COMMERCIALISATION OF ACADEMIC RESEARCH
AN EVALUATION OF GOVERNMENT AND INSTITUTIONAL SUPPORT FOR COMMERCIALISATION OF ACADEMIC RESEARCH IN MALAYSIA

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A thesis submitted in part fulfilment of the requirements of Nottingham Trent University for the degree of Doctor of Philosophy

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ABBREVIATIONS AND ACRONYMS

ACE	Access, Certainty and Efficiency – MESDAQ
APITD	Action Plan for Industrial Technology Development
ARDC	American Research and Development Corporation
CEPP	Chemical Engineering Pilot Plant
COE	Centre of Excellence
CRDF	Commercialisation of Research and Development Fund Development
EOI	Export-Oriented Industrialisation
FDI	Foreign Direct Investment
FRI	Forestry Research Institute
GDP	Gross Domestic Product
GERD	Gross of Expenditure of National R&D
GNP	Gross National Product
GRI	Government Research Institute
HEBI	Higher Education Business Interaction
HICOM	Heavy Industries Corporation of Malaysia
ICA	Industrial Coordination Act
ICT	Information and Communication Technology
IHL	Institutions of Higher Learning
IIA	Investment Incentive Act
ILO	Industrial Liaison Office
IMP	Industrial Master Plan

IMR	Institute of Medical Research
IP	Intellectual Property
IPCP	Intellectual Property and Commercialisation Policy
IPO	Initial Public Offering
IRPA	Intensification of Research in Priority Area
ISI	Import-Substitution Industrialization
MARDI	Malaysian Agricultural Research and Development
MASTIC	Malaysian Science and Technology Information Centre
MAVCAP	Malaysian Venture Capital Management
MDTCA	Ministry of Domestic Trade and Consumer Affairs
MESDAQ	Malaysian Exchange of Securities Dealing and Automated Quotation
MIDA	Malaysian Industrial Development Authority
MIGHT	Malaysian Industry-government Group for High Technology
MIMOS	Malaysian Institute Of Microelectronic Systems
MIPC	Malaysian Intellectual Property Corporations
MITI	Ministry of Trade Industry
MNC	Multi-National Company
MOF	Ministry of Finance
MOHE	Ministry of Higher Education
MOHR	Ministry of Human Resource
MOSTI	Ministry of Science, Technology and Innovation
MP	Malaysian Plan
MPOB	Malaysian Palm Oil Board
MTDC	Malaysian Technology Development Corporation
NCSRD	National Council for Scientific Research and Development
NDP	National Development Policy
NEP	New Economic Policy
NIPP	National Intellectual Property Policy
NIS	National Innovation System
NSI	National System of Innovation
OECD	Organisation for Economic Co-Operation and
OPP	Outline Perspective Plan
PORIM	Palm-Oil Research Institute
R&D	Research and Development
RRI	Rubber Research Institute
RU	Research University
S&T	Science and Technology
SIRIM	Standards and Industrial Research Institute of Malaysia
STP	Science and Technology Policy
TTO	Technology Transfer Office
UMP	Universiti Malaysia Pahang
UTeM	Universiti Teknikal Malaysia
UTM	Universiti Teknologi Malaysia
VCC	Venture Capital Companies

Abstract

Governments have realized the increasing importance of the role of universities play in creating and diffusing knowledge as part of the process of innovation. Similarly, universities are now recognised as the seed bed for business firm formation. This has led to the commercialisation of academic research within publicly funded research institutions such as universities receiving increasing recognition in studies of technology management and economic development. Numerous programmes and supporting facilities have been made available by governments to enable universities to share the 'laboratory life'. Despite positive supports from government and universities, little research has been carried out into such activities in the context of developing economies. This study aims to fill the gap by studying the commercialisation activities of universities in Malaysia.

The study investigates the role of government and universities by focusing on their initiatives to promote the commercialisation of academic research in universities. The main objective of the study is to understand the current trend of commercialisation activities in Malaysian Universities. A qualitative-interview is used as the main method of data gathering from the three universities. This study found out that the effect of entrepreneurial university is still very much limited in the three universities. The Government takes a moderate stand by giving a full autonomy to the universities on the implementation of academic commercialisation activity. The study also shows that the type of academic commercialisation i.e. spin offs formation, licensing, knowledge transfer and consultation is influence by the type of university i.e. Research University and Vocational University in the three universities. The third finding from this study is the failure to address the personal motivation of academic staff.

The findings have important implications not only for Malaysia but all developing countries seeking to enhance their innovation capability.

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Chapter 1

Introduction

1.1 What this study is about

This exploratory study intends to provide an in-depth understanding on the initiatives and measures implemented at the government and university level in promoting commercialisation of academic research in Malaysian Universities. It sheds some light on the issue of commercialisation in the context of developing economies. Furthermore this study is in line with the Malaysian government's initiative in promoting knowledge-based economy through technological development in Malaysian Universities. More importantly, this study will provide understanding of the current scenario of commercialisation activities in Malaysian Universities.

This study also seeks to investigate to what extent government and university assistance help academics to commercialise. It is anticipated that this study will provide critical views from academia on the new role they have to play in advancing commercialisation. It also provides an opportunity to investigate the adjustment in the university system in adapting to the new expectation from the government and the public as one of the key players in regional and national economic development (Martin and Etzkowitz, 2001). As scientific knowledge is increasingly becoming an important agent for innovation and business development (Mansfield and Lee, 1996) and the application of the scientific knowledge creates innovation (Newell et al 2002), identifying the best practice in promoting commercialisation is important as a competitive advantage in the country. This study examines three technology-based Universities in Malaysia, namely: Universiti Teknologi Malaysia, Universiti Teknikal Melaka and Universiti Malaysia Pahang. As an academic staff member of a University, the researcher is well placed to collect data for the study. Furthermore it is also easy to establish rapport and comradely among fellow academics.

This thesis will start off with an overview of the Malaysian national innovation system and technological development.

1.2 Overview

In several countries, the government takes the role of supporting science and technology development as an indirect role (i.e. science and technology policymaking, providing infrastructure, providing funds and incentives for science and technology activities), as well as a direct role (i.e. direct involvement in government research institution and laboratories) (Hsu and Ching, 2001; Lockett and Wright, 2005; Meyer-Krahmer et al, 1983). In Malaysia, the first Science and Technology Policy (STP) was implemented under the Fifth Malaysian Plan (1986-1990). The formulation of the STP is the evidence of the Malaysian government's attempt on strengthening the National Innovation System (NIS)[1]. The STP provides general guidelines as an effort to promote science and technology development in the country. In 1990, the Action Plan for Industrial Technology Development (APITD) was introduced to boost the science and technology policy after the government identified several basic structural weaknesses in Malaysian technology development.

Following the recommendation by APITD, new policies and strategies were identified under the plan. Malaysian Technology Development Corporation (MTDC) was incorporated in 1992, as part of the reformation in boosting technological development in Malaysia. The main function of this institution is to promote research and development (R&D) activities by providing necessary assistance to Institutions of Higher Learning (IHL) and Government Research Institutes (GRIs). MTDC was responsible for managing a government special purpose grant specifically focusing on the commercialisation activities amongst the academic and researchers in GRIs and IHL. The special purpose grant, Commercialisation of Research and Development Fund (CRDF), was the second funding initiative provided by the government besides the Intensification of Research in Priority Area (IRPA). The IRPA was established in 1986 with the intention to focus on R&D activities which are in line with the national R&D priority area whereby CRDF is specifically meant for commercialisation activities i.e. the formation of spinoff companies and through joint ventures between the industry and the university.

[1] OECD defines National Innovation System as a web of interaction or the system in achieving a certain level or output in technological development.

The main rationale of the implementation of CRDF is to assist academics to commercialise their research output. Conventional funding from financial institution (i.e. commercial banks) is difficult to secure since high technology business is associated with high risk investment (Bovaird, 1990). Funding for high-risk ventures or the provision of venture capital is important in order to promote commercialisation activity amongst academics in universities (Samila and Sorenson, 2010). The importance of funding for commercialisation has arisen due to the increasing role of universities in the country's national innovation system (Etzkowitz, 2008; Godin and Gingras, 2000). As universities are considered to be agents in technology and economic development (Mansfield and Lee, 1996) and the fact that technology directly affect everyone's life (Florida, 2002), it is important to understand the role of universities and governments in promoting commercialisation. Through understanding of the perspectives of academic on university and government initiatives and the types of assistance available will give an overview of the current trend in Malaysian universities when it comes to commercialisation activities.

This area of study received substantial interest over the past decade amongst academic, practitioner and policy makers. It is, therefore, this thesis is concerned with the issues on commercialisation activities amongst academic from Malaysian universities specifically looking at the support mechanism from government and university. The increasing attention paid to the commercialisation activities shows a growing phenomenon in Malaysia. Furthermore, a commercialisation activity is a symbolic evidence of an extension of university traditional function and relates to the economic development in the most indirect ways. Above all, commercialisation of academic research represents a specific context for the development path of innovations.

The mechanisms by which university output can be commercialised can be in a number of different forms; the development of university spin off companies, joint ventures, contract research, licensing the university IP and consultation services by university staff. The definition of commercialisation in this thesis consist all of the above but focuses more towards the commercialisation of IP.

