2.2
Key Components of the Right Ecosystem for an Innovative Society
Source: Malaysian Ministry of Higher Education (MOHE, 2010).

2.3.1 The Government

In the ecosystem, the government plays a significant role in encouraging research commercialisation activities as they oversee the whole process. The government develops comprehensive innovation plans and policies towards an innovation-driven economy. For the plans and policies to work, they also need to institute some controlling mechanisms. One of them is by coordinating activities of relevant agencies and institutions. The allocation of resources including manpower and finance is also the responsibility of the government. To ensure there is qualified and enough supply of manpower, education plays an important role.

Figure 2.3 shows who are involved and what kind of funding is available in the process of commercialisation, starting from an idea inception stage until its

commercialisation stage. The agencies involved in each stage are denoted within the parentheses.

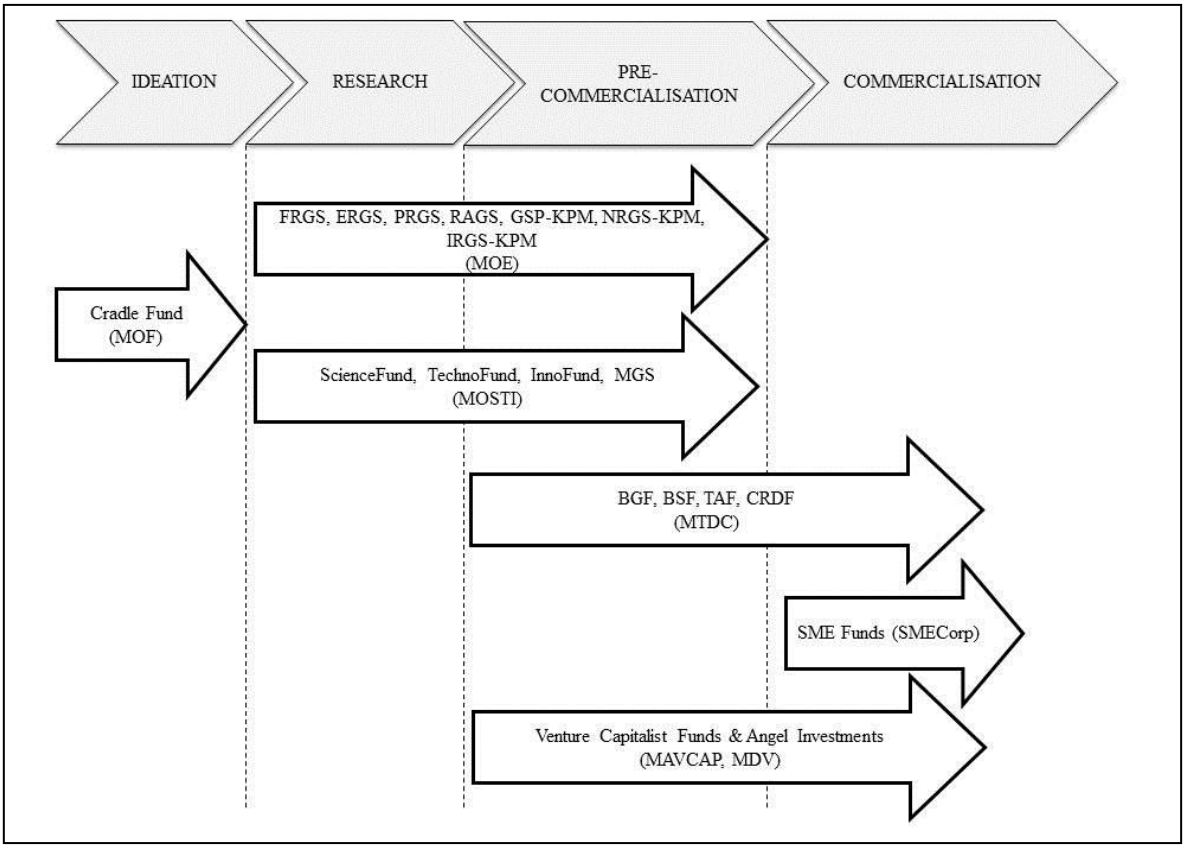


Figure 2.3
Funding for Research, Development and Commercialisation in Tenth Malaysia Plan
Source: Ministry of Science, Technology, and Innovation (MOSTI, 2013).

In addition, the government organises programs to enhance public awareness and educates Malaysians to be innovative. Promoting Malaysian-made products and brands is one way to support the Malaysian industries. To protect Malaysian inventions, protecting the intellectual property rights (IPR) of the products/processes is key to encourage inventions. The judiciary system is expected to play its role in this regard. Developing an effective system for an IPR application and approval is also necessary in developing a culture of innovation in the country.

2.3.2 The Industry

Industry refers to the private sector organizations in Malaysia. It ranges from big multinational companies (MNCs) to small and medium enterprises (SMEs) that may benefit from a university research. The industry can sell the immediate technology or product produced by a university, or it can collaborate with it to develop a specific technology or product. In the latter, the IPR for the product is normally shared. With such partnership/venture, industry players can become mentors to a university in matters related to commercialisation by providing the necessary technical assistance and financing.

One of the issues in commercialisation is encouraging industry players to participate in commercialising local technologies (MOHE, 2010). It is claimed that the MNCs, in particular, are keen in using products/technology produced by universities in their home country. The challenge is how to encourage them to use local technologies also in their operations.

2.3.3 The Venture

The venture component concerns most with entrepreneurial and financial activities (MOHE, 2010). Entrepreneurial skills are an important component to ensure that commercialisation is achieved. This means that researchers should be innovative, have vision, take calculated risks, energetic and persevere in their research work. More importantly, they need to be able to study their environment that creates opportunity for innovation. Taking ideas from various disciplines, for example, is one trait of entrepreneurship. The venture component also means that there is a need for

an integrated management system that deals with all stages of commercialisation process starting from idea incubation to IPR and product/technology use for cost efficiency.

2.3.4 The Education

The last component of the ecosystem is education. This component serves as the bedrock of the ecosystem because through education, human capital (e.g., researchers, scientists, engineers and entrepreneurs) is supplied. Human capital serves as the initiator of a research project and the main actor in any research commercialisation activities (AIM, 2011; Lam, 2011; MOHE, 2010; Vanaelst *et al.*, 2006). So this purpose, a good, quality education system is imperative.

Within the education system, the management of an education institution has an important role in developing a culture that promotes and encourages innovation. At higher education institutions, the management needs to facilitate commercialisation through its Technology Transfer Office (TTO) and Research Management Centre. Exposing local researchers to foreign technologies by participating in various exhibitions and conventions is one way to promote innovative minds and creative ideas. At these international exhibitions, showcasing local technologies and products can be effective in further enhancing the innovative spirit of local researchers and scientists.

2.3.5 Innovative Society

When each component in the ecosystem plays its functions and roles well, an innovative society is created. An innovative society is made of individuals who are creative, innovative and entrepreneurial-minded. An innovation-led economy or innovative society is composed of five groups: (1) Discoverers, Inventors and Innovators who have good knowledge and skills in specific technical domains; (2) Transformers and Entrepreneurs, who have medium technical knowledge and skills but good at transforming research outputs to commercially-ready products; (3) Manufacturers, Providers and Funders, who have low technical knowledge and skills but very good at producing/providing/funding commercially-viable products and services; (4) Marketers and Communicators, who have low technical knowledge but have marketing and communication skills to the receptive consumers; and (5) Receptive Consumers, who are the end-users who create market for innovative products (MOHE, 2010).

2.4 Why Academic Researchers?

Literature indicates five key players in a research commercialisation process: (1) university management; (2) Technology Transfer Office (TTO); (3) local government; (4) industry; and (5) academic researchers (AIM, 2011; Markman, Gianiodis, Phan, & Balkin, 2004; Rothaermel *et al.*, 2007). Even though each player has a distinct set of roles, academic researchers are central to the technology transfer process because they make the strategic decision on how to commercialise their research results best.

Moreover, as discussed in Section 2.3.4, they are the source of innovative human capital (MOHE, 2010).

Academic researchers play the most important role in a research process because they are the ones who initiate a research exercise and produce a research result. They then apply for a product prototype to be patented or licensed. In a research commercialisation activity, they are the 'key supplier' in a technology transfer process because they have to disclose their inventions to TTOs (Link *et al.*, 2003; Siegel *et al.*, 2003, refer to Figure 1.1). If they do not disclose their inventions, the research commercialisation process cannot proceed. As agents of a university administration, they bring in revenues to the university in return for the research fund given (Jensen *et al.*, 2003).

The researchers' role is not limited to invention disclosure only; their participation is important throughout the commercialisation process. They need to build a good relationship with the industry players to ensure a smooth research commercialisation activity. Besides helping the TTO to find licensees, they have to work on further development of the technology once the licenses have been granted. As most newly licensed technologies are at the early stage of development, which means a prototype is not yet available or the prototype is at the lab scale only (Geuna & Muscio, 2009; Markman, Phan, Balkin, & Gianiodis, 2005; Thursby, Jensen, & Thursby, 2001), strong support from the researchers at this stage is needed.

This study focuses only on academic researchers who have successfully commercialised their research projects.

2.5 Researchers' Motivation Factors

Researchers' motivation in research commercialisation activities has begun to receive scholarly attention (Baldini *et al.*, 2007; Baldini, 2010, 2011; Göktepe-Hulten & Mahagaonkar, 2010; Lam, 2011; Sauermann & Roach, 2012; Tartari & Breschi, 2012). Bland and her colleagues (2002) found that motivation was one of the important factors that contributed to academics' productivity. Ambos and her colleagues (2008) also asserted that individual motivation is vital in generating commercially potential outputs. In addition to motivation, institutional factors have been found to influence academic research commercialisation activities (D'Este & Patel, 2007; Göktepe-Hulten & Mahagaonkar, 2010). Even though literature on researcher's motivation is expanding, there is still room for further research (Baycan & Stough, 2013; Markman *et al.*, 2008; Rothaermel *et al.*, 2007).

According to Deci and Ryan (2000), there are two types of motivation that drive people's behavior. They are extrinsic and intrinsic motivation. Extrinsic motivation is driven by external factors, while intrinsic motivation is innate-driven or internal to the person him/herself. According to Grant and Berg (2010), there is another type of motivation, which is prosocial motivation. It is defined as aspiration to assist other people. Prosocial motivation can be extrinsically or intrinsically driven. This study considers only these three types of motivation factors.

2.5.1 Extrinsic Motivation

Extrinsic motivation is external factors that drive people's behavior. An example of an external factor is pecuniary and non-pecuniary rewards (Amabile, Hill, Hennessey,

& Tighe, 1994). Pecuniary or financial rewards for academic research commercialisation activities include personal earnings, royalty payments, salary increment, commission, prize money, and consulting and speaking fees. In the Malaysian academia, researchers receive patent royalties and get monetary incentive for publishing academic papers.

Today, academic science has become a vehicle for commercial activity. Curiosity of scientific research becomes a less important factor than marketability and applicability (Walsh & Hong, 2009). The incentivising culture at the university is often needed to attract researchers' involvement in commercialising the embryonic technologies from the lab to the market. These daunting tasks are worthwhile at the expense of handsome monetary rewards for the academic researchers (Geuna & Muscio, 2009; Jensen & Thursby, 2001; Markman *et al.*, 2008). Studies show a positive relationship between financial rewards and academic research commercialisation (Jensen *et al.*, 2003; Lach & Schankerman, 2008; Owen-Smith & Powell, 2001; Thursby *et al.*, 2001).

Recent research seeks to explore personal motive behind academic entrepreneurialism. That is, do researchers commercialise because of performance assessment, i.e., Key Performance Index (KPI) or because of entrepreneurial mind (Baldini *et al.*, 2007; Fini *et al.*, 2009; Göktepe-Hulten & Mahagaonkar, 2010; Ismail, Omar, Aziz, Soehod, & Ghani, 2012)? To encourage commercialisation, policy makers should revisit the assessment procedure. Currently, publication is given the same merit as commercialisation even though the volume and degree of work involved is not the same. If this continues to happen, then academic researchers will

focus more on publication than on commercialisation (Baycan & Stough, 2013; PriceWaterHouseCoopers, 2007).

Career rewards are also an appealing factor. This factor includes intangible returns such as reputation, job promotion, and prestige to expand research careers of the researchers. Decades ago, scientists rushed for the recognition of their discovery. The best reward was when they were heading anyone else. To some extent, 'winning the game', which means they were the winner and everybody else was the loser (Stephan & Levin, 1992). Mertonian ethos introduced the 'priority-recognition reward system' that encourages scientists to share their findings and contribute to the body of scientific knowledge (Merton, 1957). However, the economics of science has driven academics to cash-in their career rewards for money. The prize money won normally is "several years' salary [that] come at once" (Bains, 2005; Lam, 2011; Stephan & Levin, 1992; Stephan, 1996).

However, other studies found that financial rewards are not the only motive that drive academic researchers. Some researchers prefer to get access to industry resources than monetary incentives. These resources include additional research funds, sponsored research, industry facilities (i.e., laboratories and equipment), and skills from the industry (Baldini, 2010, 2011; Colyvas *et al.*, 2002; Markman *et al.*, 2004). Access to these resources enable them to develop their research and hence career further (Bengtsson, Nilsson, & Rickne, 2009; D'Este & Perkmann, 2010; Fini *et al.*, 2009).

Additional research funds can be acquired in the form of joint publications, training, contract R&D, joint R&D, consultancy, technology licenses, patents, and

hiring university graduates (D'Este & Patel, 2007; De Fuentes & Dutrénit, 2012; Geuna & Nesta, 2006; Morandi, 2013; Nilsson, Rickne, & Bengtsson, 2010; Tartari & Breschi, 2012). In addition, some universities include sponsored research term in a license. This is because the licensed technology is still at the early stage that requires more funds for further development. In this context, the academic researchers have a say in deciding how much more fund is needed for the TTO to negotiate with interested takers (Jensen *et al.*, 2003; Powell & Owen-Smith, 1998; Thursby *et al.*, 2001).

Besides research funds, academic researchers may utilise industrial facilities such as a company's equipment and laboratories in their research, as specified in the contract research or joint research agreement. When the company does not have its own laboratory facilities, it may purchase necessary equipment for the university's laboratories (Baldini, 2011; Bozeman *et al.*, 2013; D'Este & Patel, 2007; Fini *et al.*, 2009). Academic researchers are also attracted to access to special industrial data, which can be highly confidential. Building network with industry players is also an important motivation because they can be a valuable source of idea for commercialisation due to the former's practical experience (Boardman & Ponomariov, 2009; D'Este & Patel, 2007).

2.5.2 Intrinsic Motivation

Even though university management generally seeks to generate income out of commercialisation activities, such motivation is not necessarily shared by academic researchers. Rosenberg (1974) suggests that university scientists are "independent

from economic needs". Some academic researchers are genuinely motivated by the accomplishment of their research – from the prototype to the end-product, and from the lab to the end-user (Göktepe-Hulten & Mahagaonkar, 2010; Thursby & Thursby, 2002). In this context, what drives these researchers are intrinsically driven because they commercialise their product because they enjoy and are satisfied for doing so (Amabile *et al.*, 1994; Lindenberg, 2001).

Intrinsic motivation is a classic term in motivation theories, and it has been used in other fields of research including education, parenting, and work productivity (Deci & Ryan, 2000; Grant, 2008; Lindenberg, 2001). There is not much literature discussing intrinsic motivation factors on academic research commercialisation as compared to extrinsic motivation.

Doing a piece of research is like solving a puzzle; even if the whole puzzle is not solved or if only part the puzzle is solved, playing the puzzle itself is already one precious reward (Lam, 2011; Stephan & Levin, 1992). In other words, doing a piece of research is a passion, which keeps them going (Chang, Yang, & Chen, 2009; Ismail, 2008; Markman, Gianiodis, Phan, & Balkin, 2005; Miller, McAdam, Moffett, & Brennan, 2011; Thakor, 2009). So, intrinsically-motivated researchers will persevere in their commercialisation efforts (Stephan & Levin, 1992). Some researchers participate in a research activity because they are motivated to seeking the 'truth'. Some do so because of the love to expand knowledge and share it with the society. That is, they desire to put the new technology in practice or to see the utilisation of the invented technologies before their eyes (Fini *et al.*, 2009; Ismail, 2008; Perkmann *et al.*, 2013). When this happens, it is a sense of accomplishment for them (Bengtsson *et al.*, 2009; Ismail, Zaidi, Omar, & Majid, 2010). Commercialised inventions not only proof that the technology is applicable and practical to solve real-

life problems, but it is also a sign of the researchers' credibility and ingenuity (Baldini, 2011; D'Este & Patel, 2007; Perkmann & Walsh, 2009). Some high-spirited academic researchers even insist to form a spin-off instead of waiting for interested takers to commercialise their research results (Ismail, Majid, & Omar, 2011).

2.5.3 Prosocial Motivation

Prosocial motivation is different from intrinsic motivation and extrinsic motivation. Prosocial motivation sits in the middle of the two extremes, as it can be internalised in different degrees, unlike, for example, the intrinsic motivation that comes from the internal self (Grant & Berry, 2011; Grant, 2008; Lam, 2011). According to Grant and Berg (2010), prosocial motivation is an act of doing something with the desire to offer efforts to benefit others or with the intention of helping others. If a researcher is only intrinsically motivated, he/she sees the research "as an end in and of itself", and will not commercialise the result. But, having the prosocial motivation in mind, the researcher will try to commercialise the research results for the benefits of end users as well as to contribute to the economic development.

In his study, Grant (2008) showed the moderating effect of intrinsic motivation on the relationship between prosocial motivation and persistence, performance, and productivity. When the intrinsic motivation level of the employees was high, prosocial motivation was characterised as an identified regulation. Thus, the employees were likely to do work voluntarily. The study concluded that the synergy between prosocial motivation and intrinsic motivation may enhance persistence, performance, and productivity of the employees. In a later study, Grant and Berry

(2011) considered prosocial motivation to moderate the relationship between intrinsic motivation and creativity. From their study, they agreed that one who has been intrinsically motivated can come out with creative and novel idea, but it is not necessarily beneficial to others. Thus, in the context of this study, the presence of prosocial motivation may encourage researchers to come out with creative yet beneficial research product to others.

While intrinsic satisfaction motivates researchers to do their job, creative and novel ideas do not necessarily translate into commercialisation. Novel ideas are good when it has utility, i.e. it benefits other people. So, when researchers are prosocially motivated, they can produce an invention that is not only novel and unique but also useful (D'Este, Llopis, & Yegros, 2013; Grant & Berry, 2011). In other words, while intrinsically motivated researchers will not commercialise their results, prosocially motivated researchers will do so to benefit others (D'Este *et al.*, 2013; Grant & Berry, 2011; Grant, 2008). While it is reasonable to hypothesize that prosocial motivation enhances commercialisation, little empirical evidence exists to support the proposition. Hence, this an avenue for further research.