1.3 The Rationale for the Study

According to Nelson (1993), one of the major contributors towards the development of technology capabilities in a country are the universities. Over the years, the growing importance of knowledge distribution has been acknowledged by many countries as a driving force for industrial competitions (Noble, 1977; Nelson, 1993). In recognition of this fact, governments in many countries; developed (Defazio et. al., 2009; Rasmussen et. al., 2006; Landry et.al. 2006; Gregorio, 2003) and developing countries (Wong et. al., 2007; Asgari and Yuan, 2007; Zhou, 2008) have taken a series of initiatives to promote the importance of academic research, commercialisation and innovation. Furthermore, the role of universities worldwide is shifting and becoming more critical (Etzkowitz, 2008) and forms an important part in knowledge-based economy (OECD, 1997; Neef, 1998; Godin and Gingras, 2000). Therefore in Malaysia universities are now critical institutions in the country's NIS (Nelson, 1993; Godin and Gingras, 2000).

The evolution of university's functioned from teaching to research to entrepreneurial university can be traced back from the 19^{th} century. The earliest example of so called modern university was established in Germany. Gustin (1975) identified in his thesis several chemistry professors engaging themselves in spin off companies commercialising their research output. In United States, even though it is relatively limited in terms of commercialisation and the formation of spin off companies, there is evidence of professors founded a company to commercialise university technologies. The creation of land grant universities in American university system for example, had a direct effect in encouraging the development of spin off companies to exploit university's invention. The Hatch Act of 1887, which established the land grant system, was based on the principle of technology commercialisation. This act called on universities to develop and disseminate knowledge developed in the University for economic development (Rosenberg and Nelson 1994).

The new role for universities in society with respect to academic commercialisation or entrepreneurial university has become increasingly important for innovation and business development. Modern university are actively engaged in advancing knowledge particularly in science and engineering. The university has increasingly

developed their scientific capabilities that have given rise to scientific breakthrough and discoveries which lead to the creation of new technology. In the past it is expected that these scientific discoveries is commercialised by firms and industry, as they have better economies of scales and scopes in making the business venture successful. However, the scenario has change. Modern university received new challenge; an extension from the traditional function of university which is commercialisation. Academic commercialisation requires university, using their own facilities and expertise, to generate university income through the formation of spin off companies, licensing, contract research and consultation. The transition from research and teaching university to this type of University is the results of government and public demands on research outcome from the university. Many government have already provide support mechanism to encourage universities to venture into academic commercialisation. This reforms both through the changes in the academic system and instruments calls for policy change. The introduction of Bayh-Dole Act in the US for example, is one of the most influential and well known policies that encourage commercialisation activities amongst the universities. This act gave the research institution the right to control their intellectual property of their inventions that resulted from the government funding.

The academic commercialisation can take into a number of different forms. The simplest classical model of academic commercialisation is where a scientist made a scientific breakthrough and developed a prototype to 'proof the concept'. Once the 'proof of concept' stages are completed, the scientist will submit for IP protection to the proper authority. After the submission, the university's technology transfer office will then act as a middleman to find interested parties to collaborate in commercialising the research product. The technology transfer office can also assist academic to form their own spinoff companies. In reality academic commercialisation is more than that. Academic commercialisation can be in the form of knowledge transfer, services and consultation, in which academic and scientist use their knowledge to provide services. It is clear that monetization of IP is the main forms of academic commercialisation but it is also increasingly clear that academic commercialisation can be done in different ways. On the broader definition, academic commercialisation is an activity that involves university staffs in selling off university's research output and expertise to the industry and public.

From the economic perspective, academic commercialisation promotes local economic development by transforming university technology into business opportunities. This is because most of the economic activity (hiring, sourcing of supply, production and etc.) are from local. Academic commercialisation also generates a significant economic value to the local economy. According to Cohen (2000), American university spinoff generated USD33.5 billion measured by the amount of financial value they generated between 1980 to 1999. That is, the average of American university generated economic value is about USD10 million a year. Besides financial rewards, academic commercialisations also have a significant impact on job creation. According to the Association of University Technology Managers, spinoff companies from American academic institution generated 280 000 jobs between 1980 to 1999, an average of 83 jobs per Spinoff Company (Cohen, 2000).

The Government and universities in Malaysia have provided equal support and initiatives for the development of innovation and commercialisation activities as much as in other countries. At the national level, however, the development shows some slow-moving progress given that Malaysia is targeting to become a fully developed country by the year 2020. By comparing the GDP in Research and Development (R&D) expenditure (0.63%) with other Asian countries, Malaysia is still behind Singapore (2.24%), Taiwan (2.42%) and Korea (2.63%).

From a university perspective, the low R&D expenditure shows that the economic return from R&D activity is still small. This is an indication that innovation and commercialisation activities may not attract a positive attitude amongst the researchers or there is a lack of awareness of the potential economic return that can be gained from research output. As the role of universities is increasingly important in the national innovation system, two ministries are now responsible for universities affairs. These are the Ministry of Higher Education (MOHE) and the Ministry of Science, Technology and Innovation (MOSTI). The MOHE is responsible for governing Malaysian higher education institutions towards becoming premier knowledge centres in the region. This is done through the implementation of appropriate policies and education system within the local universities. The MOSTI, on the other hand, is responsible for upgrading the national science and technology

capabilities. Both ministries are responsible in technological development by assisting universities and government research institutes to conduct research, development and commercialisation. The majority (90%) of the university funding for research and development is provided by MOSTI.

From academic point of view, commercialisation is an additional task or requirement besides teaching and research. Commercialisation creates more responsibilities and is a challenge to academics. However, with it comes recognition and proof that the research output can contribute to the society besides providing a financial return through licensing and ventures. This trade balance between burden (more responsibility), potential gain (financial and recognition) and the choice that the academic has to make is worth studying in order to gain an in-depth insight regarding the current role of academics in the so-called entrepreneurial university.

Given the current state of technology development in the country, and the country's target to become a fully developed country by the year 2020[2], it is prevalent to understand the role of government and university in promoting technological development in the country. The role of academic in contributing economic return should be understood as academics play key role in university. These three main players (government, university and academic) constitute important elements in the country's technological development in order to achieve the country's national aims.

1.4 Personal Influence on the Study

The researcher's interests in this area developed following participation in one of the commercialisation initiatives at their university. Having an educational background in finance and management and as an academic staff in one of the selected universities, the researcher was involved as a consultant in financial analysis for the

[2] Vision 2020 was introduced by the former Malaysian Prime Minister (His Excellency Dr. Mahathir Mohamad). This vision was presented during the tabling Sixth Malaysian Plan. The main target is to achieve a fully developed country with Malaysian's style which includes not only be developed in economic sense but also along all dimensions politically, socially, spiritually, psychologically and culturally. The vision also stresses out the national unity and social cohesion, quality of life, social and spiritual values and confidence. There are 9 challenges presented in the doctrine that Malaysian state needs to address.

project. The project, the brain child of one Professor, involved the development and production of a compressor for use in an air conditioning unit.

Being an academic staff in one of the university gives the researcher an advantage of the surroundings factors. It gives easy access to university information and necessary assistance from the university such as working station and office facilities. Interview appointments are much easier to set up with the help from the faculty members. One important advantage is the experience the researcher hold after working with the university for the past 12 years. It gives the researcher an insight particularly on how the university system changes over the years. The down side of researcher's employment in the university is that the researcher tends to ignore and overlook the university system and neglecting important assumptions. The power of observation is less, looking at it on everyday basis instead of looking at one time. The researcher's employment proves to have certain handicapped in the study but also have some equally considerable amount of advantages and benefits.

In the course of participating in commercialisation project, casual observation suggested that commercialisation was not popular among academics and was a complicated process within the university. This triggered the researcher's inquisitive nature and interest in the issue of commercialisation especially in securing additional funding from the government. More importantly, the researcher identified the university is in possession of a large number of patents but none of them has been exploited provoking intellectual interest in the occurrence of this phenomena in the University.

Drawing from the above observations, the researcher's interest in the subject of commercialisation and technology development has developed from simple observation to a strong academic interest. It is therefore the intention of the researcher to explore the current landscape of commercialisation activity in Malaysian universities.

1.5 Research Questions and Research Objectives

The aim of this investigation is to explore the commercialisation of academic research activity in Malaysia. This is to be undertaken through a study of government and university policies and initiatives in promoting commercialisation activity and its impact on Malaysian universities. In order to better understand the current trend of commercialisation in Malaysian universities; two broad research questions were put forward to guide this study.

1. What is the nature of commercialisation of academic research activity in Malaysia?
2. What factors motivate academics to venture in commercialisation?

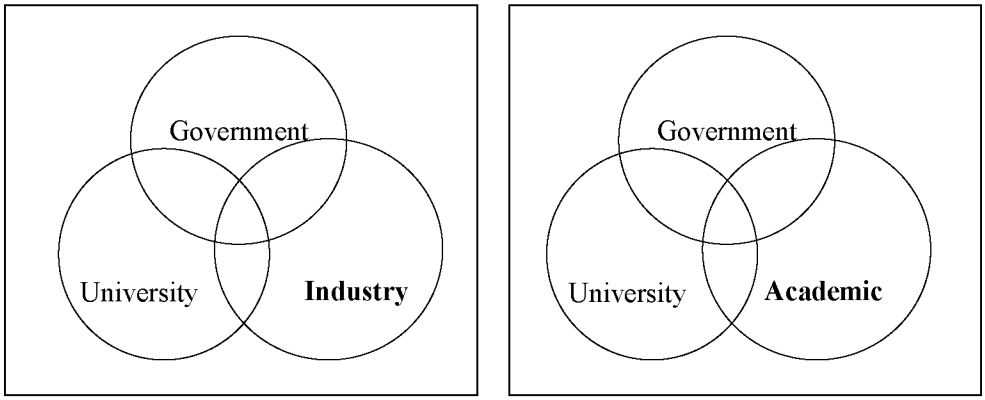
The main objective of the study is to explain the role of the government and Universities in promoting commercialisation of academic research in Malaysian technical-based university. This study also aims to understand the involvement of academics in entrepreneurial activity. The objectives of the study are:

1. To explore the Malaysian government's initiative in promoting commercialisation of academic research.
2. To examine the institutional initiatives and programmes in helping academics to commercialise academic research.
3. To evaluate a range of factors that promotes and impedes commercialisation of academics research.

In order to understand the current trend of commercialisation and the impact of government and universities assistance towards academia in promoting commercialisation, this study borrows from the triple-helix concept introduced by Eztkowitz. The triple-helix concept explains the link between the government, the university and the industry in technological development. Given the main idea of the concept, this study will employ the triple–helix concept as the conceptual framework. According to Miles and Huberman (1994), the conceptual framework explains the main things to be studied and the presumed relationships among them. In other words it is a researcher's map of the territory of whom and what will and will not be studied.

However, for the purpose of this study, a modification of the concept will be made to suit the objectives of the study. Instead of including industry in the existing concept, this study will adopt the academic perspective as shown in Figure 1.1. By using the framework, this study will argue that the framework can be fit to describe commercialisation activity in Malaysian universities.

Figure 1.1 The Triple-helix Models and the Conceptual Framework



Triple-helix Model **Conceptual Framework**

Each intersection will highlight the common views shared on commercialisation activities among the Universities, Government and Academia. Each theme will produce valuable views on factors that facilitate or/and impede the process of commercialisation in Malaysian universities. The middle intersection is the focus of the study where it is anticipated that it will shed some light on the factors that promote commercialisation activities in the public research institutions.

1.6 Structure of the Thesis

This thesis will be organized into nine chapters. The First Chapter consists of the overview of the study and the rationale for the study. This chapter also offers the research questions and objectives to guide the empirical research. The Second Chapter will present relevant literature particularly looking at the industrial development, NIS and technology development in the context of the Malaysian economy. The second part of the literature review will be continued in Chapter Three. This chapter will discuss the involvement of government, university and academic in technological development in the context of triple-helix. The literature

will particularly look at the initiatives and motivational factors that facilitate transfer of technology and Intellectual Property (IP) exploitation. The Fourth Chapter will outline the methods used in the study. A case study approach is used in the present study and the justification of the research process is offered in this chapter.

Chapter Five will provide the background of the three technical-based universities used in the present study. It discusses the physical structure of the particular university relating to technological development and commercialisation activity. Chapter Six will present analysis and findings from individual perspectives on commercialisation activity in the university. This chapter offers to answer the second research question put forward in this study. Chapter Seven presents analysis from an institutional perspective. This chapter highlights facilities and initiatives applied by universities towards the commercialisation activities. Analysis and findings from the government perspective are discussed in Chapter Eight. This chapter will look particularly at the government initiatives and intervention in facilitating commercialisation activities in the university. Finally Chapter Nine draws together the conclusions and recommendations of the study. The limitations of the study and the potential areas for further studies will also be presented in this chapter.

Chapter 2

Malaysia Industrial and Technological Development

2.1 Introduction

This chapter will present a review on Malaysia's historical and economic background. The main purpose of this chapter is to give an insight on Malaysia industrialization process and technological development. It gives the understanding behind the transition of Malaysian economy from agriculture-based to manufacturing-based and explains the reason behind the importance to develop country's technological capability. This chapter also will shed some lights on the role of government in promoting research and commercialisation.

This chapter starts by explaining Malaysian industrial policy and its industrialization process. This section presents the transition of Malaysian economy based on the four important phases. Comments on Malaysian industrialization will be presented at the end of the section. It will followed by an overview of the concept of national innovation system in Section 2.3. A brief definition and the uses of the concept give general ideas of the Malaysian national innovation system, which will be elaborately discussed in Section 2.4. Section 2.5 shows the performance of Malaysia's technological development. This will be followed by the role of government in promoting research and commercialisation activity in the country. The last section will conclude the chapter on the government role in technological development.

2.2 Malaysia Industrial Policy

Industrial policy is any form of state intervention, whether directly or indirectly, with the aim of raising factors of production in the country to achieve desirable outcome or the nation's goals. Coates (1996 p.23) gives an explanation on the definition of direct and indirect state intervention where according to him, direct policy intervention is policy geared specifically to enhance the market performance of certain industrial sectors while the indirect industrial policy is the effects on those sectors that were

triggered because of economic impact or social policy concerns. Grant (1982), on the other hand, defines industrial policy as

> *"A set of measures used by the government to influence the investment decisions of individual enterprises -public and private- so as to promote such objectives as lower unemployment, a healthier balance of payments, and a more generally efficient industrial economy"* (Grant, 1982, p. 7)

In Malaysia, the government has implemented a number of measures to develop the country's local industrial capabilities. Some of these measures were implemented through direct intervention by the government such as policy and initiatives and indirect intervention such as the formulation of policies that indirectly affect the country industrial strategy. Malaysia demonstrates the use of both intervention approaches in the developing country's industrial policy.

The evolution of Malaysia's industrialization can be divided into four phases of development (Jomo and Edwards, 1993). These four phases are

- First phase - import-substitution industrialization (ISI) from the late 1950s to the late 1960s.
- Second phase - a period of export-oriented industrialization (EOI) in the late 1960s.
- Third phase - import-substitution involving heavy industrialization in the second half of 1980s.
- Fourth phase - second push of export-oriented industrialization and market-oriented policies (1980s-mid-1990s) and High Value Added and Knowledge-Based Industry (mid 1990s-present)

- **First phase of import-substitution industrialization (ISI)**

In the first phase of ISI, Malaysia continued the laissez-faire industrial policy and focuses on the development of basic infrastructures to attract investments from international and local investors. These infrastructures include the development of

industrial estates, power supply, upgrading the road systems and communication system. Even though it was prevalent at the time that the level of poverty was relatively high and the income disparity between ethnic groups was still in existence, the government decided not to interfere with the market (Alavi, 1996). Much of the planning was focused on expanding commercialisation of agricultural products. This hand-offs policy by the government was continued until the breakout of post-election racial riots in 1969.

- **Second phase export-oriented industrialization (EOI)**

The second phase of industrial policy showed that the government took a direct intervention in the industrialization process. The limited successes of import-substitution industrialization and the separation of Singapore in 1965 made the government shift to export-oriented industrialization. The first phase of ISI of the 1960s faced a number of limitations such as saturation of domestic market and failure to penetrate export markets. It also failed to overcome the excess labour, leading to a relatively high unemployment level and subsequent political instability.

The new policy started with the implementation of Investment Incentive Act (IIA) in 1968 to encourage the production of light manufactures in the country. Under the IIA, non-pioneer export oriented firms were given the same incentives as pioneer status firms under the provision of the 1958 Pioneer Industries Ordinance. Special incentives were introduced to local export-oriented firms such as deductible taxable income for promotional expenses, export allowance, financing and insurance facilities by the government (Khalafalla and Webb, 2001).

In 1971, the Free Trade Zones Act was also implemented by the government with other related labour laws of which the main idea was to attract export oriented Foreign Direct Investment (FDI). The incentives and facilities to promote export oriented FDI provided by the government is complemented with the foreign MNC's interest in finding and locating their labour intensive assembly to lower cost countries as a result of rising production cost in their home countries (Jomo and Edwards, 1993; Alavi, 1996; Jomo and Felker 1999).

In addition, the restriction of labour unionization by the government gave an opportunity for the MNCs to invest in Malaysia with low-cost production sites. The MNCs managed to employ low wage labour in Malaysia to assemble imported raw materials and components to export. The EOI drives contributed significantly to Malaysia economic activity mainly in the manufacturing and agricultural sector (see Table 2.1).

Table 2.1: Share of Manufacturing and Agricultural Sectors in Gross Domestic Product (1955-2005)

Year	Manufacturing Sector	Agricultural Sector	Others	Total
	%	%	%	%
1955	8	40	52	100
1960	9	38	53	100
1965	10	32	58	100
1970	13	31	56	100
1975	16	28	56	100
1980	20	23	57	100
1985	20	21	59	100
1990	27	19	54	100
1995	27	10	63	100
2000	33	9	58	100
2005	36	7	57	100

Source: Figures from 1955-1990 are taken from Alavi (1996:30). Figures for 1995, 2000 & 2005 are from EPU (Eight Malaysian Plan)

- **Third phase - second push of import-substitution industrialization (ISI)**

The heavy industrialization strategy was aimed at deepening and diversifying the industrial structure through rigorous participation from local firms, *bumiputra*[3]-owned small and medium scale industries and the local technological capabilities. These industries includes the national car project, motorcycle engine plants, iron and steel mills, cement factories, a petrol refining and petrochemical project. All of these industries required a long-term investment and a huge financing assistance which was spearheaded by the government.

The Heavy Industries Corporation of Malaysia (HICOM), a public sector agency, was established in 1981 to lead the heavy industrialization programmed. However the heavy industrialization program burdened Malaysia with extreme public expenditure, which rose significantly from RM0.33 billion in 1981-1985 to RM2.55 billion

[3] *Bumiputra* or 'son of the soils' is a Malay term used widely in the 1970s when the government implemented economic policies that favor the Malay and the indigenous people of Sarawak and Sabah.

between 1986-1990 (4th & 5th Malaysian plan) and mostly financed through external borrowings. Apart from the enormous injections of public funds, the industries were heavily protected through tariffs and imported restrictions and licensing requirements.