Some examples of amazing stories of how academic researchers help the general public by fulfilling their daily needs are recorded in *The Better World Report* (AUTM, 2008). These stories show how research commercialisation can be prosocially motivated, through researchers' understanding of others' difficulties, leading to their invention of a device or system that benefit the society. For example, some technologies were invented to help increase the industry's productivity (D'Este *et al.*, 2013). In Malaysia, a prominent academic researcher, Professor Asma Ismail (2013) promoted innovation as a way to benefit the country, *ummah* and humanity. In

her public lectures, she regularly urges researchers to offer something to the society especially to the bottom billion, who are still poor, starving, need a lot of assistance. Researchers, she said, should not focus their research products only to the 2 billion people in rich countries. By focusing the bottom billion market, it enables the academic researchers to solve the current and urgent problem of the *ummah* (society) (Ismail, 2013). The intention to benefit the *ummah* is in line with the prosocial motivation factors.

2.6 Researchers' Mixed-motivation Factors

Studies on the role of extrinsic motivation on academic research commercialisation are plenty (Baldini *et al.*, 2007; Colyvas *et al.*, 2002; Fini, Grimaldi, & Sobrero, 2009; Göktepe-Hulten & Mahagaonkar, 2010; Lach & Schankerman, 2008; Larsen, 2011; Markman *et al.*, 2004; Owen-Smith & Powell, 2001; Thursby *et al.*, 2001), in contrast to those that examined intrinsic motivation (Bengtsson *et al.*, 2009; Ismail, Omar, & Majid, 2011; Lam, 2011). This present research initiates a discussion on the third type of motivation, i.e. prosocial motivation, which is widely discussed in other fields but not in research commercialisation (Lam, 2011).

Whilst previous literature discussed the three motivation factors independently, scholars argued that an individual's behaviour could be driven by more than one motivation at a time (Diefendorff & Chandler, 2010). Even though there are literatures that combine two of them (e.g., intrinsic-prosocial, or intrinsic-extrinsic motivation) (Grant, 2008; Lam, 2010), limited studies combine the three in a single study (Benedetti, 2012). Benedetti (2012) highlighted that mixed-motivations

are examined in the field of organisational behaviour and human resource management. Other studies have also investigated the mixed-motivation factors in innovation and entrepreneurship (Bhaduri & Kumar, 2009; de Jong, 2006; Zbierowski, Weclawska, Tarnawa, Zadura-lichota, & Bratnicki, 2012). Because of the scarcity of research in examining mixed-motivations on research commercialisation (refer to Table 2.1), this study embarks on such attempt.

Table 2.1
Literature on Motivation Factors of Academic Research Commercialisation

Types of Motivation Studied	**Area/Field of Study**			
	Research Commercialisation	**Organisational Behaviour**	**Psychology**	**Innovation and/or Entrepreneurship**
Extrinsic Motivation	Baldini, Grimaldi, and Sobrero (2007); Baldini (2006, 2008, 2010, 2011); and D'Este and Patel (2007)	Andersen and Pallesen (2008)		
Intrinsic Motivation	-			Bird and Allen (1989)
Extrinsic-Intrinsic Motivation	Lam (2010, 2011); Jong (2006); Zbierowski *et al.* (2012); and Bhaduri and Kumar (2009)			Levin and Stephan (1991); and Stephan and Levin (1992)
Prosocial Motivation	-		Gagne and Deci (2005); and Sheldon and Gunz (2009)	
Intrinsic-Prosocial Motivation	-	Grant and Berry (2011); and Grant (2008)		
Extrinsic-Prosocial Motivation	-		Exley (2013); Warneken and Tomasello (2008); and Benabou and Tirole (2006)	
Extrinsic-Intrinsic-Prosocial Motivation	-	Benedetti (2012); and Diefendorff and Chandler (2010)	Forgeard and Mecklenburg (2013)	

Note: The literature table is not exhausted. It is intended only to show the gap in research commercialisation field of study.

2.6 Researchers' Motivating Factors

Besides the motivation factors in one's self, the academic research commercialisation is also being leveraged by the motivating factors. While motivation factors consider the goals of doing something, the motivating factors are the additional external factors that make the researchers feel motivated to commercialise their research results. The motivating factors are closely related to the motivation factors, and the former might influence people to go for the latter. For example, the Malaysian government provides incentives for the patent registered by the academic researchers. The academic researchers might be extrinsically motivated to commercialise as a response to the incentives (financial rewards). The subsequent sections will deliberate on some of the motivating factors in the literature.

2.6.1 Research Culture

One of the factors in the environment that promotes commercialisation is research culture. For academic researchers to commercialise their research results (Zhao, 2004), the university management is responsible to develop a supportive and conducive environment. For example, some universities build their own business incubators to nurture spin-off companies, such as the famous Silicon Valley and Route 128. The Technology Transfer Office (TTO) also plays a key role in this respect by managing research funds and acting as a middle person between the researchers and the management (Jensen *et al.*, 2003; Siegel, Waldman, Atwater, & Link, 2004). TTO assists the commercialisation process by informing researchers

about proper procedures (Bengtsson *et al.*, 2009; Göktepe-Hulten & Mahagaonkar, 2010; Jensen *et al.*, 2003; Thursby *et al.*, 2001).

A research university culture is different from a non-research university culture. Because research culture is more intense than the former, industry partners tend to collaborate with researchers in those universities (Bercovitz & Feldman, 2008; Perkmann, Neely, & Walsh, 2011).

2.6.2 Peer Supports

Peer support is a social context that facilitates commercialisation. Peers include faculty members and department leaders. Peer support helps researchers to learn and compete on how to commercialise (Ding, Murray, & Stuart, 2006; Krabel & Schacht, 2012; Tartari, Perkmann, & Salter, 2012). Peer support also comes in the form of knowledge sharing and dissemination. In addition, informal personal networking is crucial between researchers and industry for collaboration purposes (Bengtsson *et al.*, 2009; Bercovitz & Feldman, 2008; D'Este & Patel, 2007; Giuliani, Morrison, Pietrobelli, & Rabellotti, 2010; Göktepe-Hulten & Mahagaonkar, 2010; Haeussler & Colyvas, 2011; Nilsson *et al.*, 2010; Perkmann *et al.*, 2013; Ponomariov & Craig Boardman, 2007).

2.6.3 Government Policy

Government policy and initiatives also contribute to the acceleration of academic research commercialisation activities. Government sponsorship comes in the form of research grants and monetary incentives. Because commercialisation requires a huge

investment from developing the prototype until the product safely arrives at end-users, government support in the form of funding is important. Also, the monetary reward that comes as a result may personally motivate the researchers (Collier & Gray, 2010; D'Este & Patel, 2007; Geuna & Muscio, 2009; Göktepe-Hulten & Mahagaonkar, 2010; Thursby *et al.*, 2001).

As a regulator, the government should also provide an environment conducive to commercialisation activity. It can play a "championing behaviour" in that it becomes the first user of the research product produced by local researchers. Besides creating the market for the technology, such action may convince foreign investors to acquire the technology to be used in their countries as well (Behboudi, Jalili, & Mousakhani, 2011).

Every country has its own intellectual property (IP) policy. Different countries' IP policy may affect their research commercialisation rate. There are two different terms of ownership in the national IP policy around the world. They are: (1) university-ownership policy, in which the IP rights are given to the university or the inventor's employer with some portion of the revenues will be rewarded to the inventor; and (2) inventor-ownership policy, in which the IP rights are held by the inventors themselves, and they are not required to disclose their inventions to the university's TTO (AUTM, 2012; Agrawal & Henderson, 2002; Audretsch & Aldridge, 2009; Mowery, Nelson, Sampat, & Ziedonis, 2001).

The inventor-ownership model is applied to some European countries. The professors are entitled to the ownership of their own inventions, and they have no disclosure duty towards the universities (Lissoni, 2012). The model has created

problems including lesser revenues for the universities and inefficient patenting records for authorities to evaluate the universities' performance as well as non-systematic database for patent search (Baldini *et al.*, 2007; Lissoni, 2012; Czarnitzki, Hussinger, & Schneider, 2011). However, the model has its own advantage since the inventors themselves are free to select their own channel to commercialise and the industrial partners to collaborate in commercialising the inventions. The academics are free to register their inventions with any IP registrar outside the university. They are also able to make their own decisions without the university intervention (Baycan & Stough, 2013; Bengtsson *et al.*, 2009; Geuna & Nesta, 2006; Kenney & Patton, 2009; Lissoni, 2012). The academic researchers may also disclose their inventions to the TTO, whether the university's TTO or private TTO in order to get the best service (Kenney & Patton, 2009; Kumar, 2010; Okamuro & Nishimura, 2012).

2.6.4 Demographic Factors

Demographic factors can be defined as the quantifiable characteristics of a group. Demographic factors have been shown to relate to academic commercialisation activities.

The gender issue is widely discussed among scholars; with most of the studies found that males outnumbered females in research commercialisation activities. It was also found that female researchers tended to be risk-averse, dependent, and have fewer networks with the male-conquered industry partners. As a result, they commercialised less (Bozeman & Gaughan, 2011; de Melo-Martín, 2012; Ding *et al.*,

2006; Link, Siegel, & Bozeman, 2007; Rosa & Dawson, 2006; Stephan & El-Ganainy, 2007; Tartari & Breschi, 2012; Thursby & Thursby, 2005; Yaacob, 2011).

Age is also an influencing factor for researchers to commercialise. On the one hand, the senior inventors commercialise more during the last stage of their tenureship. They are motivated by societal welfare and society benefits to commercialise their research results. They have vast experiences and credentials in collaborating with industry partners. The industry partners trusted them and will go for them to develop their new inventions (Baycan & Stough, 2013; Boardman & Ponomariov, 2009; Bozeman *et al.*, 2013; Geuna & Mowery, 2007; Ismail, *et al.*, 2011; Levin & Stephan, 1991; Tartari *et al.*, 2012; Wigren-Kristoferson, 2011).

"Science is a young person's game" (Stephan & Levin, 1992). On the other hand, young scientists commercialise more because they are energetic. They compete with each other for money and fame. They are more positive about academic entrepreneurship than their seniors. Young scientists can find their industrial partners or can collaborate with the seniors so that they will learn things from the expert (Bercovitz & Feldman, 2008; Boardman, Ponomariov, & Craig Boardman, 2009; D'Este & Perkmann, 2010; Mathew & Chakraborty, 2012; Perkmann *et al.*, 2013; Stephan, Gurmu, Sumell, & Black, 2007).

Moreover, a research field may also influence research commercialisation. While physical scientists patent their inventions to get access to industry facilities, life scientists patent their inventions to attract industry partners to develop their inventions, mostly drugs (Owen-Smith & Powell, 2001). However, academic researchers involved in cross-disciplinary research are more likely to commercialise

their research results because of the scientific breadth of their research. The multi-disciplinary research might lead to highly potential inventions to be commercialised, which are not only technically and operationally good but also beneficial to end-users (D'Este, Mahdi, Neely, & Rentocchini, 2012; D'Este & Patel, 2007; Yaacob, 2011).

2.6.5 Research Excellence and Track Records

Some academic researchers believe in the traditional academic norms and open science, and they are against the research commercialisation activities (Dai, 2007; Lam, 2010, 2011; Merton, 1957). However, a number of academics believe that research commercialisation activity is one of their responsibilities that will contribute to their career performance. The "star scientists" are the living proof on the productive academic researchers who are actively involved in commercialising and publishing activities at the same time. They also hold administrative position in the university. This shows that there is no conflict between these two activities (D'Este *et al.*, 2012; Lissoni, 2012; Thursby & Thursby, 2002; Van Looy *et al.*, 2004, 2006).

Some researchers refuse to disclose their inventions because they are afraid with the commitment along the commercialisation activities. This will result in patenting low-quality inventions as there are a few inventions disclosed to the TTO, and the TTO just accept all the inventions in order to fill up the quota (Czarnitzki *et al.*, 2011; Markman *et al.*, 2008; Perkmann, King, & Pavelin, 2011). Researchers needed to have good knowledge and awareness of research commercialisation procedures. Commercialising activity is a more difficult and long process as compared to publishing books and articles and presenting research papers at academic

conferences (Baldini *et al.*, 2007; Heng *et al.*, 2012; Ismail *et al.*, 2012; Jensen *et al.*, 2003; Jensen & Thursby, 2001; Thursby & Thursby, 2004).

Individual track record shows researchers' past experiences and their personal networks with the industry. Past experiences may encourage the researchers to become entrepreneurs, leaving the comfort zone in academia to the challenging world of entrepreneurship, and the industry collaboration experience will make the researchers invent more usable products to the end-users, not merely to become on-the-shelves inventions. Furthermore, the industry personnel are more attracted to engaging with the experienced academic researchers than the novice ones. In addition, informal personal networking is crucial between the researchers and industry to collaborate without hassle (Bengtsson *et al.*, 2009; Bercovitz & Feldman, 2008; D'Este & Patel, 2007; Giuliani, Morrison, Pietrobelli, & Rabellotti, 2010; Göktepe-Hulten & Mahagaonkar, 2010; Haeussler & Colyvas, 2011; Nilsson *et al.*, 2010; Perkmann *et al.*, 2013; Ponomariov & Craig Boardman, 2007). Conclusively, an academic researcher with a good individual track record is a catalyst for the research commercialisation activities.

2.7 Underpinning Theory

This section discusses on the underpinning theory in this study. The study is based on motivation theories to answer the research questions and objectives. The theories are used to underpin the conceptual framework developed at the early stage of the study.

2.7.1 Personal Motivation Theories

Since 1950, motivation theories on how to increase employee productivity have emerged. A group of theories focuses on individual needs. The famous Maslow's theory of needs proposes five levels of human needs that individuals wish to fulfil. They are physiology, safety, belongingness, self-esteem, and self-actualisation. Maslow argued that for the higher order needs to be fulfilled, the lower order needs have to be satisfied first.

Another needs theory is Alderfer's ERG (existence-relatedness-growth) theory. Alderfer classified needs into three categories: (1) growth needs (development of competence and realisation of potential); (2) relatedness needs (satisfactory relations with others); and (3) existence needs (physical well-being). Both Maslow's and Alderfer's theories argued that everyone has to be treated differently according to his needs at present.

Herzberg's two factor theory, on the other hand, introduces two kinds of factors: (1) hygiene factors, whose absence motivates, but whose presence has no perceived effect; and (2) motivators, whose presence motivates, but it does not cause any particular dissatisfaction; it just fails to motivate. The hygiene factors determine dissatisfaction, and motivators determine satisfaction. The two scales are independent, and one can be high on both. Some scholars believe that money is not a motivation factor but a hygiene factor, as the absence or reduced amount of money will make employees feel threatened and their satisfaction level could turn down (Seligman & Csikszentmihalyi, 2000).

2.7.2 Self-Determination Theory

Unlike the theories of needs, self-determination theory (SDT) does not specify what motivational factors drive behavior; rather, it proposes motivations along a continuum. SDT postulates that human motivation fulfils three innate psychological needs: autonomy, relatedness, and competence. SDT argues that individuals behavior may be determined by internal or external constraints or controls (Deci & Ryan, 2000). In the context of this study, researchers engage in research commercialisation because of the following reasons: (1) to avoid punishment (external); (2) to seek others' approval (introjected); (3) to achieve a self-valued or personally important goal (identified); and (4) to experience fun or enjoyment (intrinsic). These motivations are located along a continuum ranging from external to intrinsic, and it is possible to form a motivational score (Deci & Ryan, 2000; Sheldon & Elliot, 1999; Sheldon *et al.*, 2004) (refer to Figure 2.4).

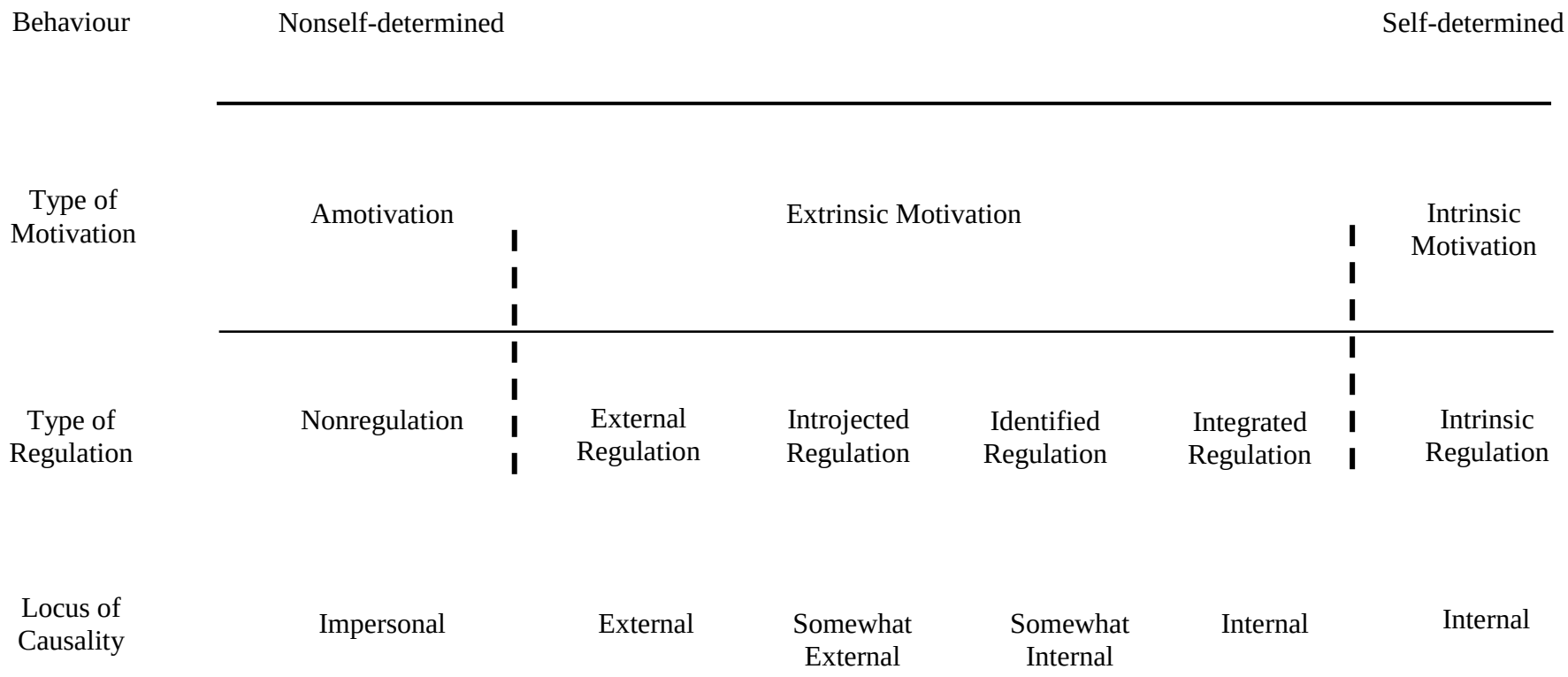


Figure 2.4
The Self-Determination Continuum
Source: Deci and Ryan (2000).