Despite the significant protection from the government, the performance of the heavy industries in the early years was rather weak, due to the recession in the mid-1980s and the high external debt. Malaysia's external debt rose from 9.5 percent of GNP to about 42.4 percent in 1986[4]. The heavy industries suffered serious financial losses due to the lower than targeted domestic demand and high operating cost. This forced the government to privatize a number of government-owned enterprises. Under the privatization scheme, some of the heavy industries performance showed improvement. To certain extent a number of products managed to penetrate the international market. The overall strategy and action taken by the government with respect to heavy industries demonstrated further liberalization of the economy and industrial policies.

- **Fourth phase - second push of export-oriented industrialization and market-oriented policies (1980s-mid-1990s) and High Value Added and Knowledge-Based Industry (mid 1990s-present)**

It should be noted that while the process of industrialization had gradually taken place in the country, the agricultural sector, mainly rubber, palm-oil and the tin-mining sector, still accounted for the major contribution to the country's economy during the period. In the mid 1980s, the manufacturing sector became the main industry under the new Mahathir's[5] administration (see table 2.1). The first industrial master plan was also launched in the same year. According to Alavi (1996), the second push of the EOI made the Malaysian market more liberalized for foreign investments and more export promotion incentives. However, at the time, Malaysia's technological development and resources were still under developed. The Malaysian technological industry relied heavily on international linkages for technological information and resources.

[4] Various Bank Negara Report
[5] The fourth Prime Minister of Malaysia since its gain independence in 1957. Dr. Mahathir Mohamad was in office from 1st July 1981 until October 2003.

By the end of twentieth century, whilst the Malaysian economy was characterized by FDI-based and export oriented manufacturing, the government focus had shifted to more high-value added manufacturing and knowledge-based industries such as ICT and biotechnology. Table 2.2 summarizes the evolution of Malaysian industrial strategies.

Table 2.2: Evolution of Malaysia's Industrial Strategies

Industrial Strategy	Policy and Initiatives	Characteristics
ISI (1957- early 1970s)	Pioneer Industries Ordinance, 1958	• Domestic market oriented • Main products: simple consumer good
EOI (early 1970s-early 1980s)	Investment Incentives Act, 1968 Free Trade Zones Act, 1971 Industrial Co-ordination ACT, 1975	• Export-oriented • Free Trade Zones • Main products: Consumer electronics and textiles
ISI (early 1980s – mid 1980s)	Heavy Industries Policy	• Domestic market oriented • Main products: Consumer durables, intermediate & capital goods
EOI (mid 1980s – mid 1990s)	Industrial Master Plan 1986-1995 Promotion of Investment Act 1986	• Encouragement of exports of manufacturing products • Manufacturing industry as the dominant sector in the economy • Main products: Resource-based products (food, rubber, palm-oil, woods, chemical and petrochemical products); electronics
EOI High Value Added and Knowledge-based Industry (mid 1990s to present)	Second Industrial Master Plan 1996-2005 Knowledge-Based Economy Master plan (2002) National Biotechnology Policy (2005)	• Encouragement of high value added manufacturing and knowledge-based industry such as ICT and biotechnology

Source: Adapted from Alavi, 1996:32

2.2.1 Comment on Malaysian Industrialization

The practice of liberal laissez-faire type of intervention proved to be unsuitable for Malaysian industrialization development. Considered as young and relatively under developed, Malaysian government needs a strong and direct intervention in

formulating Malaysia's industrial policy. The direct intervention was also due to the external factor (i.e. crisis) that had happened in the Malaysian economy. Albert Hirschman (1993) in his book on the study of policy-making in Latin American countries stated that one of the major determinants of policy is the occurrence of a crisis. A crisis is defined as events that occur and have a direct impact on the country. It can be considered to be the main avenue for the policy-maker to formulate new policies. In other words, policy initiatives will be debated under political pressure where the problem is highlighted and put on the main agenda. Thus political interest plays an important part in formulating new policies.

In this context, a number of crises that had happened in Malaysia resulted in the direct intervention by the government. The racial riot in 1969 showed an excellent example of direct intervention by the state by implementing policy and government plan to rectify the major problems of socio-economic imbalance. The political pressure forced the government to formulate a new policy: the New Economic Policy (NEP), with the intention to address what it is believed to be the basic economic problems. The NEP was formulated with two-strong objectives: "to reduce and eventually eradicate poverty by raising income level through increasing employment opportunities among Malaysians irrespective of race" and "to correct economic imbalance and abolish the identification of race in certain industries".

Under the second objective of the NEP, the Malaysian government set a target 30% of the national wealth should be transferred to the Malays by the year 1990 (NEP termination date). It can be argued that the formulation of NEP in 1970 was to break from the previous policies (policies under the influence of British Government) and that the formulation of the NEP is certainly formulated in the context of a crisis. It can also be argued that the 1969 riot was the main reason why such a policy was formulated. Furthermore the export-oriented industrialization in the early 1970s was meant to give an opportunity to the Malays to receive a slice of Malaysia's wealth. One can argue that the implementation of the EOI was not for economic development but was rather implemented to avoid another racial tension among Malaysians.

The economic crisis in the middle of 1980s demonstrated another direct action from Malaysian government in revitalizing the Malaysian economy. The implementation

of import-substitute industrialization (ISI) in the early 1980s resulted in an increase of external debt (from 9.5 percent of GNP to about 42.4 percent in 1986[6]) and forces the government to restructure and implement the privatization policy. The recession in the mid-1980s worsened the government-support heavy industries initiative and resulted in the formulation of the National Development Policy (NDP). One can argue that the formulation of the NDP was to show another intervention action by the government to answer the crisis. But it can also be that the formulation was to rectify the unachievable objective of the NEP (30% of Malays in ownership of national wealth).

Recognizing the limitations of human capital and technological capabilities, the formulation of the NDP was more challenging, given that the government had to identify the constraint; actual and potential especially in the continuation to create a conducive environment for the Malays to achieve 30% ownership of the national wealth. In short, Malaysian policy-making in the early 1990s was more difficult compared to the early 1970s where the main focus of the latter policy formulation was to correct the economic imbalance and poverty eradication. The new policy formulation had to take into consideration many aspects such as to overcome the weaknesses in NEP, globalization issues, the global market crisis and at the same time continuing the objective of NEP.

In order to generate employment among Malaysians, the government decided to focus on the manufacturing sector. The first EOI focuses on manufacturing electrical goods and textile. This phase of industrialization resulted in increase in employment, not because of the government's direct policy, but it was of other Asian countries (i.e. Japan, Korea and Singapore) looking a place to set up their production line because of an increase in cost in their own countries. It was also prevalent at the time that the government discouraged the formation of any kind of workers association.

Malaysia, at the time, was still experiencing a lack in technological capabilities and human skills. Therefore the innovation activities among Malaysians were limited and most of the technology transfer activities were at the end of the production line. None

[6] Various Bank Negara Report

of the activities were involved in the early stages of production (i.e. designing, commencing). Gradually, the Malaysian government realized the importance of establishing their own technology-base in facing the globalization era. To start with, the government encouraged heavy industries activities with the implementation of the heavy industries policy and establishing HICOM. However, the heavy industrialization program created a burden on the public expenditure when Malaysia was hit with a recession in the mid-1980s. In order to overcome this problem, the government introduced the privatization scheme which eventually helped the country to successfully overcome the problem with expenditure. In fact, in the late 1990s the GDP growth showed some remarkable increase at an average of more than 6% (See Table 2.3), while the rate of unemployment decreased to 2.9% (Islam and Chowdhury, 1997).

Table 2.3: GDP Growth rate in Malaysia (Malaysia Five Years Plan)

Year	2nd MP (1971-1975)	3rd MP (1976-1980)	4th MP (1981-1985)	5th MP (1986-1990)	6th MP (1991-1995)	7th MP (1996-2000)	8th MP (2001-2005)
1	22.93	11.56	6.94	1.10	9.55	10.00	0.32
2	9.38	7.75	5.98	5.39	8.89	7.32	4.15
3	11.70	6.66	6.22	8.80	9.89	-7.36	5.31
4	8.32	9.35	7.76	9.18	9.21	6.14	7.10
5	0.80	7.45	-1.08	9.01	9.83	8.86	5.20
Average	10.63	8.55	5.16	6.70	9.47	4.99	4.42

Source: Asgari and Yuan (2007) pp.179

The Asian financial crisis in the late 1990s also showed how governments reacted towards external factors. A number of policies were implemented and a major shift of industry was put into action. From low and middle assembly industries, Malaysia has focused on the high-value added industry in order to remain competitive with the global market. The implementation of the Second Industrial Master Plan (1996-2005) was to encourage a high value added manufacturing and knowledge based industry in the country. This industrialization phases saw another significant step when the government implemented the Knowledge-Based Economy Master Plan (2002) which focused on producing high-skilled workers. It can be argued that the Knowledge-Based Economy Master Plan was a platform in turning Malaysia into a more technological and innovation driven type society.

2.3 National System of Innovation (NSI)

The origin of the concept of National System of Innovation can be traced back to the mid nineteen century when it was introduced as the 'national system of political economy by Frederich List (Freeman, 1995). In the late 1980s, Christopher Freeman used the first notion of 'National System of Innovation' in his book on technology policy and economic performance in Japan (Freeman, 1987). Later the notion was used in Dosi's (1988) part 5 book on 'Technical change and Economic Theory', though he gave some credit to Lundvall (Freeman 1995:5), the person who introduced the concept of 'National System of Innovation'.

From academic literature, the exact definition of the term national innovation system varied, is vague and somewhat unclear (Edquist 1997). Nevertheless, the general idea of national innovation systems discusses the actors and the institutions, relationship between both sectors that perform the basis for technological development and diffusion of innovation, in which each system are co-dependent and are not mutually exclusive. Table 2.4 gives a few definitions of National Innovation System.

Table 2.4: Definition of National Innovation Systems

Authors	Definitions
Freeman (1987)	National systems of innovation refer to the network of institutions in public and private policy sectors whose activities and interactions initiate, import, modify and diffuse new technologies.
Lundvall (1992)	National systems of innovation refer to the institutions, economic agents and relationships, which interact in the production, diffusion and use of new economic knowledge.
Metcalfe (1995)	National system of innovation refer to set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process.
Edquist (1997)	National system of innovation includes all economic, social, political, organizational, and institutional and other factors of production that contribute to the development, diffusion and use of innovation.
OECD (OECD 1998)(1997)	National systems of innovation refer to a web of interaction or the system in achieving a certain level or output in technological development.

Source: Adapted from Van Der Steen (1999: p 49).

The NSI can be studied from various aspects: the institutional-government and private institutions (Nelson, 1993), the structure of the systems (policies, initiatives and program) and the cultural and ideology (Nelson, 1993). Therefore the NSI can be analyzed within these three aspects or dimensions. Apart from national level, the NSI

can also be analyzed within a number of parameters. This parameter includes regional, sectoral and technological capabilities of certain countries depending on the chosen level of analysis (Balzat and Hanusch 2004).

A number of concepts were also being introduced as alternatives to the concepts of the 'national system of innovation' (Balzat and Hanusch, 2004) such as the regional innovation systems (e.g. Braczyk, Cooke and Heidenreich 1998) sectoral system of innovation (Malerba 2002) and technological system (Carlsson and Stankiewicz 1991). Other similar concepts were the national research system (Boden et al. 2008) national learning systems (Viotti 2002) industrial cluster (Porter 1998) and knowledge system (Howells and Roberts 2000).

Regardless of the definition and the scope of the systems, Edquist (1997) pointed out the similarities of certain characteristic that most academic have agreed on or shared similar views on these 'system of innovation':

1. They placed innovation and learning activities at the very center of focus.
2. They characterized the system of innovation as holistic and interdisciplinary – encompass a wide array of determinants of innovation.
3. They used historical perspectives in determining the system of innovation of certain countries.
4. They acknowledged the differences between the systems of different countries' system of innovation.
5. They emphasized on the interdependence and non-linearity of organizations (e.g. firms, customers, knowledge, finance, schools, training institutes, universities and government agencies) to be the driving force behind the emergence of system of innovation.
6. They encompassed the importance of product and process of innovation, and the subcategories of these types of innovation; and
7. They emphasized the central role of institutions.

2.3.1 The Use of 'System of Innovation' Concept

The 'system of innovation' concept has been widely acknowledged in the academic literature. From the literature, the concept has been accepted as a framework to study innovation and technological change. It was also been used as a tool to develop science and technology policy. (Balzat and Hanusch 2004; Edquist, 1997). Accroding to Balzat and Hanusch (2004), there are three different approaches to study the NSI concepts. These are: performance oriented studies/national benchmarking (Nelson, 1993; OECD, 1997), formalization of the concept (Liu and White; 2001, Edquist 2001) and study of the NSI concept in the developing economies (Wong, 1999; Liu and White, 2001). Table 2.5 summarizes the application of the NSI concept.

Table 2.5: Recent Application of NSI concept

Performance comparisons	Formalization of the concept	Studies of low-and mid-income countries
Providing experience of other countries for comparison. Contribute to the designing innovation policy.	Initiative to enhance and formalised the concept of NSI.	Study on national innovation system in the developing countries. Introducing NIS framework for country's technological development.
Methods: Conducting international comparison to develop indicators and standard for benchmarking research policies.	Methods: Employing systematic and critical model	Methods: Using innovation indicator Verbal description of NIS

Adapted from: Balzat and Hanusch (2004)

In the context of developing countries, the concept has been used to describe the development and the performance of system of innovation (cross-national comparison) by several authors (Wong, 1999; Liu and White, 2001). In addition to that, Nelson (1993) published a compilation of several countries' NSI 'comparative analysis' which includes developed economies. However, in the context of developing economies, NSI concept being the subject of the studies, often viewed as normative or standard concept.

2.3.2 Critics on National System of Innovation (NSI)

Despite the growing literature on the NSI concept, there are a few critics on the concept. For instance, Viotti (2002) commented that the NSI was not applicable to the developing worlds, given that the NSI focuses on the 'innovation' process where 'learning' is more important in those economies and thus proposed 'National Learning Systems' as an alternative (Viotti 2002). However, Lundvall (1992) argued that the 'learning' process has always been the central issue in NSI concepts. Moreover, Edquist (1997) identified learning as one of the main characteristics of the systems of innovation approach.

Another setback of the concepts, as noted by Edquist (1997), was that, none of the major authors supplied a sharp guide to what exactly covers in the concept. In other words, the system of innovation is still associated with 'conceptual diffuseness' given the fact the authors could not agree with the definition and the boundary of the concept. Edquist (1997) also criticized that the system of innovation was not a formal theory because it did not provide convincing propositions and direction to provide a basis for causal relation between variables, hence labelling the system of innovation as an approach rather than theory (Edquist 1997).

Another limitation in the NSI concept, as noted by Balzat and Hanush (2004) was the lack of indicators of innovative activity in a country, the lack of formalized methodology to carry out the studies and mostly the studies focused on one country in order to thoroughly describe the function of NSI. In relation to the earlier studies on the NSI concept, typically gave a verbal description of national innovation pattern without any formalized concept of NIS (Balzat and Hanusch 2004: 200-201).

Although the NSI concept received a number of criticisms, this study still considered NSI concept as the basis for the current investigation. The NSI discusses the actors and the institution which directly contribute to the diffusion of innovation and the technological development in the country. Furthermore, the concept stresses the importance of the links between the actors as the driving force behind the emergence of system of innovation.

2.4 Evolution of Malaysia National Innovation System

Malaysia's scientific research activities can be traced back to the early twentieth century. These research activities are a continuance from the British colonial government in supporting their interest in tropical medicine, timber and rubber. Three main government research institutions (GRIs) were established in 1900, 1925 and 1929 respectively. These GRIs are the Institute of Medical Research (IMR), the Rubber Research Institute (RRI) and Forestry Research Institute (FRI).

The development of the Malaysia's National Innovation System can be distinguished by four phases of development since its independence in 1957. Each phase will be described in detail below.

- **First Phase: 1957- 1970**

British colonial government had established a number of world-class research institutions before Malaya gained its independence in 1957. In the early years of independence, trade was concentrated on two primary commodities, rubber and tin. The dependency of the commodities is illustrated from Table 2.6.

Table 2.6: Dependency on tin and rubber in exports earnings

Year	Gross Export Earnings (RM million)	Rubber and Tin Exports Earnings (RM million)	Rubber and Tin Exports Share in Total Exports (%)
1947	835	701	83.9
1950	2608	2252	86.3
1955	2372	2018	85.1
1960	2924	2336	79.9

Source: Adapted from Alavi (1996: 29)

The rubber and tin exports contributed 85 per cent of export earnings and export generated almost half of the national output. Thus support for agricultural activities, which dominated by the Malay ethnic population, was a high priority policy of the new government (Jomo and Felker 1999). The Rubber Research Institute (RRI) for example, played an important role as the source of growth in the Malaysian economy as well as maintaining the country's global dominance in rubber production and export. Thus another government research institution, the Malaysian Agricultural Research and Development Institute (MARDI) was established in 1969 to conduct

research and provide technical assistance for agricultural activities (Jomo and Felker 1999).

The Palm-Oil Research Institute (PORIM) was established later on in 1979. This was an effort by the government to cater for the palm-oil industry, which had already replaced rubber as Malaysia's main export commodity in the late 1960s (Jomo and Felker 1999). It is worth to mention that during this period, most of the research activities were conducted by these small numbers of GRIs. The two universities set up i.e. University of Malaya (1962) and University of Pulau Pinang (1969) were primarily concentrating on teaching mission.

- **Second Phase: 1970- mid-1980s**

It can be characterized that in this period substantial encouragement and mechanism was developed relating to science and technology (S&T) policy, advice and support. The first ministry dedicated for S&T issues, the Ministry of Technology, Research and Local Government, was established in 1973. In 1975, the National Council for Scientific Research and Development (NCSRD) was established with the main objective of giving advice on science policy matters. Following the establishment of the advisory council, the Malaysian government cabinet underwent restructuring and the new Ministry of Science, Technology and Environment was created in 1976. At the outset, this establishment was served primarily to nurture Research and Development (R&D) activities in public universities and GRIs. The encouragement in engaging private sectors in S&T activities appeared not to be the main priority of the government.

During the early years of the establishment, MOSTE, being a minor ministry with limited budget, lacked the political and financial resources, held a low profile performance. The ministry did not have the absolute influence over the trade and industry policies affecting the country's technological development. The NCSRD, although inter-ministerial in composition and chaired by the Chief Secretary to the Government, was unable to impose a co-ordinated agenda on the various ministries, and concerned itself primarily with supporting basic research activities in the

university and public sectors. It was prevalent that at this stage the private sectors involvement in the council was very limited (Jomo and Felker 1999).

It should be noted that during this period, the economic policy in general was primarily concerned with generating employment through EOI strategies. Developing indigenous technological was not the primary concerned by the government. This was reflected with the absence of government initiatives to boost such activities within the industrial framework.