2.7.3 Self-Concordance Theory

This study uses self-concordance theory, an off-shoot from self-determination theory (SDT), as a more suitable theory to explain the phenomenon under study. Self-concordance is defined as the degree to which a task expresses an individual's interests and values (Deci & Ryan, 2000; Sheldon & Elliot, 1999). The theory argues that individuals will put more effort and better achieve their goals when those goals are naturally aligned with the person's interests and values. Goals that are more autonomously chosen are considered to be more self-concordant (Bono & Judge, 2003; Sheldon & Houser-Marko, 2001). Thus, individuals' reasons for acting range on a continuum from complete control by reward or punishment to full integration and internalisation (Bono & Judge, 2003)

Sheldon, Ryan, Deci, and Kasser (2004) found that the type of goal (autonomous or controlled) and motivation (intrinsic and extrinsic) shows significant main effects on life satisfaction, happiness, and a positive effect at within-person and between-person levels. Highly self-concordant tasks represent the individuals' authentic interests and values and as such are integrated with the self. The individuals want to achieve the task because it helps their own long-term goals. Moreover, the motivation is expected to be relevant for long periods and receive sustained effort over time. On the contrary, if the same assigned tasks are less self-concordant for the individuals, then they experience an external locus of control; the desire to task achievement is likely to fade when obstacles are encountered (Sheldon & Elliot, 1999).

In this study, the researcher hypothesizes that the motives for commercialising research results determine academic researchers' research commercialisation activities. If the academic researchers feel that commercialising their research may help achieve their own goals, they will be more motivated to commercialise. If commercialisation produces the desired result, they will keep on commercialising their product. For example, if an academic researcher wants to earn extra income for his/her family, he may strive in commercialising his R&D products. However, if there is no monetary incentives for him/her to so, he/she will not commercialise his/her product.

2.7.4 Proposed Conceptual Framework

The proposed conceptual framework for this study is developed based on literature reviews. This framework guides the development of a case study protocol (refer to Appendix A). Past studies relevant to the topic under study are considered in developing the protocol for each motivation factor (refer to Table 2.2). Some of the studies were conducted on research commercialisation, while others were from the fields of organisational behaviour and psychology.

Table 2.2

The Elements of Motivation Factors in the Conceptual Framework

Extrinsic Motivation	**Intrinsic Motivation**	**Prosocial Motivation**
1) Financial Rewards [i.e., royalty payments, monetary prizes, commission, and consultant fees] Geuna & Muscio, 2009; Hong & Walsh, 2009; Jensen *et al.*, 2003; Jensen & Thursby, 2001; Lach & Schankerman, 2008; Markman *et al.*, 2008; Owen-Smith & Powell, 2001; Thursby *et al.*, 2001	1) Sense of Accomplishment/Putting Technology into Practice Amabile *et al.*, 1994; Bengtsson *et al.*, 2009; Deci & Ryan, 2000; Grant, 2008; Ismail, Majid, *et al.*, 2011; Ismail *et al.*, 2010; Lindenberg, 2001; Thursby & Thursby, 2002	1) Benefits to the Society Andersen & Pallesen, 2008; D'Este *et al.*, 2013; Grant & Berry, 2011; Grant, 2008; Lam, 2011
2) Career Rewards [i.e., recognition, reputation, award and prize, KPI fulfilment] Bains, 2005; Baldini *et al.*, 2007; Fini *et al.*, 2009; Göktepe-Hulten & Mahagaonkar, 2010; Ismail *et al.*, 2012; Lam, 2011; Merton, 1957; Stephan & Levin, 1992; Stephan, 1996	2) Puzzle-Solving/Intellectual Curiosity 3) Love/Passion/Enjoy/Self-Satisfaction Baldini, 2011; Chang *et al.*, 2009; D'Este & Patel, 2007; Ismail, 2008; Lam, 2011; Markman *et al.*, 2005; Miller *et al.*, 2011; Perkmann & Walsh, 2009; Stephan & Levin, 1992; Thakor, 2009	
3) Getting Access to Industry Resources [i.e., additional research funds, sponsored research, skills and facilities from industries, data and feedback from industry to improvise future research works] Baldini, 2010, 2011; Bengtsson *et al.*, 2009; Boardman & Ponomariov, 2009; Bozeman *et al.*, 2013; Colyvas *et al.*, 2002; D'Este *et al.*, 2007; D'Este & Perkmann, 2010; De Fuentes & Dutrénit, 2012; Fini *et al.*, 2009; Geuna & Nesta, 2006; Jensen *et al.*, 2003; Markman *et al.*, 2004; Morandi, 2013; Nilsson *et al.*, 2010; Powell & Owen-Smith, 1998; Tartari & Breschi, 2012; Thursby *et al.*, 2001	4) Entrepreneurial Minds Bengtsson *et al.*, 2009; Fini *et al.*, 2009; Ismail, Majid, *et al.*, 2011; Ismail *et al.*, 2010; Ismail, 2008; Perkmann *et al.*, 2013	

Sources: Compiled by the author from the literature reviews.

According to motivation theories, extrinsic and intrinsic motivation are mutually exclusive. However, the third motivation, which is prosocial motivation, can be driven extrinsically or intrinsically. The Venn diagram is used to show the relationship between the three types of motivation. The Venn diagram comprises three overlapping circles. The overlapping interior of the circle symbolically represents the elements of the set, while the exterior represents elements that are not members of the set. The overlapping areas in this study are extrinsic-prosocial and intrinsic-prosocial motivations. For example, the first shaded overlapping area is the area in which prosocial motivation is extrinsically driven. It means the elements in that area belong to both prosocial and extrinsic motivation. The Venn diagram shows that academic researchers' motivation influences research commercialisation.

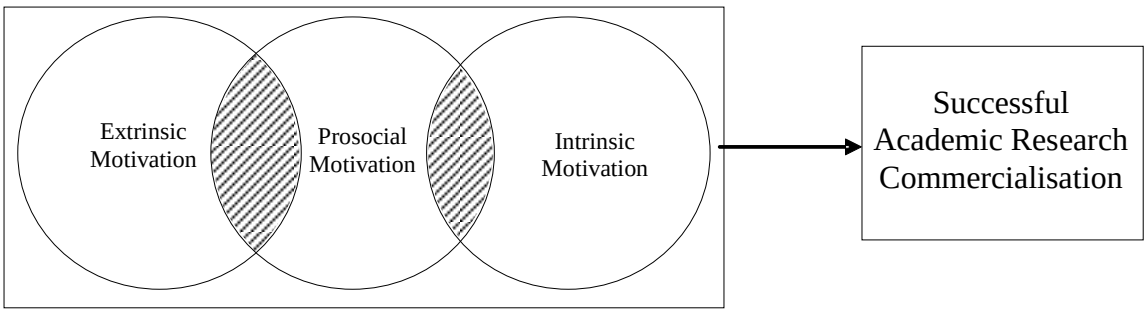


Figure 2.5
The Proposed Conceptual Framework

2.8 Chapter Summary

This chapter discussed the literatures related to academic research commercialisation. It elaborates how extrinsic, intrinsic, and prosocial motivation

drives academic researchers to commercialise their research results. Self-concordance theory is used to explain the researchers' motivation. A proposed conceptual framework that depicts the relationship between the three types of motivation was shown, and how they theoretically affect research commercialisation was shown. The subsequent chapter discusses the research method employed to answer the research questions.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the methodology employed in this research. It begins with a discussion of the research questions and strategies to answer them. Then, the chapter discusses qualitative case study method, including how the cases were selected. Next, the chapter explains data gathering and strategies of analysis employed. Finally, the chapter deliberates issues of research validity and reliability relating to qualitative research.

3.2 Qualitative Case Study

This study applied qualitative research method because it was the most appropriate strategy to answer the "how" questions. A qualitative research usually starts with a discussion on philosophical assumptions (refer to Table 3.1). The assumptions shape how the researcher formulates research problems and research questions as well as how the researcher seeks information to answer those questions (Creswell, 2012). The researcher has to understand the assumptions first before adopting a qualitative research design (Creswell, 2012; Merriam, 2009; Yin, 2009).

A case study research is used to illustrate the phenomenon being studied (Creswell, 2012). A case study can be defined as "an in-depth description and analysis of a bounded system." A bounded system means that there is a boundary for each case, while the term "case" refers to an in-the-box phenomenon in which the researcher can fence in the case that the researcher wants to study. A central

phenomenon is the “heart” of a case (Merriam, 2009; Yin, 2009). A case can be individual, organisation, community, programme, or system that depicts or illustrates the phenomenon in the natural setting.

Special features of case study approach include: (1) particularistic, which means it focuses only on a particular case; (2) descriptive, which means that the researcher produces a thick description of the case; and (3) heuristic, in that the case study helps readers to understand the phenomenon under study, which in this research was the motivation factors to commercialise (Merriam, 2009). Furthermore, a case study approach enabled the researcher to understand the phenomenon studied from various informants and data sources. By interviewing the informants, the researcher understood each case in detail, through which new and unexplored findings emerged from the research (Yin, 2009).

Table 3.1
Philosophical Assumptions with Practical Implications

Assumption	Question	Characteristics	Practical Implications (for this study)
Ontological	What is the form and nature of reality?	The reality is subjective and multiple as seen through many views.	The researcher reports the motivation factors from the informants' answers. These answers give the meaning of the reality/phenomenon.
Epistemological	What is the relationship between the researcher and that being researched?	Subjective evidence from participants; researcher attempts to lessen distance between herself and the phenomenon that is being researched.	The researcher spends time at the academic researchers' workplace. The researcher made observations regarding the performance, environment, and their behaviour (i.e., body language, responses).
Axiological	What is the role of values?	Researcher acknowledges that research is value-laden and that biases are present in research study.	The researcher interprets the data according to how the researcher values them and how the background of the researcher shapes the interpretations.
Rhetorical	What is the language of the research?	Researcher writes in an informal style using personal voice, yet his/her understanding may evolve during the study, due to the informants' answers.	The researcher listened to own view and explained these views using the researcher's understanding (emic analysis).
Methodological	What is the process of research?	Researcher uses inductive logic, studies the topic within its context, and uses an emerging design.	Using this assumption, the researcher knows the possible research methods to be applied in the study. This study uses case study method/approach in order to answer the research questions.

Source: Adapted from Creswell (2012) and Easterby-Smith, Thorpe, and Lowe (2002).

3.2.1 Preliminary Investigation

In March 2012, the researcher conducted a preliminary investigation by reviewing the literature. This was followed by interviewing two informants who played very important roles in research commercialisation at selected two MTUN universities. One of them was the director of a research management office, while the other one was the officer at the university TTO. The purpose of this preliminary investigation was to identify the real-life issues in research commercialisation at MTUN universities. The researcher used semi-structured interview protocol, developed based on the literature. The average time taken for each interview was 65 minutes. The researcher transcribed the conversations and then coded the findings into meaningful themes.

Based on the findings from the preliminary investigation, the researcher conducted a second phase of literature review to narrow the study scope. A decision was taken to investigate only the people factor in research commercialisation activities. As a result, the researcher used the term 'academic research commercialisation' to focus in-depth on the people factor.

3.2.2 Data Collection Techniques

In this study, the researcher used two data collection techniques to answer the research questions. They were document review and interviews. Table 3.2 shows the list of research questions and types of data collection technique(s) used to answer the questions.

Table 3.2
Research Questions and Data Collection Techniques

Research Questions	Data Collection Technique	
	Document Review	Interview
RQ1: How did the motivation factors encourage the successful academic researchers to commercialise their research results?	✓	✓
RQ1(a): How were they extrinsically motivated?		✓
RQ1(b): How were they intrinsically motivated?		✓
RQ1(c): How were they prosocially motivated?		✓
RQ2: How did the mixed-motivation factors influence the successful academic researchers to commercialise their research results?		✓
RQ3: What were the motivating factors that boosted the successful academic researchers to commercialise their research results?		✓

3.2.2.1 Document Review

Document review was used to answer the first research question about the types of motivation factors available in the literature. This process involved content analysis of secondary data sources. The documents reviewed include the Malaysian plan, the government blueprints, related policy papers, newspaper archives, and other published documents. The review provided understanding of past research and helped the researcher to establish the theoretical gaps of the study. The review also exposed the researcher to the details of the informants. For example, through newspaper cuttings of their success stories and their personal blogs or websites, the researcher got to know the background of the informants. Initial information about

the informants was important to help the researcher probe further questions during the actual interview (Marshall & Rossman, 1989; Merriam, 2009; Patton, 1990).

3.2.2.2 Semi-structured Interviews

Prior to the fieldwork, an interview protocol was developed (refer to Appendix A). This interview protocol contains semi-structured interview questions to answer three research questions. The interviews began in November 2013 and ended in January 2014. To set up a meeting, the researcher communicated with all informants via email. The contact details were obtained from the university website.

During the interview session, the interview protocol was adhered to even though questions were asked following the informant's response. Whenever necessary, the researcher probed for more information. All interviews were conducted in English, but the informants had the option to answer in Malay or English language. On average, the interview session lasted about 65 minutes. The interview sessions were voice recorded and transcribed by the researcher. Email enquiries were sent to the informants if the researcher needed clarification of their responses.

After case descriptions were written, the researcher emailed them to the respective informants for verification. The verification was more so important in some cases where technical jargons unfamiliar to the researcher were used. The informants responded by emailing the modifications. This approach increased the validity of the research. Besides interviewing the informants, the researcher made

observations of the informant's office, took pictures, and requested personal documents to support the interview data.

3.2.3 Ethical Considerations

Qualitative research has to deal strictly with ethical issues related to data collection method used. Because interviews normally involve informants revealing their personal experiences, a good researcher-participant relationship is important. Reciprocally, the researcher has to protect the anonymity and secrecy of the information received. Whether or not the informants will disclose personal information depends on how well they understand the objectives of study and how the information is communicated (Merriam, 2009). To achieve a win-win situation, the researcher provided a case clearing card for case presentation in the thesis and in subsequent publications (refer to Appendix B and C).

In this study, the following safeguards were employed to protect the informants' privacy: (1) the research objectives were communicated verbally and in writing to the informants (via email) so that they had the opportunity to filter the information they wished to communicate; (2) the informants were informed that the interview would recorded and transcribed for data analysis (note: the informants who requested for an off-record moment, their statements were not transcribed or directly quoted); (3) the researcher used pseudonyms to present the case findings (Creswell, 2003, 2012) and to protect the anonymity of the informants (note: all informants had agreed for their real names to be used in the thesis and subsequent publications); and (4) the researcher presented the findings by generalising emergent themes.

3.3 Sample Case Selection

The cases were selected using purposive sampling technique. In this study, successful research projects at MTUN universities were the cases considered in this study. The researcher used the database from MOHE publication (RMC-MOHE, 2010) and the internal database from the Research Management Centre (or TTO) of each university to get the list of successful research projects. The researcher personally contacted the research management centre of each university for the list.

There were 13 successful research projects at the time of data collection, which was November 2013. The research projects had successfully passed all phases in the research commercialisation process, from the scientific discovery to the product launching. The projects also had generated some revenue for the university. All 13 cases were included in the study. Table 3.3 shows the list of all 13 successful research projects by university. Pseudonyms were used to designate the university and the research projects.

Table 3.3
Commercialised Products by University

University	**A**	**B**	**C**	**D**
Research Projects	Alpha Beta Gamma	Delta Epsilon Zeta Kappa	Omicron Theta Lambda	Sigma Upsilon Omega
	3	**4**	**3**	**3**
	TOTAL		**13**	

The informants were the project leaders. However, some project leaders assigned their team member to be interviewed, and normally the member chosen was the one who could supply the right information of the research projects (refer to

Nilsson, Rickne, & Bengtsson, 2010; and Bengtsson, Nilsson, & Rickne, 2009). The single study design and multiple units of analysis were used in this study. The unit of analysis, which was the research projects, was analysed using cross-case analysis. It is a powerful tool to develop a new theory because it allows replication and extension among individual research projects (Eisenhardt, 1991; Yin, 2009).

In all successful research projects, each project had its own challenges, merits, and limitations. Even though the same researcher had completed two different research projects, the motivation to complete each project might be different. Two research projects in this study had the same project leader but different project members. The collaborative work was needed to support the research commercialisation as it involved complex procedures. Although an idea of the product (the invention stage) could be initiated by an individual researcher, its commercialisation required a team of people to support the product development, patent application, or marketing the end product.

3.4 Data Analysis Procedures

The ultimate goal of data analysis is to answer the research questions in the study (Merriam, 2009). In a qualitative research, the data analysis process does not wait until the data collection was fully done. In this study, the first interview was promptly transcribed within 24 hours. The transcription text was typed in the word document with line numbers feature for easy coding and retrieval processes. The transcription can also be typed directly in the Atlas.ti software. The document used

double spacing and the interviewer column was in bold while the interviewee's answers were in normal font (refer Figure 3.1).

Date: December 31, 2013
Research Project: Upsilon

SFS: **Assalamualaikum and good morning. I am Saida Farhanah Sarkam, a master of science student from UUM. Currently, I'm doing my research on research commercialisation at technical universities.**

SH: Who is your supervisor?

SFS: **Dr. Siti Norezam.**

SH: Ok. From which faculty?

SFS: **Technology Management. Upsilon is one of the products commercialised by University, right?**

SH: Ya. So, what you are looking for?

SFS: **Would you please tell me, who initiated the idea of developing Upsilon? And then, would you describe in brief the research commercialisation process involved along commercialising Upsilon.**

SH: For Upsilon actually there are eight members. It was back in 2006. It took from a final year student project and from there we see a potential for the courseware to be further enhance and commercialize lah. So the project was conducted with a Dyslexia NGO. So, we doing the project together and after few revision of the project finally in 2008 the commercialization process countered. So as I said there are eight members in a team, so why is eight members? Because it started with one student project supervised by one lecture and other continue other student supervise by other lecturers and then some of them .

Figure 3.1
A Sample of Interview Transcript – Project Upsilon

An interview protocol was incorporated to assist the interview sessions in order to understand the motivation factors of the academic researchers involved in the research projects (refer to Appendix A). The data analysis phase began immediately after the completion of the first interview session. The simultaneous data collection and data analysis phases avoided the researcher from 'drowning' in the bulk of data at one time. Moreover, when the researcher analysed the first interview transcript, she noted things that she would like to ask or observe in the second interview (Merriam, 2009). The data analysis procedures were divided into:

(1) manual data analysis; (2) computerised data analysis; and (3) a Venn diagram development.

3.4.1 Manual Data Analysis

Manual data analysis was the first step in analysing the collected data. The analysis was used to carefully screen the data before uploading them on to the computer-aided qualitative data analysis software, which is Atlas.ti software. Firstly, the interview transcripts were analysed using within-case analysis. The analysis enabled the researcher to develop a detailed case study write-up called case study database or a thick description of the case (Creswell, 2012; Merriam, 2009). The researcher wrote the case description based on the interview transcripts. In this description, the full case was written chronologically with full information and actual names. It also highlighted the uniqueness of each case. The cases presented in Chapter Four were the summarised version of the full case descriptions to protect the anonymity of the informants and to merely introduce to the readers the main issue of the case.

To find the answers to the research questions, the researcher used thematic analysis to categorise the information from the interview transcripts within a case. The researcher applied open coding process to the case. The researcher coded the transcripts carefully line by line. The codes developed a number of codes, with some codes emerged according to the conceptual framework while others emerged as new findings.

The open codes then were merged together to build more general themes called axial coding. The axial codes are a group or parent code for a number of open

codes that were being coded before (Merriam, 2009). Some open codes can be grouped into an axial code while some were still open codes as they were not suitable to any groups of axial codes. The codes in the second interview were compared to the first interview. However, if there were any emergent findings from the interviews, they were coded differently. The researcher did not force any uniformity of the codes if there were none. In this study, the axial codes developed had constructed the elements in the motivation factors identified in the study. Then, the axial codes were categorised in the super axial codes or termed as "categories" by Merriam (2009). Super axial codes were the parent categories for the axial codes. In this study, the super axial codes were the types of motivation factors in the cases. According to Creswell (2012), the axial codes can be as much as 25 to 30 codes while they can be categorised into smaller categories of five or six super axial codes.

Next, the researcher performed cross-case analysis to compare and contrast between the cases. The aim of the cross-case analysis is to build general explanation that fits the individual cases (Merriam, 2009; Yin, 2009). The analysis had brought together the findings across 13 cases. The researcher completed the cross-case analysis using a computerised data analysis for easy retrieval.

3.4.2 Computerised Data Analysis

The researcher used a Computer-Aided Qualitative Data Analysis Software (CAQDAS) for this study, which was Atlas.ti software. Invented in Germany, Atlas.ti is capable to manage many types of data documents for qualitative analysis. It also can be used to manage a systematic literature review. In this study, the

software was used to execute the cross-case analysis with a systematic and easy retrieval instrument.

First of all, the researcher uploaded the interview transcripts on to the software. Using the software, the codes were tagged to the interview transcripts. Then, the manually coded open codes, axial codes, and super axial codes were inserted into the documents. The advantages of using the software was it enabled the same sentence to be coded to a number of codes and it allowed the researcher to see the interrelatedness between the codes using the Network View tool (refer to Figure 3.2). It also eased the researcher to extract any parts of the interviews to be inserted into the findings as the proof for the analysis. While quantitative researchers used numeric data to explain their findings, the qualitative researchers prove the findings using the excerpt from the interviews (Creswell, 2012; Merriam, 2009).

A sample of the network diagram developed using Atlas.ti software, in Figure 3.2, the Project Upsilon case was presented using the Network View tool. In the diagram, the open code tagged in the interview transcript was ‘passion with special needs work’. This open code can be grouped under an axial code labelled as ‘passion’. Finally, the ‘passion’ code was classified under a bigger group of ‘intrinsic motivation’ family. It is named super axial code as it is higher level than the axial code. In Atlas.ti software, the Code Family Manager tool is used to generate the hierarchical family of codes. Intrinsic motivation is one of the variables in the conceptual framework while passion is one of the elements in the intrinsic motivation.

In order to answer the second research question, the researcher presented the mixed-motivation factors of the cases. The within-case analysis was run once again to understand the mixed-motivation typology for each independent case. The typology was presented in a Venn diagram in line with the initial conceptual framework.

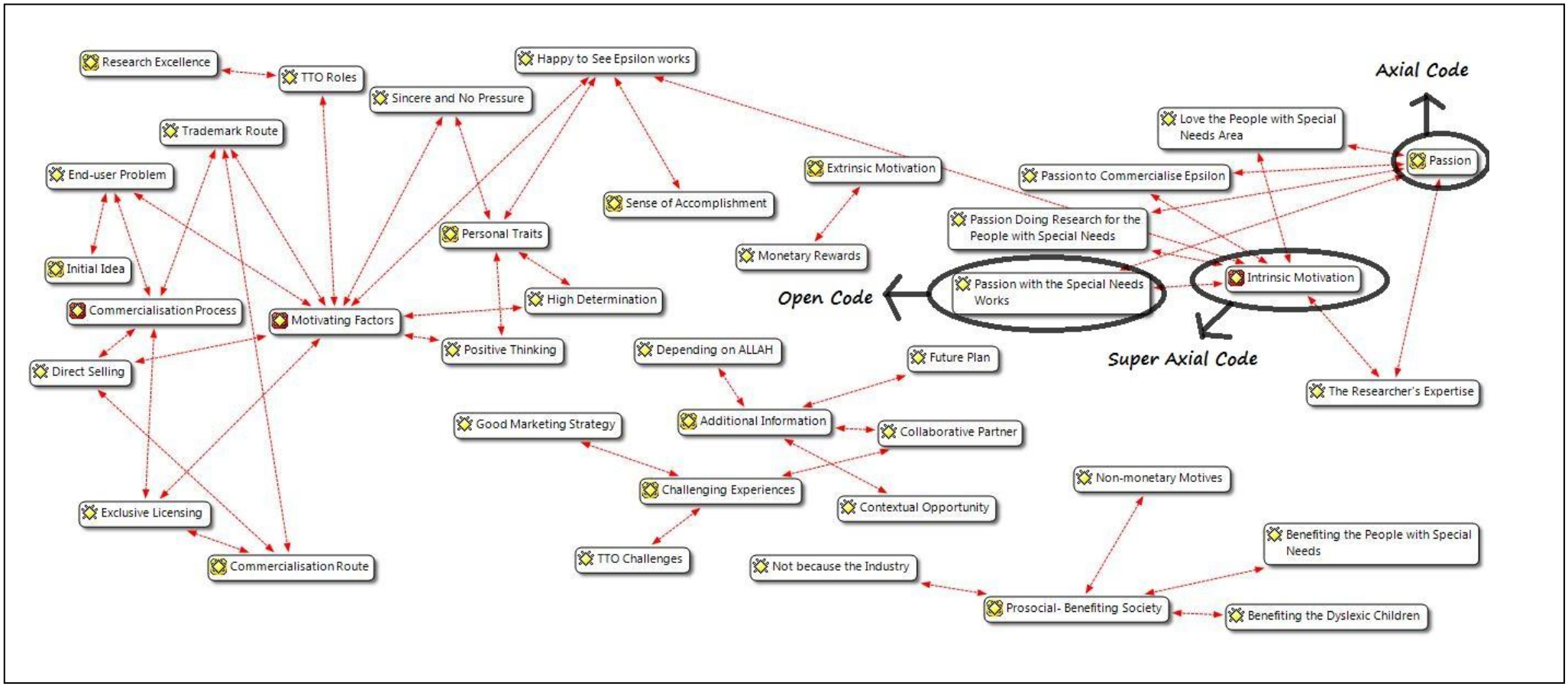


Figure 3.2
Open, Axial and Super Axial Coding in Atlas.ti Software

3.4.3 The Venn Diagram Development

A Venn diagram developed in this study was to show the nature of the mixed-motivation factors. The diagram was relevant to be used in this case as the three mixed-motivation factors had been identified in all 13 cases. The diagram showed the relationship between extrinsic, intrinsic, and prosocial motivation. The prosocial motivation circle overlapped with the extrinsic and intrinsic motivation circles. It was because prosocial motivation can be extrinsically or intrinsically driven. In order to develop a Venn diagram for each case, the within-case analysis once again was run.

From the within-case analysis findings, the next step was to do the cross-case analysis for the mixed-motivation factors. The latter analysis might probe whether the cases in the study shared any similarity and be categorised into some uniform typology of the mixed-motivation factors (Merriam, 2009; Yin, 2009). In this study, two types of mixed-motivation factors identified. The difference between the two types was the overlapping size of the prosocial-extrinsic circles and prosocial-intrinsic circles in the Venn diagram. The first one contained a bigger size of prosocial-extrinsic intersection while a smaller size of prosocial-intrinsic intersection.

In order to develop the Venn diagram, the researcher observed carefully the codes developed in the software. The overlapping sections in the Venn diagram concern with the prosocial motivation factors, whether the factors were more extrinsically-driven or intrinsically-driven. As a result, the researcher drew the

network diagram for the mixed-motivation factors for each case in order to classify the type of mixed-motivation for that case. The size of the overlapping section in the Venn diagram was determined by the arrows that showed the relationship between each motivation type. More arrows between the typology showed that the relationship between them were higher than their counterpart. In Section 4.4.1.4, the researcher presented in detail an example of how a case was classified into its mixed-motivation type.

3.4.4 Research Validity and Reliability

Qualitative studies ought to be trustworthy and authentic. In explaining qualitative validation, Lincoln and Guba (2000) used alternative terms that apply more to naturalistic axioms, which are "credibility, transferability, dependability, and confirmability". Merriam (2009), however, used the following: (1) internal validity/credibility questions "how much research findings match the reality?"; 2) reliability/consistency determines the replicability of the research findings if the same research is done once again; and (3) external validity/transferability concerns with the generalizability of the findings if the same study is applied in other situations. Yin (2009) added construct validity factor, defined as identifying correct operational measures for the concepts being studied. As this study applied qualitative case study method, the generalizability/transferability of the findings was based on the reader or user generalizability. This means that it can be generalised to other cases if the user feels the findings suit his/her case. Moreover, the goal of the study was to understand in-depth, not what is "generally true of the many" (Merriam, 2009).

Merriam (2009) came out with some suggestions to promote the validity of a qualitative research. The suggestions were applied in this study. First, the researcher used multiple sources of data to confirm emerging findings (refer to Section 3.3.2). The source of data included another cycle of literature reviews to compare and contrast with the emerging findings. Second, the researcher did member checks. In this step, the data and tentative interpretations (i.e., the categories proposed for the informant statements) were checked with the informants to see whether the data and tentative interpretations were acceptable or not. Finally, the findings were reviewed by peers (i.e., other graduate students, or committee members, or other faculty members) to assess their plausibility and the congruency with the raw data.

Yin (2009) suggested to use a case study protocol to promote the reliability of a study (refer to Appendix A). In this study, the protocol contained only the details of the commercialised research projects, the overview and direction for the informants, and the interview questions.

3.5 Chapter Summary

This chapter discussed the methodology used in the research. This study adopted qualitative methodology to answer the research questions. The research procedures were well-prepared before the researcher went to the real field. In the next chapter, how the data were analysed and what was found are presented.

CHAPTER FOUR: RESEARCH FINDINGS

4.1 Introduction

This chapter presents brief descriptions of each case, followed by cross case analyses of the academic researchers' motivation to commercialise. Next, the mixed-motivation factors were discussed. Finally, this chapter presents the findings of the motivating factors that promoted commercialisation.

4.2 Case Description

There were 13 cases analysed in this study from four technical universities. This section discusses all cases in brief. Actual names were given pseudonyms. The case description was written based on the interview responses as well as from other secondary sources such as newspaper cuttings, online documents, and database from the research management centre at each university.

4.2.1 University A

University A was located in a rural area, kilometres away from the main city at the south of Malaysia. The establishment of University A had resulted in a rapid development in its vicinity. It would have its first branch in late 2014, about 60 kilometres away from the main campus. University A was well-known for its aeronautics courses as well as technical and vocational education.

4.2.1.1 Project Alpha: Air Conditioning Simulator

Alpha was a simulator in air conditioning courses. The simulator, which was the basic air conditioning system for domestic use, was first built in 2005 and used as a teaching aid. The simulator demonstrated how a real air conditioning system works. It was found that students learnt more effectively with the use of the simulator.

The lead researcher, R1A, was an Associate Professor of the Technical Education Faculty and had served the faculty since 2003. He had more than 20 years of experience in teaching air conditioning courses to school teachers. The research project started since 2004 with the involvement of two team members. One of the team members was R1B, a senior technician in the air conditioning laboratory. The initial idea was developed by R1A, while R1B was in charge of the product development. R1A did the paperwork and administration tasks, while R1B did the hands-on works. In early 2012, before R1A passed away, they succeeded in inventing five products: one was successfully commercialised, while the other four had patents granted. And one of the products was Alpha.

In 2008, Alpha was licensed to a well-known electrical multinational company, which also produced simulators for educational purpose. The type of licensing was exclusive licensing, and the royalty was paid based on the company sales. The company's manager, Mr. Chi, was also registered as one of the inventors because he developed the software to operate Alpha, which had a patent granted in 2010. However, Mr. Chi was not classified as an academic researcher because he was not a university employee.

4.2.1.2 Project Beta: Portable Al-Quran Incinerator

Beta was a portable incinerator, which was specially developed for Quran incineration. Unlike other incinerators, Beta had a feeder and gasket at the bottom of the machine. The feeder was designed to put the shredded Quran, while the gasket was to collect the ashes in a container, which was then thrown at sea or inside unused wells. The ashes would not be easily blown away but trapped at the bottom of the incinerator. Beta used a swirling concept for complete combustion inside the incinerator so that all parts of the Quran were fully burnt. The burner supplied flame to the shredded Quran in the incinerator for ten minutes before the air was supplied to swirl the burnt Quran. Finally, the ashes were collected from the bottom of the incinerator. Beta was portable and easy to be dismantled, thus making it easy to transport. The parts were quite easy to be re-assembled, requiring only two people to do it.

The lead researcher, R2A, was asked by a state religious council to develop a portable incinerator to solve the massive unused Quran problem. R2A was an Associate Professor at the Advance Materials Research Centre. He was an expert in Rapid Prototyping. In this project, R2A was helped by his final year student, R2B. R2B made some modifications to the first version of Beta to ensure that the machine worked effectively and efficiently. R2B did his two-month internship with the council to understand the real issues and frequently discussed the suitable features of the machine with the council's management team. R2A first built the machine in early 2012, and the latest version was produced at the end of 2013.

Beta is yet to be patented. It will be patented with the council's officer's name on it, together with R2A and R2B. Beta will be licensed to a manufacturing company for mass production because the demand of the machine in the country is quite high.

4.2.1.3 Project Gamma: Lightweight Concrete

Gamma was an eco-friendly lightweight concrete. It came with good heat insulation, compressive strength, sound proofing qualities, and low water absorption. It used Industrialised Building System (IBS) technology. The technology was based on a Swedish technology used hundred years ago. Gamma was made of cement, fine sand, water, chemicals, and special foam. The block was bigger than a normal block and could be produced in a large volume within a shorter time on the construction sites. Moreover, Gamma might save piling, superstructure, plastering, and labour costs. The block was easy to cut or reshape using saw - a feature that cannot be found in other normal blocks.

The lead researcher, R3, was an expert of industrialised construction system for soft soil. He was a Professor at the Environmental Engineering Faculty. He did not register Gamma for patent. Currently, he had a joint venture with two contractors who had used the block to build a few apartments at different locations. The contractors were his friends. He used a nonexclusive license to any industrial partners to commercialise the blocks. He allowed companies to use their own brand for the blocks, with the acknowledgement of University A's research product. Since 2010, Gamma had generated a big amount of income to University A.

4.2.2 University B

University B was located in a rural area, but nearby industrial parks and ports. It was in the east of Peninsular Malaysia. The university had built its first campus in another district by the end of 2014. University B was popular with its automotive engineering as it had collaboration with a famous local car manufacturer.

4.2.2.1 Project Delta: Artificial Bait for Termites

Delta was an artificial bait to kill termites. It was made of cellulose in an empty fruit bunch (EFB) of palm oil. The cellulose was mixed with a special chemical that killed termites. The mixture was then poured into ceramic containers. Finally, the containers were buried two feet under the ground around a building. Before Delta was installed, existing termites that had been attacking the buildings were killed using a safe green chemical. By doing those jobs, the existing termites in the building will be killed and Delta that had been buried will prevent future attacks by the termites.

The lead researcher, R4, started working on Delta since 2006. He invented two wastewater treatment processes before joining University B. He also had experiences working with a well-known palm oil plant company that had made him familiar with palm oil research. At the university, he was a senior lecturer at the Chemical Engineering Faculty.

Delta was a patent-granted product of University B. It was licensed exclusively to a pest control local company. The sales of the trial run in 2008

generated thousands of ringgit to the company and University B. However, the company breached the agreement in 2010. As a result, R4 formed his own spin-off company dedicated to marketing Delta. R4 and his staff employees ran the company to market Delta. The company had been generating income for University B since then.

4.2.2.2 Project Epsilon: Jawi Writing Software

Epsilon was a Jawi writing software. There were additional six characters in Jawi as compared to Arabic characters. By using this software, it would be easy for teachers to write not only Quranic verses but also Jawi texts and transliteration. The software was convenient with QWERTY keyboard as it followed the Roman letters. Plus, it can be read by other computers, even without the software installed in those computers. Users could also write Jawi in email and presentation slides by using Epsilon.

The lead researcher, R5, was an Arab language instructor at the language centre of University B. Even though he was not an expert in computer programming, he developed the software with the help of a software developer company. The mass production of Epsilon was assigned to an outside company. The company paid a lower price for Epsilon and then sold the product to end users at a higher price. The sale of Epsilon had generated a huge amount of income to University B and R5. R5 did not register for patent or any other intellectual property rights. The commercialisation activities for Epsilon were exclusive licensing and direct selling.

4.2.2.3 Project Zeta: Bricks from Industrial Waste

Zeta was a brick made of red gypsum. In other countries, red gypsum waste was used to produce bricks for construction. Physically, the Zeta bricks were similar to the normal red bricks. But the latter's level of quality were lower than red bricks though higher than cement bricks. The price of Zeta bricks were positioned in between the red bricks and the cement bricks. Gypsum was one of the contents in the scheduled waste of a titanium dioxide processing company. The company sought the lead researcher, R6A, for consultation of the company's waste management system. After a lab test on the waste, one of the R6A's team members, R6B, found that the waste contained a big amount of red gypsum, which was suitable for brick-making.

R6A then formed a spin-off company to manage the bricks production. Next, he applied for a small plant at the vicinity of University B. He had a business partner to run the operation of the plant. The plant had a warehouse to store the rare red gypsums received from the titanium dioxide company. The plant was able to produce 3,000 bricks per day. The sales of the bricks generated a good monthly income for the university and also for R6A and his team.

4.2.2.4 Project Kappa: Engine Oil from Spent Lubricants

Kappa was engine oil made from spent lubricants extraction. Kappa was developed 14 years ago. The spent lubricants were extracted using some processes before it became clear engine oil. The company applied external grants to build a plant for producing the oil. During the grant application, R7 dealt with his business partner to

run the project with him. The partner not only pumped in money, but also technical advice. R7 patented the extraction process of the engine oil in 2004.

The manufacturing plant to produce Kappa was first built at the company's premise. The company charged transportation costs for transporting the raw materials and processing cost. The raw materials would be acquired by R7's team from an outside supplier. In 2010, the plant was dismantled and moved to an industrial park at the vicinity of University B. The move took a year before it started running again in mid-2011. However, the operation had only started in early 2014 because the plant had to be endorsed by the local authority first.