Even though investment projects were promoted under the 1968 Investment Incentives Act and the 1975 Industrial Coordination Act (ICA), the projects were required to register the agreement with Technology Transfer Unit in the Ministry of Trade and Industry (MITI). However, in practice the regulations were quite passive and concerned more with policing restrictive rather than screening and measuring technological content of the promoted projects (Jomo and Felker, 1999).

It can also be argued that the presence of government initiatives to encourage foreign direct investment should be given a credit in making a significant impact in upgrading Malaysia's technological development (Jomo and Edwards 1993). However according to Tidd and Brocklehurst (1999) there was less evidence that the MNCs had significant effects on the local development design and R&D capabilities. Most of the technology transfer concentrated at the final assembly stages of the production process, with relatively low inputs in design, development and other advanced skills that are normally associated with such activities (Lall, 1999).

Studies of electronics industry development during the 1970s and the early 1980s indicated extremely limited technological development within MNCs' Malaysian operation, and noted few spill-overs to the local economy (Jomo and Felker, 1999). In contrast, Korea, for example, acquiring foreign technology and implementing reverse engineering strategy was the main feature of its early phase of its industrialization. Taiwan, on the other hand, encouraged affiliation or technological cooperation with foreign firms which eventually became original equipment manufacturing (OEM) supplier (Nelson, 1993).

There was also a significant development in terms of education systems in this period. Five public universities were established in the early 1980s with their main concentration on undergraduate education rather than developing their research capabilities.

- **Third phase: the mid-1980s – mid – 1990s**

There was a significant shift in the economic policy and greater emphasis on technology development when Dr. Mahathir Mohamad became the fourth Malaysian Prime Minister in the early 1980s. The structure and content of S&T policy making was altered into a more vigorous action through central co-ordination and strategic targeting to support technological development.

In line with the implementation of strong support by the prime minister, the office of Science Advisor was created and the first science advisor was appointed to the Prime Minister's office in 1984. Further to catalyze the development of S&T, a national science and technology policy document was highlighted for the first time in a separate chapter during the tabling of the Fifth Malaysia Plan (1986-1990).

In 1986, Mahathir's government issued the first Industrial Master Plan (IMP1) which attempted to integrate S&T policy with industrial policy. The plan included a separate volume on technology development issues which highlighted the weaknesses of indigenous technology capabilities. The report recommended aggressive strategic investment and regulation to build up local talent and capabilities for future growth in technological development (MIDA/UNIDO 1986:5, Jomo and Felker 1999: 18).

Under the Fifth Malaysian Plan (1986-1990), the first National Science and Policy (STP1) were published. The document provided general guidelines in an effort to promote S&T development in the country. Among significant policy measures were the tax incentive for R&D activities, creating new technology institutions for specific industrial sector, the establishment of centralized policy planning and funding and encouraging private-sectors participation in R&D activities (Jomo and Felker 1999:20).

In 1990, the Action Plan for Industrial Technology Development (APITD) was introduced to further boost the STP1. The STP1 was lacking in terms of action plan within the technology policy framework and had only been realized after four years of the implementation. The Action Plan identified five basic structural weaknesses in Malaysian technology development (i.e. inadequate institutional infrastructure, low private sector participation, poor human resource base, lack of awareness and focus on critical generic technologies and lack of awareness among societies in S&T issues) and offered forty-two recommendations to develop the country's national innovation system (Jomo and Felker 1999: 20).

Following the recommendations by APITD, new policies and strategies were identified under the plan. The government strengthened the role of science and technology amongst the GRIs and established a few more institutions to further boost the technology development in Malaysia (See ttable 2.7). Most of the GRIs that used to be under the control of various ministries had been transferred to the Ministry of Science, Technology and Environment to improve the coordinating action.

In the Action Plan, the first grants scheme was created for public universities and GRIs i.e. Intensification of Research in Priority Areas (IRPA) in 1986. The main purpose of IRPA programme was to exploit public research investment and contribute to the economic development. The central planners hoped to use IRPA to boost the overall national R&D activities (Jomo and Felker, 1999).

Table 2.7: Establishment of Institution under APITD

Institutions	Date of establishment	Function
Malaysian Technology Development Corporation (MTDC)	1992	To promote R&D activities.
Malaysian Science and Technology Information Centre (MASTIC)	1992	To conduct national survey on S&T activities
Malaysian Industry-Government Group for High Technology (MIGHT)	1993	To address issues on high technology development.

Source: compiled by author

Beside IRPA program, there were a number of grants created by the MOSTI[7] to promote industrial technological development. Table 2.8 summarizes the grants and the allocation of funds by the government for public universities and GRIs under each Malaysian five-year-plan.

Table 2.8: Grants Scheme for Public Sectors and Allocation

Grants	Purpose	Allocation (RM million)			
		5MP	6MP	7MP	8MP
Intensification of Research in Priority Areas (IRPA)	The aim of IRPA Program is to focus on R&D activities which are in line with the national R&D Priority Areas.	413.58	629.0	755.0	883.9
National Directorate Oceanography (NOD)	The NOD is committed to spearhead marine science and oceanography development in Malaysia.	N/A	N/A	N/A	3
National Directorate Biotechnology (BIOTEK)	The main mission is to spearhead the biotechnology development for wealth creation and social well-being through R&D, international bridge for local industry, human capital and resource planning, public funding and research funding	N/A	N/A	33.7	134.1

Source: MOSTI 2006

In order to further boost the collaboration from the private sector, the government created a number of grant schemes (See Table 2.9). Even though the range of policy and grants introduced by the government stressed on the need to stimulate S&T activities within the private sectors, in practice, however, the emphasis was heavily placed on the public research institutions, including public universities and GRIs. Public S&T programs and incentives for private sector remained minimal until the mid-1990s.

[7] Formation of MOSTI after the restructuring of MOSTE following the cabinet decision in 2004.

Table 2.9: Grant Schemes for Private Sector and Allocation

Grants	Purpose	Allocation (RM million)			
		5MP	6MP	7MP	8MP
Industry Research and Development Grant Scheme (IGS)	The aim is to increase private sector R&D and promote closer cooperation between the private sector and Public Research Institutions (PRIs) as well as public sector universities through collaborative linkage.	N/A	N/A	124.9	127.1
Demonstrator Applications Grants Scheme (DAGS)	The purpose of DAGS is to spur the growth of bottom-up innovations, which are indigenous in design, contain local content and culturally relevant to meet the demands of the Malaysian community.	N/A	N/A	15.6	80.2
MSC Research and Development Grants Scheme (MGS)	The aim of MGS is to help innovative local companies, including joint venture, develop multimedia technologies and applications that will contribute to the overall development of the MSC.	N/A	N/A	37.3	81.5

Source: MOSTI 2006

- **Fourth Phase: Mid 1990s – present**

The R&D activities in the country saw an increase since mid-1990s, when the industrial R&D activities received full support from the government in terms of the introduction of a series of programme and incentives. The increase of R&D activities can be illustrated by measuring the total gross of expenditure of national R&D (GERD) (See Table 2.10).

As the total gross of expenditure of national R&D increased within the period, large local companies (government owned companies) i.e. Proton, PETRONAS, and Telekom has started to set up R&D facilities with the majority of the staff being the local people. A number of MNCs such as Intel, Komag and Robert Bosch also set up their in-house R&D facilities in a way to contribute to the technological development in the country. The increasing participation from the private sectors was partly due to the government programmes and incentives to develop local indigenous talent in R&D activities (See Table 2.9).

Table 2.10: R&D Expenditure

	1992		1994		1996		1998		2000		2002		2004	
R&D Expenditure (RM Million)	550.7		611.2		549.1		1127.0		671.5		2500.6		2843.8	
R&D Performers:														
Private Sector	246.3	(44.7)	292.6	(47.9)	400.1	(72.9)	746.1	(66.2)	967.9	(57.9)	1633.1	(65.3)	2033.6	(71.5)
GRI	253.7	(46.1)	164.9	(27.0)	108.7	(19.8)	247.3	(21.9)	417.5	(25.0)	507.1	(20.3)	296.9	(10.4)
HEI	50.7	(9.2)	150.9	(24.7)	40.4	(7.4)	133.6	(11.9)	286.1	(17.1)	360.4	(14.4)	513.3	(18.0)
GERD/GDP	0.37		0.34		0.22		0.39		0.5		0.69		0.63	

Source: National Survey of R&D, various years. Compiled by the author.

The development of the programme and incentives was also meant as an encouragement by the government to forge a stronger linkage between governments and industry in developing the country's technological development. It has also been argued that the need to establish R&D activity within each large local company can be evidence for the lack of collaboration with the university. Local companies which set up R&D facilities within the companies may incur extra cost whereby if they collaborated with the university/research institute, the cost of research would have been lower. This is because most of the research funding in public universities/research institute are funded by the government. In Japan, for example, local companies used university labs as their technology development place for new inventions (Jomo and Felker, 1999).

As illustrated in Table 2.11, the number of manpower involved in R&D activities increased in the country. The number of researchers from higher education institution increased from 383 researchers in 1994 to 6434 researchers in 2004. The participation of the private sector in R&D activities also showed an increase from 1116 researchers in 1994 to 4104 researchers in 2004. In total, there was an increase of 10382 in the number of researchers in the country from 1994 to 2004.