4.2.3 University C

Since its establishment, University C campuses were scattered across the state in the north of Malaysia. It was located at shop lots, and some were at factories acquired by the university. By mid-2014, all campuses had moved to a spacious campus at the main road connecting two north states in Malaysia. University C was active in nano-engineering research.

4.2.3.1 Project Omicron: Solar Uninterruptable Power Supply

Uninterruptable Power Supply (UPS) was a device that stores energy in its battery for emergency use. The UPS system had normally big electrical capacity, and the current was supplied by the national electrical supplier, Tenaga Nasional Berhad (TNB). But, Omicron came with the idea of a portable UPS sourced by solar energy, which was stored using a photovoltaic cell. Omicron applied high switching

transformer inverter using microcontroller. It was smaller but had higher capacity to store energy than the UPS available in the market.

The project leader, R8A, was a Professor at the System Engineering Faculty at University C. Another member of the research project was R8B. He was a senior lecturer at the same faculty and was previously a doctoral student of R8A. R8B developed Omicron since he was a student. In 2010, R8B made an agreement for exclusive licensing of Omicron with a multinational high-end materials processing company. The company planned to penetrate the Middle Eastern market in mid-2014. In Malaysia, the product was used in rural areas at Sabah and Sarawak because electricity could reach these areas. Omicron could also be used at homes to save electricity bills or avoid sudden electricity cut-off.

4.2.3.2 Project Theta: Natural Insects Repellent

Theta was a repellent made of essential oils from many plants. The plants had to be extracted first for oil. The oil could be extracted from the stem, roots, leaves, or fruits of a plant. Malaysia was blessed with a lot of plants with essential oils, such as, lemongrass, ginger, turmeric, screw pine, cloves, and curry leaves.

Theta came in two forms: (1) liquid form in the spray bottle to kill the insects; and (2) gel form, a lotion for insect bites, to be applied on to the skin. This natural product did not contain any poison but was powerful enough to kill insects. It was not harmful to human. Moreover, the smell from this repellent was pleasant and natural unlike many chemical repellents available in the market.

The lead researcher, R9, was an expert in biochemistry, and he was a member of Bioprocess Engineering Centre at University C. He had served a number of universities and government research institutes before joining University C. Theta was sold through direct selling by R9's friends. He did not patent the repellent but registered it for a trademark under the Theta brand. In early 2014, R9 was expecting the government to initiate his product to be commercialised. His product would be licensed to a company managed by university graduates. The programme was a collaboration between a government-linked venture capitalist and the region development authority. The students would manage the funds and the factory for the mass production of Theta. R9 planned to diversify Theta by offering it in to a butane-filled can form for the convenient use of Theta users.

4.2.3.3 Project Lambda: Decorative Artificial Marbles

Lambda was artificial marbles made of dolomite that contained high calcium magnesium carbonate content. The dolomite was normally used for road construction and cement industry. In Project Lambda, the dolomite was processed with thermoplastic material to become marbles. The marbles were moulded into decorative items like chess set and other souvenirs. The project was initiated by the state government where University C was located. The state had abundant deposits of dolomite.

The lead researcher, R10A, was in top management position at the university. He then formed a team with cross-functional members among the university lecturers including a polymer expert, R10B. University C used the artificial marbles

to produce exclusively official university gifts for guests. There was a smart pilot plant at the vicinity of the university dedicated to developing Lambda. By using the product as gifts, the university had saved a lot of money. The budget allocated for souvenirs in university's programs was channelled instead to the plant. The plant had since then generated income to the university.

4.2.4 University D

University D was at the heart of the historical state of Malaysia. The state was full of tourists' attractions as well as industrial parks and had five campuses all over the state, which two were factory buildings acquired by the university management. The university was known for its multimedia and creative engineering. The university first leased the shop lots before the main campus was fully built.

4.2.4.1 Project Sigma: Vehicle Fuel Saver Device

Sigma was a vehicle fuel saver device. It was designed with a battery indicator for monitoring battery condition easily without having to open the car trunk. It also had a USB port for electronic devices charging. There were three types of Sigma: (1) Basic (white); (2) Pro (silver); and (3) Du'a (gold) with the sound of prayer for embarking on a journey. The device was attached to in-car cigar-lighter socket plug. Unlike other fuel saver devices, Sigma used current source from the inductor because it produced more current at a shorter period so that it saved more fuel than transistor-based devices.

The lead researcher, R11A, was an Associate Professor at the Electrical Engineering Faculty of University D. He had a vast experience in doing research with a government research institute for 16 years. Sigma had been patent-registered and the commercialisation route for Sigma was assigning it to an industrial partner, R11B. R11B was the owner of a car devices company. University D had transferred complete ownership to the company in return for some revenue.

4.2.4.2 Project Upsilon: Malay Courseware for Dyslexics

Upsilon was a Malay language learning module that consists of a compact disk (CD) and 12 workbooks for dyslexic children. Normally, dyslexics were attracted to colourful and fun materials including virtual learning in CDs. Dyslexics had reading difficulty, which reflected a problem within the language system in the brain. However, dyslexic people were highly creative, intuitive, and very good in hands-on learning. Upsilon had been used and seemed workable for other children with special needs, such as, those with Down syndrome and other disabilities problems. The modules could also be used by normal children to learn simple Malay language.

Upsilon was developed by a team of eight including a manager of a Malaysian non-government organisation for dyslexics. One of the inventors was R12. Seven other lecturers in the team were from the Interactive Media Faculty of University D. In 2008, Upsilon was exclusively licensed to a local book publisher. Besides direct and online selling to the public, Upsilon was also distributed for free to dyslexic children at dyslexic special schools across Malaysia. The product had

been registered for trademark for its intellectual property right (IPR) that provided the team the right to use and commercialise the brand name of Upsilon.

4.2.4.3 Project Omega: Mobile Edutainment

Omega was an educational game for mobile phone. It was a simple math game for kids. Players would be shown things bought from a shop and they would act as cashiers. Omega had three levels of difficulties: easy, intermediate, and difficult. The software had won a second prize in a mobile content competition which was jointly organised by a giant mobile operator and a government agency in 2007.

The inventor, R13A, developed the software in 2007 for his final year bachelor's degree project. With close guidance from his supervisor, R13B, it took almost three months for the software to be developed. Their mentor company, a well-known software developer in Malaysia, then registered the game with the Nokia Store and generated some money from a number of downloaders worldwide. The software had not been patented and the trademark had also not been registered.

4.3 Academic Researchers' Motivation Factors

From the document review and interviews, three motivation factors were considered. This section discusses the findings from all cases. The factors discussed were extracted from the interviews on 13 research projects.

4.3.1 Extrinsic Motivation

In the study, extrinsic motivation factors were identified in all 13 cases. It showed that the academic researchers were motivated by external goals. There are three categories of extrinsic factors that motivated them in commercialising their research projects: (1) monetary rewards; (2) career rewards; and (3) industry assistance. The monetary rewards were in the form of royalty, monetary prizes in competition, or consultant fees. R7 said very clearly that, *"I want to be a millionaire one day* [laugh]*."* For R9, his current university provided a better incentive for researchers, unlike his previous one. According to him, "*Researchers from other universities received RM4,000 for each Gold while I received nothing, not even a single cent for four Golds at Geneva…"*.

Some researchers were motivated by career rewards such as attending conferences and exhibitions. These "rewards" could further embellish their curriculum vitae (CV). According to R1B, to be a co-inventor and non-academic staff, it was an opportunity for him to enhance his CV, just like R1A did. He remarked,

> "*It's okay… as I long as I get certificates for presenting paper at conferences. No other technician get such an opportunity."* (R1B)

Another career rewards identified was the graduate-on-time factor. In some research projects, the student under the supervision of the project leader was also the co-researcher. So, the research project was not only helpful to meet the Key Performance Indicators (KPIs) of the academic staffs, but also to enable the student

to graduate on time. The student was not able to graduate if they failed to finish the project. For example, R13A developed Omega for his final year project, which was also the finalist in a mobile game competition.

> *"She* [R13B] *helped prepare the proposal and submitted it. So, it's my luck when Omega was chosen as the finalist. So I finished it up…it's my Final Year Project."* (R13A)

Some academic researchers were also motivated by industry assistance in commercialising their research products. For instance, R7 was motivated to commercialise when he realised the benefits of collaborating with the business people in the industry. He wanted to learn and get exposed to industrial experience. He also received valuable input from the industry to improve his technology. He noted,

> "*I went to Dubai and India, also Thailand. After I visited their plant, I realised that my technology is not efficient, not suitable to be commercialised. Then I went back to the lab to make adjustments to some features."* (R7)

4.3.2 Intrinsic Motivation

Intrinsic motivation factors were the factors that came internally from an individual. These factors drove academic researchers to commercialise. Thirteen cases indicated intrinsic motivation was at play in commercialisation. These factors can be grouped into six categories: (1) entrepreneurial mind; (2) sense of accomplishment; (3) puzzle

solving/intellectual curiosity; (4) sense of belonging; (5) passion; and (6) sense of responsibility.

There were a number of researchers with entrepreneurial mind, which might be inherited or nurtured through experience. For example, R5 was born into a family of businessmen who owned shops. For R3, he already had a business venture with his friends. As a result, he knew a lot about the industry. To be a good businessman for him means making other people rich first.

> *"Then I nurture him. After I retired, my friend will call me for a help, then I will become a business partner. Then I will become one of the big investors in the company. Can't you see that? There is no harm to nurture and train others. At last, I will become a construction or biomass businessman."* (R3)

For others, it was more about eagerness to see the research result. A sense of accomplishment was achieved when their product was in the market or put into practice. For R7, his 18 years of patience in developing Kappa would come to an end after the product had been sold in the market. He developed the process, the plant, and he was waiting patiently for the production of the end-product.

> *"Yes, I did everything; I wanted to be in-control. Yeah, this is my first 'baby' after years of waiting."* (R7)

In addition, the academic researchers were highly curious. They were motivated to solve a 'puzzle.' Every research was like a piece of puzzle where the latest finding became an additional piece to complete the jigsaw puzzle. It was their

curiosity that made them explore new possibilities. In the case of R8B, he developed an instrument on a trial-and-error basis at the laboratory after reading some news. He was amazed at what he found and began to research further to develop Omicron.

> *"It started when I was reading a newspaper about the photovoltaic capability. Then I started to try it on the circuit blackboard. 'Eh, it works!' I asked my supervisor* [R8A]*, 'Can we do this?' And he said, 'It's worth trying'. Then I started to realise that the photovoltaic cell was able to create AC* (alternate current)*."* (R8B)

A sense of belonging to the university had prevented some academic researchers from using backdoor to commercialise their research results. For example, in the case of Project Epsilon, R5 knew that he was able to produce Epsilon on his own and he could have sold it to anyone he pleased. However, the sense of belonging stopped him from doing. He said,

> *"I can produce and sell it on my own; just ignore the TTO. I can order the packaging boxes, the thumb drives, and seal them nicely. Then sell it to the customers directly. But, I belong to my employer, my university. Win-win lah. Me and university."* (R5)

In the cases studied, all successful academic researchers had a passion about research and commercialising their research results. They did not mind spending a lot of hours in research. Commercialisation involves a lot of daunting tasks. Without passion, they would have not been successful. For R12, she was interested in studying the needs of special people after obtaining her master's degree. She was brought up in a family with philanthropic values. Her parents were active in

nongovernmental organisation (NGO) for special people. She also joined the association to voluntarily work for them. She remarked,

> *"I think it is that I like it. I'm doing research for what I am passionate about. So when I'm doing that, I don't feel like I need to force myself. Basically I don't feel like I'm doing research. I feel like I'm doing something that I love. As simple as that."*(R12)

Another element in intrinsic motivation that was found was a sense of responsibility. There were two types of responsibility identified from the findings: (1) responsibility to self; and (2) responsibility to others. These two types of responsibility seemed to be underpinned by religious values and beliefs. As Muslims, the academic researchers felt that they had an *amanah* to fulfil. Secondly, they felt that they had the responsibility to the Muslim society because they had the knowledge to solve the problems that exist.

In the case of Beta, R2A felt that it was his responsibility to build Beta to solve problems related to the religion. It was one of his duties as a Muslim. He knew that he could develop the incinerator for the religious authority because he had expertise in rapid prototyping. Through his invention of Beta, he felt he had contributed to the Muslim society in managing unused Quran according to the Shariah.

> *"I personally developed Beta not for exhibitions or competitions. It becomes Fardhu 'Ain* [an obligation] *when no one did it so I developed it."* (R2)

For R12, her product was dedicated to help dyslexic children. She said that it was her responsibility as a Muslim scholar to develop Upsilon. This showed her responsibility of being a helpful Muslim. R5 also felt responsible to solve problems for teachers because the product might help people to write Arabic (and Jawi) texts. By doing so, he was contributing to the Muslim community and playing a role as a good Muslim.

4.3.3 Prosocial Motivation

In the study, prosocial motivation factors were also identified in all 13 cases. Prosocial motivation is a new avenue in academic research commercialisation literature. Prosocial motivation concerns with doing something for the benefit of others. It was found that the academic researchers were motivated to commercialise their research results for the benefits of the following: (1) society; (2); industry; and (3) the environment. In some cases, more than one group benefited from the commercialisation effort.

From the interviews, seven academic researchers commercialised their research results for the sake of the society. The end-users or target market of the products were part of the society. The academic researchers tried to solve practical problems before developing the product. Besides generating money, the products would fulfil the needs of the target market. For instance, in Project Omicron, the device was useful *"for people in rural areas where the national grid cannot reach them so that the people can generate electricity at their houses."* Alpha was developed *"to make students understand the subject better and at a shorter time."*

Likewise, Project Upsilon was developed because the absence of Malay language training module for dyslexic children. By commercialising the product, R12 hoped that any dyslexic children could use the materials for learning purposes. The researcher stated as followed:

> *"We are not saying that we want to commercialise because we work together with the dyslexia association. Why we were doing this because the children with dyslexia will get benefit from it since it was meant for them."* (R12).

As for R2A, the Quran incinerator would benefit the Muslim society. By developing Beta, *"Malaysian Muslims now have the solution on how to dispose unused Quran."* Besides, "*it is an initiative to protecting the sacred Quran by incinerating it with honour in accordance with the Fatwa."*

Similarly, Epsilon was developed for teachers of Islamic studies because no software had Jawi fonts in the market. Moreover, because R5 himself also faced the same problem during his studies, he believed that the development of Epsilon could facilitate the end-users in their daily tasks.

Research commercialisation was also found to benefit the industry. Six academic researchers commercialised with the assistance of their industrial partners. Most of them invented the product upon the request of their partners. For example, R2A helped the Islamic authority "*to solve the ever-rising problem of dumping unused Quran at their premise."* Project Delta, Zeta, and Sigma were developed upon the partners' requests. Both Delta and Sigma were requested because there were products produced locally with novel technologies. The researchers mentioned,

"He [R11B] came with his product's requirement. He knew the local market needs." (R11)

"He said that this is from overseas [while showing the product]. *Can you make one like this? We then made the local ones"* (R4)

For Project Gamma, R3 was encouraged to commercialise to help his friends in the construction business. He himself did not want to start the same business in Malaysia so that he did not have to compete with his friend; instead, he intended to commercialise the product overseas. He said,

"In Malaysia, I have old friends, twenty years. No issue. Let them make money. I become investor. Because we are close friends. I am interested to tackle Libya, Czech, Yemen, Sudan. Depends on where my students are." (R3)

Six academic researchers were found commercialising their research output to benefit the environment. There were three types of environmental research projects: (1) waste-to-wealth; (2) saving or finding alternative for non-renewable resources; and (3) natural resources optimisation. In the first category, the research projects involved turning wastes from natural resources to money-generating products. For instance, in Project Kappa, the spent lubricants were extracted to produce base oil for vehicles.

"You preserve the environment because you recycle waste to be used. Besides, we may consume less non-renewable energy and turn into useful products for the customers." (R7)

Some of the researchers tried to preserve the environment by using alternative sources to generate power. The initiative might reduce the use of non-renewable resources like petroleum and minerals. For example, Omicron focused on generating renewable energy from the solar power.

Finally, there were academic researchers who were involved on how to manufacture products from locally abundant natural resources. For example, R9 used natural herbs in repellent, while R10 fully utilised dolomites to be converted into valuable products.

4.4 Mixed-motivation Factors

Three types of motivations were independently discussed in the previous section. Next, the mixed-motivation factors will be discussed with regards to the following: (1) the mixed-motivation typology; (2) a sample procedure on how the mixed-motivation type was classified; and (3) the type of mixed-motivation in each research project.

4.4.1 Mixed-motivation Typology

A Venn diagram was used to explain the three motivation factors. The diagram showed that extrinsic and intrinsic factors did not overlap with each other, but prosocial motivation overlapped with both types of motivation factors. There were two types of mixed-motivation factors. The difference between those two types was the size of the prosocial overlapping section. The overlapping size did not indicate any major motivation factor in the research project. It was merely to depict that the

prosocial motivation in the case was driven more extrinsically rather than intrinsically, and vice versa. For example, if the case fell under Type I of the mixed-motivation, it did not mean that the academic researchers were more extrinsically driven to commercialise their research result. Instead, it only showed that the prosocial factors in the project were more extrinsically driven than intrinsically driven.

4.4.1.1 Type I

In the first type of mixed-motivation factors, the extrinsic-prosocial overlapping section was bigger than the prosocial-intrinsic motivation (refer to Figure 4.1). It showed that the prosocial factors in these academic researchers were more extrinsically driven. Seven cases were under this category, namely, Project Alpha, Gamma, Zeta, Kappa, Theta, Sigma, and Omega.

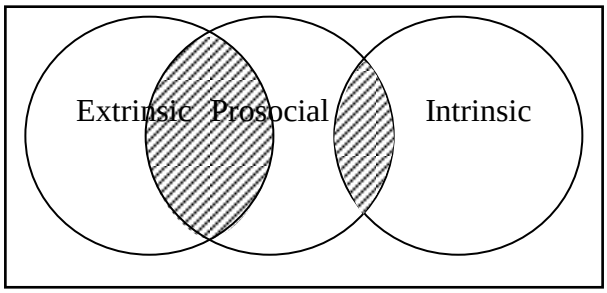


Figure 4.1
Type I Mixed-motivation Factors

In this type, all researchers were extrinsically motivated since the initial stage of the research commercialisation process. They had the prosocial motivation to commercialise but were more extrinsically motivated than intrinsically motivated. For example, in some cases, the academic researchers developed the products for the industrial partner for monetary return. In another cases, the academic researchers

developed the products for the end-users for the career rewards. However, even though they were extrinsically motivated, all of the academic researchers in Type I had the intrinsic-passion factor in them while commercialising their research results.

4.4.1.2 Type II

The second type of the mixed-motivation was the overlapping section of prosocial-intrinsic motivation that was bigger than the extrinsic-prosocial section (refer to Figure 4.2). The prosocial motivation in these cases was driven intrinsically more than extrinsically driven. There were six cases in this category, namely, Project Beta, Delta, Epsilon, Omicron, Lambda, and Upsilon.

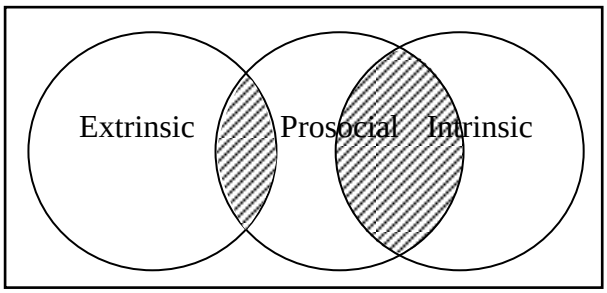


Figure 4.2
Type II Mixed-motivation Factors

In this type, the academic researchers' prosocial motivation was more intrinsically driven than extrinsically driven. The academic researchers were passionate (intrinsic motivation) about their research work but not when it came to commercialising the product. However, they started to commercialise after other parties recognised the growth potential of their products. In most cases, they thought about the extrinsic-financial rewards at the later stage of the commercialisation process. At this stage, they thought that 'killing two birds with one stone' would be good for them.

4.4.1.3 Type I and Type II

This section compared and contrasted the two types of the mixed-motivation factors.

The similarities between Type I and Type II motivation are as followed:

1) All academic researchers had passion in their job. This passion can be classified into several types. Some of them were passionate about doing research, some in serving the society or target market, and some in commercialising their research results. It showed that the ignition of the commercialising fire was always come from the intrinsic motivation, which was from the internal self of the researchers; and

2) The prosocial factors can be extrinsically or intrinsically driven. This means that the extrinsic motivation would never overlap with the intrinsic motivation, and vice versa.

On the other hand, the differences between Type I and Type II motivation are as followed:

1) The academic researchers in Type I were more entrepreneurial than those in Type II. They commercialised for some material gains, either career or money. As discussed in Chapter Two, with career development came monetary benefits. However, they were also intrinsically motivated to endure the commercialisation process; and

2) The academic researchers in Type II were more traditional academic researchers. They did their research not for the sake of material gain in the first place. Even though they acknowledged the financial reward that came with their effort, they

intended to use the reward to extend their research or give back to the society. In this way, they were different from Type I researchers.

4.4.1.4 Sample of Classification of Mixed-motivation Type

This is a sample procedure on how the researcher classified a case into a mixed-motivation type. The sample case selected was Project Upsilon, a Malay courseware for dyslexic children. The whole classification procedures were fully computerized using the Atlas.ti software.

The first step was identifying keywords for elements of the motivation factors. For example, in the Project Upsilon, after the first within-case analysis, the three motivation factors were identified. They were: (1) Extrinsic motivation – monetary rewards; (2) Intrinsic motivation – passion and puzzle solving; and (3) Prosocial motivation – benefit to the society (dyslexic children).

Next, the researcher developed a network diagram using the Network View tool in the Atlas.ti software. From the network diagram, the researcher examined the relationship between extrinsic, intrinsic, and prosocial motivation factors. Figure 4.3 shows that more arrows were connecting between the intrinsic and prosocial motivation factors. However, there were fewer arrows connected between the extrinsic and prosocial motivation factors. This network confirmed that the Project Upsilon can be classified under Type II of the mixed-motivation factors.

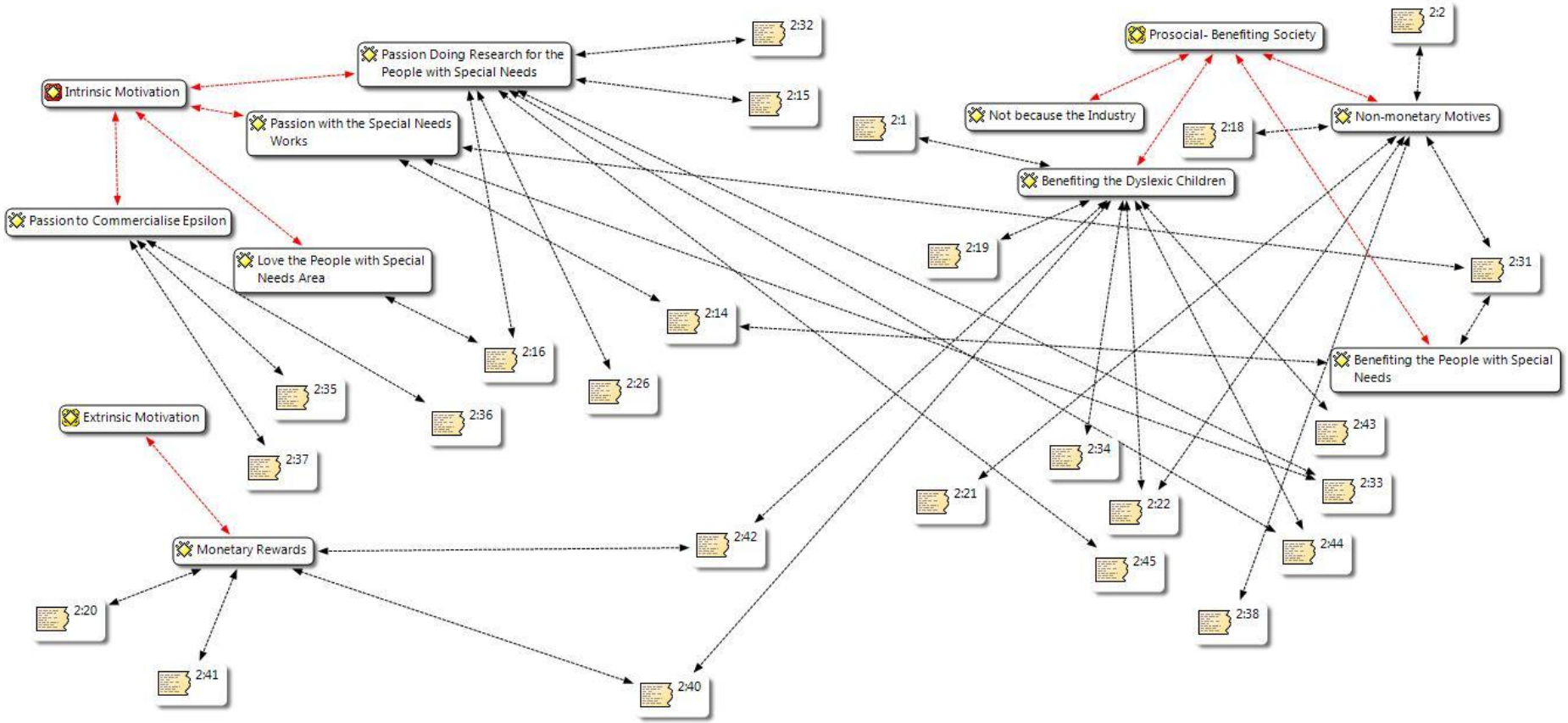
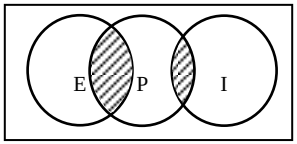
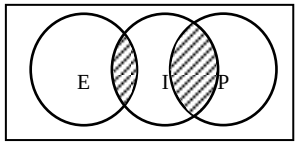
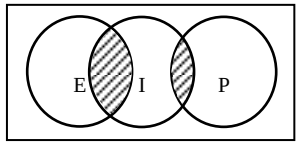
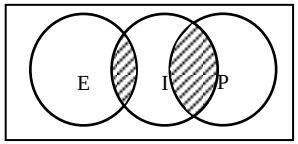
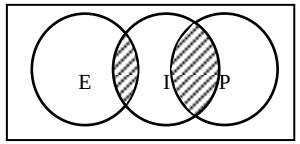
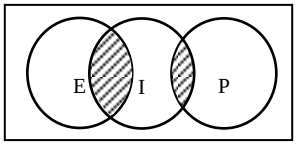
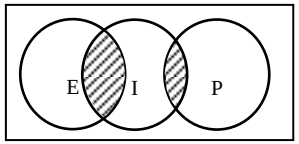
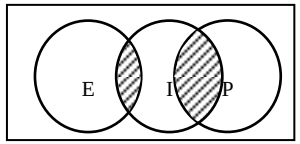
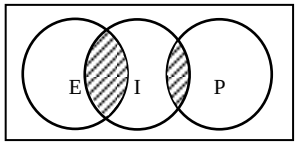
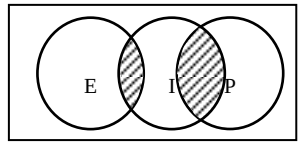
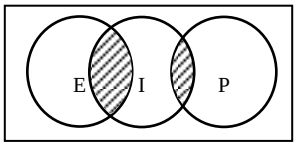
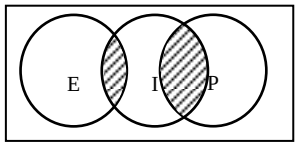
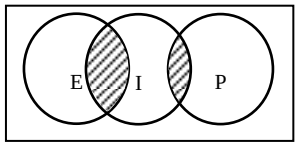


Figure 4.3
Network View Diagram in Atlas.ti Software

4.4.2 Mixed-motivation Factors in Research Projects

From the study, it can be concluded that all successful academic researchers were motivated by three factors. The motivation types for each case are simplified in Figure 4.4. The mixed-motivation factor showed the combination of motivation factors in each case. The mixed-motivation emerged either at the initial idea stage or at the later stage of the research commercialisation process. The motivation factors might also happen simultaneously or in sequence.

Figure 4.4
The Mixed-motivation Types for the Cases

CASES	**Alpha**	**Beta**	***Gamma***	***Delta***	***Epsilon***
Mixed-motivations Type					
Details	Type I: E∩P>P∩I	Type II: E∩P<P∩I	Type I: E∩P>P∩I	Type II: E∩P<P∩I	Type II: E∩P<P∩I
CASES	***Zeta***	***Kappa***	***Omicron***	***Theta***	***Lambda***
Mixed-motivation Type					
Details	Type I: E∩P>P∩I	Type I: E∩P>P∩I	Type II: E∩P<P∩I	Type I: E∩P>P∩I	Type II: E∩P<P∩I
CASES	***Sigma***	***Upsilon***	***Omega***		
Mixed-motivation Type					
Details	Type I: E∩P>P∩I	Type II: E∩P<P∩I	Type I: E∩P>P∩I		

Source: Compiled by the author from the interviews.

4.4.2.1 Project Alpha: Type I

In the case of Project Alpha, R1B was motivated to commercialise the product because he would like to help the students learn the air conditioning subject. He felt happy to be involved in the commercialisation activities because he could attend conferences and exhibitions worldwide, which was unusual for technicians to receive such opportunity. He was also able to enhance his CV by getting involved in the project. In this case, his prosocial factor was extrinsically driven. He said,

> *"It's okay… as I long as I get certificates for presenting paper at conferences. No other technician get such an opportunity."*

> *"Alpha might be able to help students understand the concept easier and faster… R1A had used it in his class…"* (R1B)

But he was also passionate about air conditioning education. He had served a multinational air conditioning company before joining the university. He would like to see Alpha being widely used to facilitate students in understanding an air conditioning system. This finding showed his sense of accomplishment towards this project. Moreover, he was the only hope to commercialise Alpha after R1A passed away last year.

> *"My background education is in the air conditioning system… I worked in the air conditioning company for a few years…"*

> *"The main target is for the product to be commercialised and used. If we cannot achieve that, it does not mean anything to me…"* (R1B)

4.4.2.2 Project Beta: Type II

In the case of Project Beta, R2A was prosocially motivated to commercialise the product to help the religious body solve the unused Quran dumping problem. Besides the benefits to the industry, Beta might be beneficial for the Muslim community. R2A would also like to commercialise the product because of his sense of responsibility as a Muslim. He had the sense of accomplishment to see Beta solving the ever-rising unused Quran in the country.

> *"The religious body came to us and discuss the problems… The unused Quran, the handling and storing problems occurred during the transportation of the Quran…"*
>
> *"I personally developed Beta not for exhibitions or competitions. It becomes Fardhu 'Ain* [an obligation]. *When no one did it so I developed it. I enjoy developing it when I know it will be used by the needy…"* (R2A)

His passion in commercialising Beta came after attending commercialisation courses organised by the Higher Education Ministry. He then started to realise the commercial potential of Beta; he was extrinsically motivated by the financial rewards that he might receive if Beta was to be sold worldwide.

> *"Our product is not a bottom billion like that of Prof. A. But it still has potential… I've attended her* (Prof. A) *talk last month… good insights…"*

"Can you imagine how big the market is? In Johor, we have eight districts. Each district has many villages, which means many mosques. If we count other states… Pahang, Melaka… if we also count Brunei… But we don't really go for that. If it is our rezq [the bounty from God], *then we get it after this…"* (R2A)

4.4.2.3 Project Gamma: Type I

R3 was prosocially motivated to benefit the industry in commercialising his research results. The industry players were his business friends. He helped his friends, who later would in turn help in the future. By helping them, R3 himself would get his share eventually.

"Then I nurture him. After I retired, my friend will call me for help, then I will become a business partner. Then I will become one of the big investors in the company." (R3)

R3 also had an entrepreneurial mind to succeed in the business. He was passionate about doing soft soil research, and he was passionate to commercialise Gamma by himself, with little assistance from the university and the TTO. He also had a sense of accomplishment to see Gamma being used by the university. He also succeeded in commercialising many other construction projects outside the university.

"Gamma is the solution for the soft soil… the concrete used has to be less dense than the soil… that is why I come out with the lightweight concrete with special foam inside…"

"I have friends everywhere… if they say there is a new market in Pahang, I will supply Gamma to them… I don't go for licensing; I want my friends to make profit."

"But I feel uneasy… I succeeded in Penang, Ampang, but not at my own university… Last year we got a contract to build a university hostel. Then I feel happy…" (R3)

4.4.2.4 Project Delta: Type II

Initially, the idea of inventing Delta was brought by the industry partner, who then requested R4 to invent Delta. R4 was an expert in the palm oil industry. He agreed to help the partner because he believed that the artificial bait can also be created from oil palm's empty fruit bunch (EFB). R4 was passionate in doing the research, and he would like to answer his own intellectual curiosity with regards to other potential uses of EFB.

"The company's manager came to me and said that, 'I've seen this product from overseas, why don't you make local ones?' I've looked into the bait…and from the journals… 'Eh, this came from the waste'. Then suddenly I started to think about oil palm, the waste of empty fruit bunch (EFB)." (R4)

However, after the partner breached the contract, R4 had to continue with the commercialisation process alone. It was then when he started to be motivated by the financial reward. He formed his own spin-off company and ran the company with the sales made every month.

"After the contract was breached, I was left alone to continue with commercialising the products… so I had no choice. I learnt things by myself… Alhamdulillah the sales were good, RM20,000 for two months…"

"It was formed to get government grants and to further commercialise the research product. The company focuses on my product ONLY."(R4)

4.4.2.5 Project Epsilon: Type II

The idea to develop Epsilon came after R5's wife told him that she needed to use Jawi fonts in her teaching. Other teachers in her position were also facing the same problem.

"It started with the problem that… in the academic world of Islamic studies, especially for the Islamic subject teachers… Like my wife… There was no Jawi letters in Arabic. This caused problems in typing the Jawi transcripts." (R5)

R5 was prosocially motivated to develop Epsilon for the use of such teachers. He gave the university's TTO to market the product. At first, he was not aware of the product's potential. But, he started to be extrinsically motivated at the opportunity recognition stage.

"The TTO proposed Epsilon to be commercialised… They said it has potential. Then they started to commercialise it. They were good in that respect…"

"The market is not less than 2 million. If you sell Epsilon for RM1 each, you will get RM2 million just like that… The Islamic education teachers, Islamic studies students in universities, religious bodies…" (R5)

R5 would like to serve the society because he felt responsible to solve the problems of teachers. Besides, it was part of his contribution as a Muslim to develop Epsilon because the product was related to the Quran, which is written in the Arabic language. He was very passionate about developing the product and commercialising it even though R5 had no IT background. He built his own network and learned about software development from his friends. Because he came from an Islamic education background, he knew the difficulties in writing in Arabic and Jawi texts when product like Epsilon was not available. He remarked,

"The formal education is not that important… the most important thing is your desire and effort. Mark Zuckerberg, Steve Jobs and Bill Gates are did not complete their formal education but they succeed…"

"I used to face the same problems in my first degree in transliteration… Now you can even email Quran and Jawi texts to your friends, put the Quranic text in the Friday sermon slides presentation… with Epsilon, now you can…" (R5)

4.4.2.6 Project Zeta: Type I

Zeta was first developed to solve the scheduled waste in a titanium dioxide plant. It was developed out of prosocial motivation, i.e. to save the environment. The

manager of the plant came to R6A for consultation. After the discussion, R6B decided to transform the waste into bricks. The bricks were then sold to any interested company or used to make buildings at the university. In early 2014, the project began to generate income for the university. R6B noted that,

> *"The company had to do something with their scheduled waste and they did not have the authority to handle the waste. That is why they asked us to do so… They focused on the company products… the waste was not their job…"* (R6B)

The bricks were made of red gypsum contained in the waste. Besides helping the company to manage their scheduled waste, the project was dedicated to preserve the environment by turning the waste into wealth. R6A formed his own spin-off company dedicated to managing this project and to getting some revenue from the sales of Zeta.

He said,

> *"I did the literature search on gypsum. I just realised that in India, US and UK, they transformed the gypsum from waste into bricks… they did it since twenty years back… now, the gypsum* (waste) *they had is almost finished…"* (R6B)

4.4.2.7 Project Kappa: Type I

Kappa was initiated by a basic research of R7 and his first master's student. He then hired more students to extend the research and closely supervised them. In this

project, they extracted the spent lubricants to make base oil for vehicles. It was one of the waste-to-wealth initiatives. Besides, Kappa could save non-renewable resources, specifically petroleum. R7 highlighted,

> *"It started in 1997 while I was supervising my first master's student. The student focused on the solvent extraction process to recycle waste oil... The first student tested the first solvent… Then the second mixed two solvents together to treat waste oil…"*
>
> *"You can preserve the environment because you recycle the waste to become useful products…"* (R7)

The prosocial factor of preserving the environment for R7 was extrinsically driven. Ever since his first attempt in developing Kappa, he knew that it would generate a huge return for him. He patented the process of producing Kappa from the lab scale to the pilot scale. He remarked,

> *"I want to be a millionaire one day* [laugh]*."* (R7)

Besides the extrinsic factor, R7 was also driven by intrinsic factors. He was passionate about doing research in this area. He was also passionate about commercialising Kappa, and he had an entrepreneurial mind. Unlike other researchers, R7 went to the industry to search the relevant information himself. He learnt from the industry partners about business survival. He also received advice from them and their plant. Because Kappa was 'his baby' (he developed it until it was successfully commercialised), he decided to keep Kappa under his wing. Thus, he chose to form a spin-off company instead of licensing Kappa to outside firms

since the former would generate more income for the university than it would have should the latter be chosen.