Table 2.11: Total Full-Time Equivalent (FTE) of Researchers*

	1994	1996	1998	2000	2002	2004
Government Research Institute (GRIs)	768	471	740	1297	1203	2130
Institution of Higher Learning (IHL)	383	395	677	3141	3186	6434
Private Sector	1116	1026	1996	1982	2767	4104
Non-Profit Organization	18	-	-	-	-	-
Total	2286	1893	3415	6421	7157	12669

Source: National R&D Survey (various years). Compilation by the author.
*Note: This figure does not include the technicians and support staff. The figure counted is the number of researchers.

In the mid-1990s, the higher education systems in Malaysia underwent deregulations. The amendments of University and University-College Act in 1996 resulted in more autonomy for the universities. Moreover, the introduction of Private Higher Education Institution Act in 1996 made the country flooded with private higher education institutions. These private higher educational institutions included corporate universities established by government-linked companies such as the PETRONAS (Oil and Gas Company), Telekom (Telecommunication Company) and

Tenaga Nasional (Electric Company). The main motive behind the liberalization of Malaysian education systems was to increase the supply of skilled workers by training and producing engineers, managers and technician to meet the market demand.

A more recent development in Malaysian HEIs is the establishment of University Colleges (UCs)[8]. These UCs are a spinoff of branch campuses of existing public universities, where five of the UCs have been established since 2000. The ultimate goal of the establishment is to increase the supply of skilled workers as well as to promote regional economic development. Even though the idea of having one public university in every state in Malaysia is indeed the sign of government taking a direct action in producing more engineers and technician for the nation, the university's authority scope is still limited. Unlike the knowledge landscape in the United States, the U.S. system was highly decentralized among public universities. State universities were funded by the state governments and thus responded to local commercial needs to a greater extent than centralized practices (Chesbrough, 2006). It can also be argued that the monitoring mechanisms in Malaysia still lacking due to the multi-task of government agencies that overlook the Malaysian educational systems. The Ministry Of Higher Education, for example was not only responsible for public universities but also responsible for private universities, polytechnics, scholarship etc. (Kondo 1999: 202).

Another significant development made by the government in this period was the establishment of a number of property-led initiatives i.e. the technology park. These technology parks established by the government were to encourage the development of high-tech industries in the country. The first technology park, Technology Park Malaysia (TPM), was opened in 1988, followed by a number of technology parks established during the 1990s. These included Kulim Hi-tech Industrial Park in the northern state of Kedah; the Johor Technology Park in the southern state of Johor; and Subang Hi-tech Park and Selangor Science Park in Selangor near the capital area in Kuala Lumpur.

[8] The establishment of UCs was in line with the government's aim of having one public HEIs in each thirteen states in Malaysia.

The Multimedia Super Corridor (MSC) is another well-known property-led initiatives by the government in pursuing the technological development in the country. The MSC was established in 1996 with the aim of promoting and improving local technological capabilities. It also to encourage R&D in both public and private sectors besides providing sites for the development of high-tech industries, to disseminate hi-tech information and facilitate technology transfer to local industries. The MSC was built upon a piece of a land measuring fifteen by fifty square kilometres, south of the capital, which is equipped with the state-of-the-art infrastructure and latest technology to attract investments from overseas and domestic.

Realizing the importance of knowledge, in 2001 the government formulated the Knowledge-based Economy Master Plan, with a primary intention of transforming the Malaysian economy from the input-driven growth strategy to high value added and knowledge-based industry. The STP1 was revised and the Second National Science and Technology Policy (STP2) was published in 2002. The STP2 addressed seven key priority areas which included fostering a linkage between industries and universities, encouraging commercialisation activities and developing human resource capacity.

2.4.1 Challenges in Malaysian NIS

Even though Malaysia has shown a significant improvement and development in terms of the country's NIS, some weaknesses have been pointed out in a few reports. These included the lack of co-ordination between ministries and government agencies involved in S&T issues (Kondo 1999: 202). Acknowledging the issues, in the mid-1990s, the government underwent a restructuring and reforms between the ministries and agencies to enhance the co-ordination between agencies.

Another challenge in the Malaysia NIS is the lack of well qualified bureaucrats within the relevant ministries and agencies, especially in policymaking and monitoring of S&T issues (Kondo, 1999; Rasiah, 1999). In relation to that the government mistakenly put heavy emphasis on training scientists, rather than technicians and engineers. Technicians and engineers were to be given a priority if the country

wanted to develop their industrial technology capabilities (Kondo, 1999). At the government level, the government should develop their human resource to the extent that at top management levels in any department, there should be a person who posses 'bravery' skills. That is to say, innovation needs someone who, not only can foresees the marketability of a product, but also has an authority to persuade subordinate to innovate (Smith, 2007). In order to rectify this problem, the government continuously invested in human resource development by sending staff for specific courses or programmes related to S&T development (Rasiah, 1999).

The lack of private sector input in the policymaking also constituted major challenges in the development of S&T in Malaysia in the early 1990s. As noted by Jomo and Felker (1999), the collaboration between government and industry is important in achieving a highly industrialized country (Jomo and Felker, 1999). Some initiatives were taken to improve the collaboration such as appointing more representatives from the private sector in the NCSRD, the S&T policy advice body; and the active consultations with the Federation of Malaysian Manufacturer in S&T policymaking.

Malaysia also lacks the evaluation mechanism to assess government programmes or initiatives whether it has achieved the targeted objectives. Without this initiative, the government will find it difficult to identify any flaws in the programmes and the current level of achievement. Unlike in the UK, the foresight exercise introduced in 1993, was used to identify the level of development in science and technology in the country.

The collaboration of R&D activities between public university and private sector was still under developed given that a number of local companies had already set up R&D facilities within their own organizations. This meant that the industries did not rely on the universities R&D for new idea or invention. Instead, they conducted their own R&D activities to address their business need. It can be argued that the initiatives of the private sector should be given credit for funding their own R&D and contributed to the country's technological development. However, from another perspective there is obviously a gap between these two sectors in terms of R&D collaboration activities. Even though the Malaysian government had already introduced a number of initiatives to encourage stronger links between these two sectors, the outcome of the

collaborations was still unfavourable. Barriers to the flow of knowledge and technology transfer between university and industry have also been widely studied. Perez and Sanchez (2003), for example, pointed out that such barrier including: lack of financial resources, small market size, too risky, lack of information on market features, lack of time, lack of information on potential business partners, lack of information on know-how and lack of trust among partners. Siegel et al (2004) summarized the barriers in several categories, including: lack of understanding regarding the university corporate or scientific norms and environments; insufficient rewards for university researchers; bureaucracy and inflexibility of university administrator; insufficient resources devoted to technology transfer by universities, poor performance of technology transfer offices; and the 'public domain' mentality of universities. Malaysia also faced the same challenges in R&D development activities.

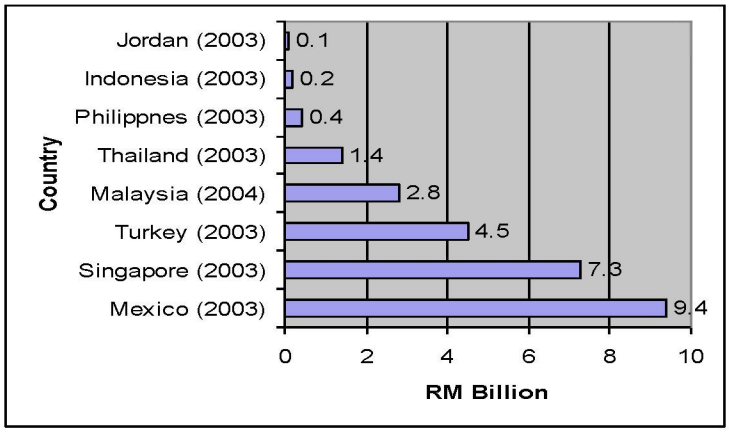
2.5 Performance of Malaysian National Innovation System: International Comparison

This section will be discussing to what extent the Malaysian National Innovation System has developed the country's technological generation and use; the R&D output and R&D investments. Malaysian's R&D performance will be compared and evaluated in relation to other countries.

2.5.1 Malaysia's R&D Expenditure

From the outset, Malaysia's R&D expenditure showed an increase from RM 2.50 billion in 2002 to RM 2.84 billion in 2004. Although there was a positive increase of RM 343.2 million over the previous expenditure, Malaysia was still behind Singapore (RM7.3 billion in 2003), but higher than Thailand (RM1.4 billion in 2003), Indonesia (RM 200 million in 2003) and Jordan (RM 100 million) (See Table 2.12).

Table 2.12: R&D Expenditure by Country

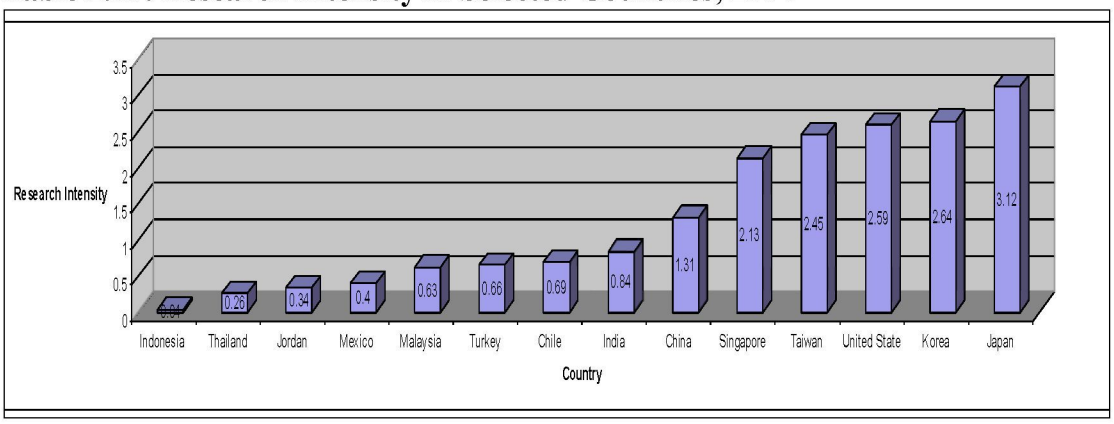


Source: Malaysia National Survey on R&D 2004 (MASTIC, 2004)

2.5.2 R&D Expenditure

Viewing R&D expenditure from an international perspective, Malaysia was still behind most industrialized economies and its neighbouring NIEs. Malaysia's R&D expenditure as a ratio of GDP was below one percent (See Table 2.13) and the private sector expenditure on R&D was far less than other Asian countries (See Table 2.14).