> *"A lot of challenges will come at your door. Once you are committed to the project, settle it until the end… successfully commercialising it is my ultimate goal…"*
>
> *"Yes, we can make money from it… but my main concern is about feeling satisfied for accomplishing my research."*
>
> *"If we license it to the firm, yes we could have put the technology into practice. And the firm might be successful… but the university gets little from it…"*
>
> *"You have to know one thing. Business is business. They always know how to play the trick. That's not good. I'm talking about the real world. That's what it is because you are the one who runs the company. So, they always play around the figure. The company plays around to make money… I want to be in control… I want to participate in every process."* (R7)

4.4.2.8 Project Omicron: Type II

In Project Omicron, R8B was prosocially motivated to provide solutions for the people in rural areas because the national grid could not reach them. Omicron can store energy from solar to create electricity. Not only it was beneficial to the rural people, the product also had a positive impact on the environment. The prosocial

motivation was intrinsically driven by his intellectual curiosity, which enabled him to work persistently at the laboratory to develop Omicron. He said,

> *"It started while I was reading a newspaper about the photovoltaic capability. Then I started to try it on the circuit blackboard. 'Eh, it works!' I asked my supervisor* [R8A]. *'Can we do this?' And he said, 'It's worth trying'. Then I started to realise that the photovoltaic cell was able to create AC* (alternate current)*."* (R8B).

Another motivation for R8B to develop and commercialise Omicron was for his career. At the time he invented Omicron, he was a doctoral student of his supervisor, R8A. Omicron was part of R8B's PhD project.

> *"It was part of my PhD project… another part was transformerless photovoltaic inverter. It was just like Omicron but without a transformer. It also can produce AC."* (R8B)

4.4.2.9 Project Theta: Type I

In Project Theta, the prosocial factor was for the environment because the product used local resources. Theta benefited the society because it provided an alternative to repellents that were harmful to human. Theta was produced from 100% natural resources. R9 was an expertise in biochemistry. He studied essential oils for 11 years at a government research institution. From his research and publications, he decided to develop his products.

"You ought to have your publications as an academician. At the end of the day, you will produce your own product. Without product, your research is nothing! I used to do many publications, but now I'm focusing on developing products out of it…before other people do that…" (R9)

R9 was extrinsically motivated by the financial and career rewards. His current university provided better incentives for researchers, unlike his previous one. He had moved to several government research institutes and universities for better pay and better incentives for commercialising his work. According to him,

"Researchers from other university received RM4,000 for each Gold while I received nothing, not even a single cent for four Golds at Geneva…" (R9)

Besides his passion in his research, he was also passionate about commercialising Theta. He would like to see Theta successfully commercialised after he was cheated by the previous industry partner. At present, he directly sells Theta before it is taken over by a graduate firm under a government programme. According to him:

"I've got RM2 million grant from a company… then they cheated me, they didn't pay me. We settled in court for RM20,000. Then I don't even care about the company…"

"We have an agreement with the company [the student's company]*... they will provide the infrastructure; the filling machine, the labelling*

and seal. They will repackage it into high pressure butane-filled can, just like Ridsect. Now I'm waiting for the students to finish attending workshops and training before they setup the company…" (R9)

4.4.2.10 Project Lambda: Type II

In Project Lambda, the first intention of the academic researchers was to help the local government fully optimise the usage of its natural sources, the dolomites, before they ran out. The project would also benefit the environment. However, the project had to be stopped due to management reshuffle after the national election.

"We were asked to develop the product… 'He' said that the state government will take this technology, for the state income, to benefit to the citizens… But, once 'he' was no longer in the state management anymore, the project was stopped… Now it became the university's product…" (R10B)

R10A then formed a cross-functional team to investigate what type of product could be manufactured from the dolomites. One of the team members was R10B who was in the material engineering faculty. R10B was a polymer expert and suggested the idea of mixing the dolomites with plastic materials to build decorative items, such as chess set and plaque.

"The dolomites cannot stand alone. That is why we had to mix it with thermoplastic or thermoset. The procedure is called higher-filler loading composite… we put a lot of dolomites with a small amount of plastic, around 25 to 35%." (R10B)

Then, R10A suggested that Lambda could be produced exclusively for honouring the university's guests or upon request. R10B himself would produce Lambda in his lab, which was called a mini pilot plant. Because R10B was very passionate about the polymer products, he was willing to produce them personally by hand. The product was remarkable.

> *"… R10A believed that the product can be the university's identity. It is exclusive for our university. The product will be made upon request… He (R10A) did not want Lambda to be available anywhere else…"* (R10B)

4.4.2.11 Project Sigma: Type I

In Project Sigma, R11A was approached by R11B, who was the manager of a car device company. Because Sigma was very important to R11B, he entrusted R11A to develop a fuel saver device. In this case, the prosocial motivation factor was to benefit the partnering industry for monetary rewards (extrinsically motivated). After the prototype was developed in the final quarter of 2008, R11B fabricated the product to make it more marketable. He put some additional features to ensure that the device was different from its competitors.

> *"He came to my office and we discussed the company's request. I didn't expect this thing will get commercialised at such level. My intention was just to help him [R11B]… He is an entrepreneur; he doesn't receive salary like us… I pitied him…"*

"I was not the one who designed this device to be like this… I did not have time… He (R11B) did all these, with the additional features. He wanted to sell it as soon as he could…" (R11A)

Even though R11A was aware of the financial rewards for developing a research product for commercialisation, he gave a reasonable price of one-off licensing to R11B. He simply wanted to see Sigma being sold by R11B's company and used. Even though he was interested in the monetary rewards, he did not want to be greedy. He said,

"I offered just RM100,000 for Sigma. I didn't go for more. Some of us put a very high price. Do you think an entrepreneur will afford to pay RM500,000 for this product? In business, there are risks and uncertainties... I believe that we won't get rich by selling product like this only ... we have to be noble-hearted, developing the product for the benefit of the entrepreneur…" (R11A)

4.4.2.12 Project Upsilon: Type II

R12 worked hard for the commercialisation of Project Upsilon because she was passionate about people with special needs, including the dyslexic. She joined an association for the dyslexic and did voluntary work. Commercialising Upsilon meant that it could be used by other dyslexic children, who wished to learn the Malay language. It was her prosocial motivation to commercialise Upsilon. The income generated from the product would be channelled to the children centre and for

further development of Upsilon. As such, the extrinsic (monetary) reward was not for herself, but for the dyslexic.

> *"The children with dyslexia will get benefit from it because it was meant for them...Upsilon was used by the children at the dyslexia centre…."*

> *"When we get money from this commercialisation, we will give it back to the children. So, we will have money to develop more products. It's a bonus if we manage to get money from it. So whatever money we will get from the commercialisation, we will use it to pay GRA* (Graduate Research Assistant) *to develop other products or we will give it to the NGO for their activities. Of course it would be great if you can generate billions. In that way, we can develop more products and help more children. We can set up more centres. So, the idea is, if we have more, we would give more."* (R12)

4.4.2.13 Project Omega: Type I

Omega was developed by R13A, a young guy with an entrepreneurial mind. He was deeply interested in developing an edutainment mobile game. Omega was to help children learn mathematics easily and in an attractive way. R13A was motivated by the extrinsic-monetary reward. With some grants, he could establish a company. Besides, this project would help his career because he could complete his studies on time element. Omega was his final year bachelor's degree project. It showed that his prosocial motivation was

extrinsically-driven. But, he was also intrinsically motivated for the passion he had in developing mobile games.

> *"She* [R13B] *helped prepare the proposal and submitted. So, it's my luck when Omega was chosen as the finalist. So I finished it up…it's my Final Year Project."*

> *"At that time, the government provided some funds. There were MDeC and Cradle Fund. I went to the interview once but failed. I succeeded after my fourth attempt… I received RM150,000 and managed to set up a private limited company."* (R13A)

4.5 The Motivating Factors

In addition to the external and internal factors, several other factors also played a role in accelerating commercialisation. Seven types of motivating factors were found: (1) research excellence; (2) government initiatives; (3) working experiences; (4) personal traits; (5) peer or family support; (6) leadership roles; and (7) commercialisation process. The following section discusses them.

4.5.1 Research Excellence

The first factor was research excellence. Academic researchers who were excellent in research actively published works at journals and developed products for commercialisation. They also held university management position.

In the case of R7, he held a top management position at the university when he commercialised his product. By doing so, he set an example for others. He emphasised the importance of research commercialisation at the university. He admitted that his position he had allowed better access to resources. Furthermore, he could make decisions that benefited his own research projects and those of his subordinates.

> *"I supported them, kindled their commercialisation desire… That is why you can see three or four academic researchers from our university had seriously commercialised their research results. I advised them not to dream of moon and stars. This thing takes time… During my leadership, my mind was focused on commercialisation…. There are some advantages of being at that high position… I had access and made decisions… it helps in a way…"* (R7).

4.5.2 Government Initiatives

The second factor was government initiatives. Government played a vital role in the academic research commercialisation ecosystem by disbursing funds and carrying out initiatives to promote commercialisation. One such initiative was organizing talks by successful academic researchers. In Malaysia, the Higher Education Leadership Academy (AKEPT) was active in organising such talks while the Malaysian Technology Development Corporation (MTDC) involved in organising spin-off company projects managed by university graduates. As mentioned by one of the academic researchers,

"You have to know which facilities are provided by the government for commercialisation. There are many grants and the researchers have to be attached to the industry… I attended a seminar last November… new insight for me…" (R2A)

The government also established spin-off companies to commercialise university research products. The government provided some funds for such purpose. R9 was happy when the government agreed to consider Theta in the latest spin-off program at his university. He said that,

"When they formed the company, they provided all the infrastructure. The machine for automatic filling, sealing and labelling. It cost them RM24,000… But, of now I have to wait until the students had finished their training first…" (R9)

4.5.3 Work Experiences

The academic researchers who had been working at the university for quite some time were involved in commercialisation for prosocial reason in addition to extrinsic and intrinsic motivation. Most of researchers interviewed in the study had been working in the academia for more than ten years. From the experience, they knew what products that were needed in the market. They also had good networks both in the academic field and with industrial partners. Moreover, the experienced academic researchers knew that industry-driven products were easier to be commercialised than research-driven products. For example, R11A had experience in the

commercialisation activities in 16 years, while R9 had worked for a number of governmental research institutes and universities during his career. They said that:

> *"Previously I was at Research Institute S. I worked on a number of products to be commercialised. I went to many firms to promote the product… I was the engineer, I was the promoter, I was the plumber, wiring… for sixteen years."* (R11A).

> *"After getting my professorship there, I am serving this university for good… I've gone all around Malaysia… but not Sabah and Sarawak… I know which product is potentially commercialised"* (R9)

4.5.4 Personal Traits

Of the facilitating factors, the most important one that affected commercialisation was the personal traits of the academic researchers. All researchers in the study had positive personal traits, including being positive thinkers. They were highly determined, patient, and hardworking. In the face of hurdles in commercialising their product, they were still resilient and persevered. They also demonstrated high religious spirituality, especially those who were Muslim. They believed that God would help in their commercialisation exercise. For instance, R12 faced many problems in commercialising her novel product for University D. However, she and her team managed to survive after several times of trial and error attempts. The same thing happened to R1A who also pioneered product for the university. They said,

> *"When we first started the commercialisation, CRIM did not have a proper mechanism yet so we sort of doing trial-and-error. Because*

back in 2008, I would rather say, the process was not that clear yet. So, we did some trial-and-error basically. That's why it took longer for us to commercialise because there was no clear mechanism." (R12)

"It was the first project; nobody had done that before…So no one had any experience. No mentor. R1A did everything. I pity him… he was like an experiment." (R1B)

But, R7 was very positive in explaining his experiences during the interview session. It shows R7's enthusiasm in inventing Kappa.

4.5.5 Peer/Family Support

The fifth factor was peer or family support. Peer and team were important in academic research commercialisation because no research could be successfully commercialised by the inventor alone. The commercialisation process was very daunting; so, the involvement of other parties would accelerate it. In case of R12, she was raised by her parents who were active in social work. In case of R1A, he was helped by his wife in his research.

4.5.6 Leadership Role

The sixth factor was leadership role. In some cases, there was a significant leader who encouraged the research commercialisation activities at the university. For University B, R7 (also R6A) was the top management person at that time who

pushed his staff towards commercialisation. During his tenure, Project Delta, Epsilon, Zeta, and Kappa were commercialised successfully.

R11A explained that the previous top management at his university was the one who introduced R11A to R11B. R12 who came from the same university also said that the person always gave moral support to academic researchers at the university. They said,

> *"Dato' Ali was the top management of the university at that time. He was very supportive. He had his own idea but he also listened to others… R11B came to Dato' Ali and he introduced him to me."* (R11A)

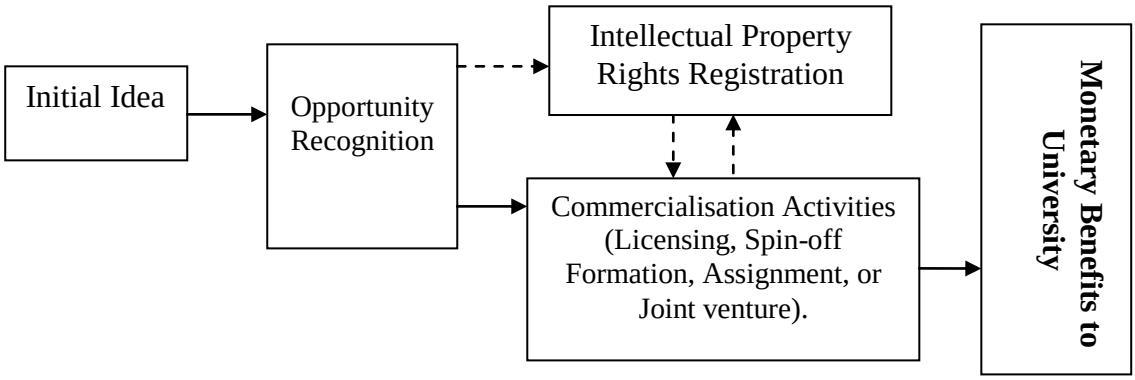
> *"I quote the words from our former top management person, Dato' Ali: When you do research, it's like you throw money into the sea. If it turns up you get something, but most of the time it does not. You cannot say that when you invest RM10,000, you will get back RM1 million. It can happen but perhaps one in every 100,000."* (R12)

The leaders instilled a research culture at the university, which was imperative for commercialisation activities. Even though all universities in this study were relatively new (less than 10 years old), the leaders appointed were prominent researchers from more established universities. In some cases, the successful academic researchers were from other established universities in the country. When they came to work at the current university, they brought with them the research culture from the previous university. For example is in this quote:

"Datuk is very good… He asked me to come to this university. He gives good incentives for the well-performed academic researchers. Now I receive money after winning medals at the exhibitions… but not at the other university… During my time with my previous university, I won six gold medals in Geneva… that is why Datuk came after me. He likes productive researchers. He invited me to join the university." (R9)

4.5.7 Commercialisation Process

Finally, the study found that the commercialisation process was the seventh motivating factor in academic research commercialisation activities. There were four major processes involved in all the 13 cases. Refer to Figure 4.5 for the commercialisation process for all research projects. The figure was drawn from the literature review and being amended with the findings from the study.



Source: Compiled by author

Figure 4.5
The Commercialisation Process of MTUN Academic Research Projects

In some cases, the mixed-motivation factors were identified along the process. For example, at the initial idea stage, the motivation factors were normally intrinsic and prosocial. However, when it came to the opportunity recognition stage, some of the academic researchers started to be extrinsically motivated, as shown in this quote:

> *"The TTO told me that Epsilon has market potential. It was then when I started to realise that Epsilon might go farther… to be commercialised and to make more sales…"* (R5)

In the case of Project Delta, at first, R4 invented the product because of the industrial partner and his passion in oil palm research. However, after the partner breached the contract, R4 had to continue marketing the product himself. He re-routed by forming a spin-off company, and at that stage, the monetary motivation came in. But, the extrinsic factor did not diminish his intrinsic and prosocial motivation to commercialise. In this case, the extrinsic motivation appeared only at the commercialisation channel stage because R4 had to re-route the channel. He said,

> *"After the company breached the contract, I was left alone to survive. I didn't know about commercialising and did some trial and error. And then, I managed to get RM68,000 sales in three month."* (R4)

Details of the commercialisation process in all cases are presented in Table 4.1. There were four stages in each process, which took place in all cases of with different typologies.

First, the initial idea stage involved source of ideas. There were three sources: (1) end-user - from the potential users of the commercialised products; (2) industry problem - from the industrial partners (who approached the academic researchers); and (3) basic research - from the literature survey or from the academic researchers' knowledge and experiences.

Second was the opportunity recognition stage where parties recognised the commercialisation potential of the research product. Those parties could be: (1) the researcher; (2) the industry; and (3) the TTO.

The third stage listed the types of intellectual property rights (IPR) registered. They were: (1) patent, (2) trademark, and (3) no patent. Six research projects were granted a patent while three of them registered for trademarks. A trademark was registered because the researchers aimed to expand or diversify the product with the same brand name in the future. Four researchers had not registered any IPR because they believed that the registration might expose them to the threat associated with patenting a product. For instance, they had to reveal all the formulae and trade secret to the patent registrar body.

The final stage of the commercialisation process was the route to commercialisation. There were six routes identified from the cases: (1) exclusive licensing; (2) nonexclusive licensing; (3) a spin-off company; (4) direct selling; (5) joint venture; and (6) assignment. In some cases, two commercialisation routes were used after the first attempt failed (refer to Table 4.1).

Table 4.1
The Commercialisation Process of the Cases

Commercialisation Process	Case Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Kappa
Initial idea	End-user problem	Industry problem	End-user problem	Industry problem	End-user problem	Industry problem	Basic research
Opportunity recognition	Researcher	Industry	Researcher	Industry	TTO	Researcher	Researcher
IPR registration	Patent	Patent	-	Patent	Trademark	-	Patent (process)
Commercialisation activities	Exclusive licensing	Exclusive licensing	Nonexclusive licensing	Exclusive licensing and spin-off company	Direct selling and exclusive licensing	Spin-off company and joint venture	Spin-off company and joint venture

Commercialisation Process	Case Omicron	Theta	Lambda	Sigma	Upsilon	Omega
Initial idea	End-user problem	Basic research	Industry problem	Industry problem	End-user problem	Basic research
Opportunity recognition	TTO	TTO	Researcher	Industry	Researcher	Researcher
IPR registration	Patent	Trademark	-	Patent	Trademark	-
Commercialisation activities	Exclusive licensing	Direct selling and exclusive licensing	Direct selling	Assignment	Exclusive licensing	Joint venture

Source: Compiled by author from the interviews.

4.6 Chapter Summary

This chapter presented the findings from the interviews with the informants. Some findings were in line with the existing literature, while some were new findings. In the subsequent chapter, the researcher discusses the findings in relation to the extant literature. Then, a finalised conceptual framework will be presented along with the underpinning theory.

CHAPTER FIVE: DISCUSSIONS, RECOMMENDATIONS AND CONCLUSIONS

5.1 Introduction

This chapter concludes the whole study. In this chapter, the study's findings are discussed in relation to the existing literature. The new motivation factor was identified, which contributes to the literature on research commercialisation. The conceptual framework and underpinning theory are also presented in this chapter. This chapter ends with recommendations and suggestions for future studies.

5.2 Discussions

In order to fulfil the research objectives, this chapter wraps up the findings from the cases. After proposing the problem statement in Chapter One, reviewing the literature in Chapter Two; constructing the methodology for the study in Chapter Three, and executing the study as discussed in Chapter Four, finally this Chapter Five concludes the whole study.

This study aims to have an in-depth understanding on the motivation factors of successful academic researchers in commercialising their research results. The interviews showed that the academic researchers were motivated extrinsically, intrinsically, and prosocially.

5.2.1 The Academic Researchers' Motivation Factors

The study found that the academic researchers commercialised their research results because of three motivation factors. Unlike previous studies that focused on extrinsic rewards (De Fuentes & Dutrénit, 2012; Geuna & Muscio, 2009; Göktepe-Hulten & Mahagaonkar, 2010) and intrinsic motivation (Baldini, 2011; Lam, 2011; Perkmann *et al.*, 2013) only, this study introduced a third motivation factor absent in academic research commercialisation literature but exists in other fields of study, which is prosocial motivation (Andersen & Pallesen, 2008; Grant & Berry, 2011; Grant, 2008). In this study, passion was identified as the intrinsic motivation factor of all academic researchers while personal traits were the shared facilitating/enabling factor.

The study found graduate-on-time as a new component of external motivation of career rewards. This new element emerged because the research projects involved researcher-student teamwork. Other components of external motivation factors are in line with the literature. On the other hand, two additional elements of intrinsic motivation factors emerged. They were a sense of belonging and sense of responsibility (in Arabic term, it is called *amanah*). However, the component emerged for Muslim academic researchers only. As Muslims, they felt that they had a responsibility to commercialise their products. Some felt that the commercialisation would benefit the Muslim community. Such finding is not surprising because most of the informants were Muslims, with the exception of only one case (Project Gamma). In addition, because of their sense of belonging, the

academic researchers would not resort to commercialising behind the university's knowledge even though they had the opportunity to do so.

The prosocial motivation factor elements in the study are aligned with the literature. Besides engaging in commercialisation to benefit the society, the finding also showed the academic researchers did so for the benefit of the industry and the environment. These two beneficiaries, which were a new finding, specified clearly what prosocial motivation is, which was originally defined as benefiting others. In this study, the term 'others' include the industry and the environment.

Benefiting the industry means that the research commercialisation offers positive result directly to the industry, that is, the industry can profit directly from the university's invention. The public good and mixed good models have been discussed in the literature (Agrawal & Henderson, 2002; Baycan & Stough, 2013). However, the mixed good model better serves the society as well as the industry than the public good model. Even though the industry profits from the commercialisation directly, indirectly the society also benefits. This is because the industry will manufacture the products for the consumption of the society. For example, in Project Sigma, R11A developed Sigma for the industrial partner, R11B. Even though R11B will sell Sigma for profit, the product will benefit the users by saving their vehicle fuel. In this case, both parties (the users and seller) will be the winners from the commercialised research products.

Research commercialisation was conducted for the benefit of the environment. As agents to the world, human beings have responsibility to take care of the environment. Islam, for example, emphasises its believers to have good

relationships in three aspects: (1) with God; (2) with man; and (3) with the environment (Qur'an 16:81; 26:183). The interviews with the academic researchers showed that they cared about the environment, and actively carried out research on how to preserve it. When the environment is preserved, the society eventually benefits. The society will lead a better and healthier life in a good environment, as a result of the academic researchers' transforming waste into useful products. Hence, this is why preserving the environment is prosocial motivation.

5.2.2 The Academic Researchers' Mixed-motivation Factors

This study also discussed the mixed-motivation factors in commercialisation. Benedetti (2012) and Diefendorff and Chandler (2010) argued that an individual's behaviour could be driven by more than one motivation at a time. This study considered three mixed-motivation factors i.e. extrinsic, intrinsic, and prosocial. Because academic research commercialisation involves a lengthy process, this study found that the academic researchers were motivated by more than one factor at a time. The mixed-motivation was closely related to the research commercialisation process. In the early stage, the academic researchers might be motivated by one type of motivation factor but at the later stages of the process, other motivation factors come in. For example, in one case, the academic researcher was being intrinsically motivated during the scientific discovery stage, then, the extrinsic and prosocial motivations came in at the opportunity recognition stage.

Previous studies focused only on one factor (Baldini, 2010, 2011; D'Este & Patel, 2007) or two factors (Lam, 2010, 2011; Levin & Stephan, 1991) namely

extrinsic and intrinsic motivations. This might be because most of these studies used quantitative methods that were not meant to discover the dynamics of how motivation works. Secondly, previous studies tended to focus on one quantifiable measure, for example, patenting records and royalty allocation (Baldini, 2010), or patent citation counts and the number of organisations cooperating with the university (Nelson, 2012).

5.2.3 The Academic Researchers' Motivating Factors to Commercialise

From the cases studied, the motivating factors can be classified into seven categories. The factors are in line with the literature, suggesting their relevancy. The factors accelerated the three motivation factors (extrinsic, intrinsic, and prosocial) either simultaneously or in sequence (refer Figure 5.1).

The first factor was research excellence. The finding corroborated the "star scientist" concept introduced by Zucker and Darby (1996). The academic researchers who excelled in their research works tended to engage more in prosocial behaviour than less productive researchers (D'Este *et al.*, 2013; Larsen, 2011). The second factor was government initiatives. Previous studies emphasised the government roles in academic research commercialisation. Some of the studies also included the importance of triple helix in the academic research commercialisation ecosystem (Etzkowitz & Leydesdorff, 2000; Göktepe-Hulten & Mahagaonkar, 2010).

Another motivating factor was work experience, which was normally treated as a demographic factor in previous studies. However, unlike previous studies, no effects of age and gender on commercialisation were found. The work experience

factor is aligned with past literature that emphasises the importance of tenure in accelerating academic research commercialisation activities (see Bengtsson *et al.*, 2009; D'Este *et al.*, 2013).

The fourth factor was personal traits. This factor includes high determination, self-confidence, perseverance, independent, resilience, and risk taking (Fini *et al.*, 2009; Ismail, 2008). In the study, the successful researchers were found to have good personal traits in order to persevere with the length commercialisation process. They were able to explore new methods to help the TTO to commercialise their research products despite the fact that the university was new and there was no proper mechanism to commercialise at the university. Four of the research projects in the study were pioneers in the commercialisation projects at their universities. The researchers' positive thinking drove them to commercialise at all cost.

The next factor was peer support. Previous studies indicate that this factor influenced academic research commercialisation (Krabel & Schacht, 2012; Tartari & Breschi, 2012). Peers include leaders and colleagues at the university, and industrial partners. Since most of the past research was done by Western scholars, family support was not emphasised much. However, given that this study was conducted in an Asian context, family support was found to play an important role in motivating the academic researchers to commercialise.

The sixth factor was leadership role. In some cases, there was a significant leader who encouraged the research commercialisation activities (Azoulay, Ding, & Stuart, 2007; Ding *et al.*, 2006). The leader was an important figure who nurtured the research culture at the university. The leader could be part of the university

management, the TTO leader, or the research project leader (Bercovitz & Feldman, 2008; Perkmann *et al.*, 2011). The TTO acted as a bridge to connect the university with the industry. Furthermore, some academic researchers entrusted the TTO to commercialise their products (Bengtsson *et al.*, 2009).

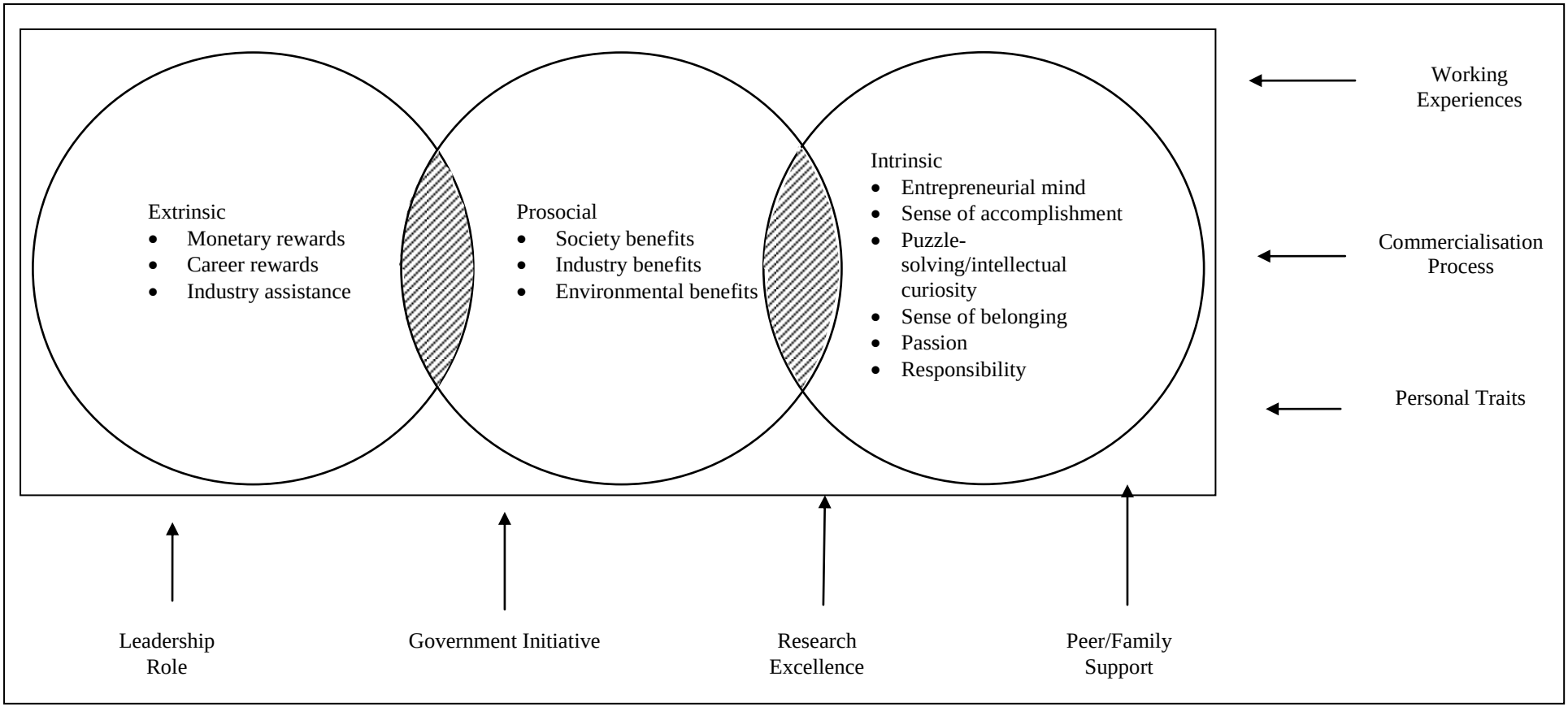
Finally, the study found that the commercialisation process itself was one of the motivating factors in academic research commercialisation. Normally, at the initial stage of the commercialisation process, the academic researchers were engaged with the industry about their research project. According to Perkmann *et al.* (2013), those who are engaged with the industry and those who commercialise have different motivation factors; while the latter is more entrepreneurial the former is more research-based. In other words, those who focus on commercialisation are primarily attracted to the monetary rewards while those who remain engaged with the industry do so to further their research (D'Este & Patel, 2007; D'Este & Perkmann, 2010; Perkmann *et al.*, 2013). Bhaduri and Kumar (2009) also discussed the transition of mixed-motivation factors along the innovation stage among the innovators in India. However, their study focused on the mix of extrinsic and intrinsic motivation factors only.

5.2.4 The Finalised Conceptual Framework

After data collection and analysis, it is important to note the role of motivating factors in affecting the mixed-motivation factors of academic research commercialisation. While the motivation factors explain "why academic researchers

commercialise", the motivating factors explain "what encourages academic researchers to commercialise".

In Figure 5.1, the extrinsic, intrinsic, and prosocial motivation factors are presented in a Venn diagram with the overlap of extrinsic-prosocial and intrinsic-prosocial dimensions. The elements found in the study are listed in the diagram along with new findings. The new findings are a sense of belonging and a sense of responsibility in intrinsic motivation; and societal and environmental benefits in prosocial motivation. The Venn diagram in the box shows the motivation factors while the motivating factors are outside the box. The arrow shows that the motivating factors influence the motivation factors of academic researchers to commercialise their research results. Seven motivating factors were identified.



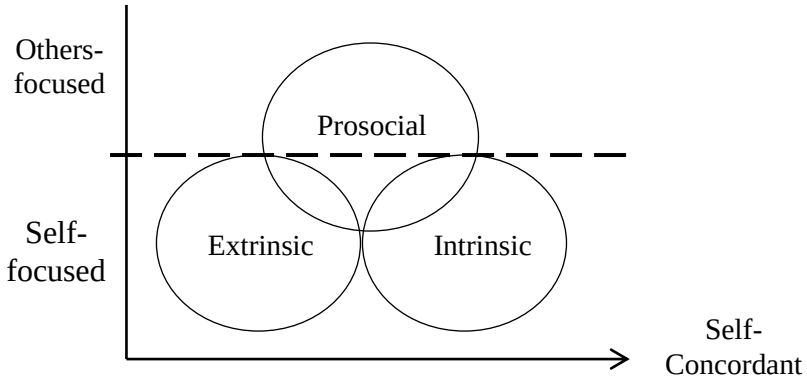
Source: Compiled by author.

Figure 5.1
The Finalised Conceptual Framework

5.2.3 Self-Concordance in Academic Research Commercialisation

The result corroborated self-concordance theory. Self-concordance refers to a state where a goal aligns with personal interests and values. A self-concordant individual is someone who pursues his/her life's goals. Thus, a self-concordant goal represents one's actual interests, passions, central values, and beliefs (Koestner, Lekes, Powers, & Chicoine, 2002; Sheldon *et al.*, 2004).

From the research findings, it can be concluded that the academic research commercialisation activity was a self-concordant goal for the successful academic researchers, regardless of whether they commercialised for the sake of it or for the sake of others. The academic researchers were intrinsically-driven and had positive personal traits to commercialise their research results. Dardak (2013) argued that one of the critical success factors for successful technology transfer is passion. Passion is an intrinsically driven motivation (Lam, 2011). In this study, all the academic researchers were passionate about commercialising their research results. Besides, they also had the personal traits that kept them motivated. Because commercialisation was in accordance with their personal goals, they persevered and were determined even though it was a lengthy process. In the case of prosocial motivation, Sheldon *et al.* (2004) noted that when one pursues self-concordance goals, one engages in an activity regardless of whether it benefits other people or own self (refer to Figure 5.2). But, those who are focused on others, their tendency to commercialise was more than those who were not (Andersen & Pallesen, 2008; Grant & Berry, 2011; Grant, 2008).



Source: Compiled by author.

Figure 5.2
Self-concordance, the motivations, and the focused

It is interesting to note that the mixed-motivation factors found in the study explain that the research commercialisation activity was self-concordant with the academic researchers involved in the 13 successful research projects of MTUN universities. They believe that the activity was in line with their goals in their careers. They are self-determined to juggle with all daunting tasks in commercialising their research results. Moreover, for those who are others-focused or prosocially motivated, their tendency to commercialise was more than those who are not (Andersen & Pallesen, 2008; Grant & Berry, 2011; Grant, 2008). If the goals are non-concordant, the academic researchers would give up if any barriers or challenges came to their way along the commercialisation process. Even if the goals are achieved, the effectiveness of the goals could be lower than those who are self-concordant (Sheldon & Gunz, 2009).

5.3 Recommendations

This section offers some recommendations to the stakeholders of academic research commercialisation on how to increase the research commercialisation rate.

In this study, the academic researchers were found to be motivated by extrinsic and intrinsic rewards. Hence, the government should retain the existing incentives to encourage commercialisation. The focus should not be at the IPR registration only, but also at the potential products that are marketable even without the IPR. The government should encourage the industry personnel to visit universities and other academic institutions to examine the new inventions that have the potential for commercialisations. Such visits also help build good relationships with academic researchers. The quadruple helix model (QHM) that is being implemented by the Malaysian government may be helpful to link the industry people with academic researchers. The government may champion the research commercialisation by being the first user of the research products produced by the local universities. This strategy may create a new market for the university's research products and attract big multinational companies to acquire the technology too (Behboudi, Jalili, & Mousakhani, 2011).

The academic researchers were also motivated by prosocial factors. The university's management should encourage them to have good networking with the industry to identify the market needs. The management can also provide a programme where the academic researchers can complete their sabbatical or develop an industrial attachment programme at the industry to enable them to know more about the market demand.

It is also important to develop and nurture a research culture at universities to encourage commercialisation. One way to do this is by appointing someone to take a role of a leader who shares similar values and goals. Multidisciplinary research across diverse faculties should also be encouraged. For example, Project Beta (i.e. the portable Quran incinerator) was led by a researcher from the manufacturing faculty. But, the environmental faculty should also be involved to ensure that the air level is acceptable. The business faculty is needed for marketing, while the IT faculty can develop software to operate the incinerator. Besides relying on industry takers for their products, academic researchers may also consider forming their spin-off companies themselves by using this channel. Therefore, the university would generate more income than if it were to license the product.

The university's TTO also has to improve their roles in accelerating commercialisation at the university. Employees at the TTO should not be frequently changed to ensure continuity in the management. They should also be trained well to reach the standard of top universities such as Harvard University and Massachusetts Institute of Technology (MIT) on how to commercialise successfully. Furthermore, the TTO has to be reasonable in determining the amount of royalty given to academic researchers. This is to prevent them from commercialising behind the university's back.

5.4 Future Studies

Future studies should identify the motivation factors of academic researchers at other universities, either local or foreign. By doing so, comparisons can be made so that a

good model of successful commercialisation that is suitable to the local context can be developed.

Future studies may also apply other research methodologies, whether mixed-method or quantitative, to validate the present study's findings. Multiple case study method can also be used as compared to the single case study applied in this study. Besides, future studies may investigate the applicability of self-concordance theory to non-successful academic researchers or to those who are novel in commercialisation. It is because the activity is self-concordant to those who were successful but may be less or non-concordant to the non-successful academic researchers.

As this study found that the research commercialisation process also might influence the academic researchers' motivation, further research can be done to focus on the impact of each commercialisation process to the motivation factors. Finally, future studies can consider investigating mixed-motivation beyond academic research commercialisation activities and the field of technology management such as organisational behaviour and human resource management.

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