Table 2.13: Research Intensity in Selected Countries, 2004



Source: Taken from Malaysia National Survey of R&D 2006 (MASTIC, 2006)

Table 2.14: Private GERD by Country

Country	Expenditure (RM Billion)	R&D Expenditure Private Sector per Capita (RM)
United States	725.60	2493.1
EU 15	451.90	19307.2
Japan	341.90	2683.3
Brazil	9.20	53.8
India	3.10	3.0
Mexico	2.70	27.0
South Africa	1.80	39.6
Turkey	1.30	18.6
Jordan	0.03	6.5
Asian NIEs		
Singapore	4.40	1056.1
Korea	45.10	940.5
Taiwan	16.20	715.7
Other Asian Countries		
China	42.90	33.2
Malaysia	**2.03**	**79.4**
Philippines	0.30	3.3

Source: Taken from Malaysia National Survey of R&D 2006 (MASTIC, 2006)

2.5.3 Number of Researchers

As for number of researchers, there was a significant increase in number of researchers from 1548 researchers in 1994 to 23092 researchers in 2004 (See table 2.15). However international comparisons of Malaysian R&D labour forces indicated that Malaysia was still far behind other countries. According to MOSTI facts and figures 2006, for every 10,000 Malaysians employed, there existed, an average of 21.3 researchers. This placed Malaysia close to Thailand (8.6 per 10,000 labour force) and Philippines (2.2 per 10,000 labour forces) but behind other Asian NIEs; Singapore (111.3 per 10,000 labour forces) and Korea (89.5 per 10,000 labour forces) (See Table 2.16).

Table 2.15: Number of Researchers (Headcount)

Year	Total Number of Researchers	Researcher per 10,000 labour force
1994	4545	5.8
1996	4243	5.1
1998	6249	7
2000	15022	15.6
2002	17790	18
2004	23092	21.3

Source: Taken from MOSTI facts and Figures 2006

Table 2.16: Headcount of Researchers per 10,000 Labour Forces

Country	National Headcount of Researchers	Headcount of Researchers per 10,000 Labour Force
Japan	830,545	131.5
Singapore	22,640	111.3
EU 15	1,231,004	99.6
Korea	198,171	89.5
Argentina	43,609	50.9
Turkey	71,288	33.4
Romania	25,968	28.2
South Africa	26,913	24.8
Malaysia	**23,092**	**21.3**
Chile	8,658	15.3
Thailand	29,850	8.6
Philippines	6,803	2.2

Source: Taken from MOSTI facts and Figures 2006

2.5.4 R&D Output

In terms of R&D output, the Malaysian file for patents showed a modest progress, with a total of 80,121 patents being filed. Out of this only 5.2% were filed by the local researchers in 2006. Comparing non-local (contract and foreign researchers) filed for patents with the local; it showed that the local were still behind in terms of research activities in the country. The number of patents granted to local was also small (24 patents) and this accounted for only 1.6 percent of the total Malaysian patent granted (See Table 2.17)

Table 2.17: Malaysian Patent Applied and Granted

	Patent Applied For			Patent Granted		
Year	Local	Non-Local	Total	Local	Non-Local	Total
1986	29	233	262	-	-	0
1987	71	3195	3266	-	-	0
1988	73	1547	1620	-	6	6
1989	84	1803	1884	11	121	132
1990	92	2213	2305	20	498	518
1991	106	2321	2427	29	1021	1050
1992	151	2259	2410	10	1124	1134
1993	198	2684	2882	14	1270	1284
1994	223	3364	3587	21	1608	1629
1995	185	3992	4177	29	1724	1753
1996	221	5354	5575	79	1722	1801
1997	179	6273	6452	52	737	789
1998	193	5770	5963	21	545	566
1999	218	5621	5839	39	682	721
2000	206	6021	6227	24	381	405
2001	271	5663	5934	18	1452	1470
2002	322	4615	4937	32	1460	1492
2003	376	4686	5062	31	1547	1578
2004	522	4920	5442	24	2323	2347
2005	522	5764	6286	37	2471	2508
2006	176	1823	1999	24	1525	1549
Total	**4418**	**80121**	**84539**	**515**	**22217**	**22732**

Source: Taken form MOSTI Facts and Figures 2006. Available at: www.mastic.gov.my

The number of patents granted to Malaysians showed a modest increase despite of the government initiatives and support programmes to encourage R&D and innovation activities. In 2007, the total patent granted to Malaysia is 173, an increase of 32 percent from previous years (See Table 2.18). Even though there was an increase in terms of number of patents granted to Malaysia, the country's achievement still lagged far behind the Asian NIEs and China (See Table 2.19).

Table 2.18: Number of Patents Granted to Malaysia

Year	Number of Patent Granted
1994	16
1995	8
1996	24
1997	29
1998	35
1999	34
2000	47
2001	56
2001	62
2003	63
2004	93
2005	98
2006	131
2007	173

Source: USPTO statistics available at www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_all/htm

Table 2.19: US Patent Granted to Selected Asian Countries (2007)

Country	Number of US Patent Granted
Japan	35942
Asian NIEs	
Korea	7264
Taiwan	7491
Singapore	451
Other Asian Countries	
Thailand	25
Malaysia	173
China	756

Source: USPTO statistics available at www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_all/htm

2.6 The Role of Government in R&D

Malaysia has implemented a number of measures and initiatives towards strengthening local technological development in the country. At the macro level, the implementation of five-year plan showed that the government is taking a direct government intervention towards economic development. The introduction of action plan besides the Malaysian plan showed the government's initiative in shifting from manufacturing based economy towards knowledge based economies. Further to strengthen the technological development in the country, a number of measures and initiative were implemented at national level to boost the country's agenda in becoming a fully industrialized country.

At the micro level, the implementation of policies for S&T and commercialisation showed that the government is more aggressive at the bottom level (research institution and industry). With the main objective in developing local technological capabilities, a number of initiatives and measures were implemented such as funding mechanism, policies and infrastructure towards university and industry. The government also provided mechanism to integrate collaboration between the university and the industry by allocating specific research grants i.e. CRDF, incentives (tax incentive) and infrastructure (Technology Park). In summary, the Malaysian government took an active role through direct and indirect intervention in country's technology development. The next section will highlight government initiatives towards S&T activity in the country.

2.6.1 The Government and the S&T activities

A number of government agencies have been set up to monitor the S&T activities in the country. In the mid-1990s, several government agencies were restructured, in order to improve the co-ordination of S&T policymaking and development of S&T activities.

At the top level, there is a committee chaired by the Prime Minister known as the Cabinet Committee on Science and Technology, responsible in making decision on the policy direction and policy co-ordination between ministries and agencies.

- **National Council for Scientific Research and development (NCSRD)**

The main objective of the establishment of National Council for Scientific Research and development (NCSRD) in 1975 was to give an advice on policy on S&T matters to the government. It was chaired by the Chief Secretary to the government and the members comprised from different related areas i.e., government officials, academics, industries as well as the NGOs. Besides providing advice to the government, the council, through their technical committees, provides assistance to the Ministry of Science, Technology and Innovation (MOSTI) in the screening and evaluating IRPA application, the main grant scheme for public sector R&D. In the early years of its establishment, the number of representatives from the industry was minimal. Following the recommendations in the APITD published in 1990, the council was restructured and to include more representatives from the industry and NGOs, in order to supply an input for technological development in S&T matters.

In 1996, the NCSRD made a recommendation to the government to establish Akademi Sains Malaysia (ASM). The academy, acted as an independent body, served the purpose to establish strong linkages with the government and ensuring the effective implementation of government plan and activities on S&T matters.

- **Ministry of Science, Technology and Innovation (MOSTI)**

In 1973, the first ministry created to administer S&T matters was the Ministry of Technology, Research and Local Government. Even though the ministry was assigned to monitor the development of S&T activities, it should be noted that at this period S&T activities was not the main concern of the government. Hence in 1976, following the restructuring of the cabinet it was renamed Ministry of Science, Technology and Environment (MOSTE). In 2004, the ministry was restructured, to have more targeted roles in S&T matters, and was renamed Ministry of Science, Technology and Innovation (MOSTI).

Malaysian Science and Technology Information Centre (MASTIC), was established in 1992 under MOSTI, to play a significant role in providing information and statistical information on S&T issues, crucial for the policy maker. MASTIC had published a number of reports such as the National R&D Survey, National Innovation Survey and Public Awareness Survey since 1992. These reports gave an insight to the government on the direction of policymaking and monitoring mechanism on S&T matters.

- **Office of Science Advisor to the Prime Minister**

The first science advisor to the Prime Minister was appointed in 1984, which was located under the Prime Minister's office. However in 2004, the Office of Science Advisor was transferred to MOSTI. Even though the post had been transfer, the science advisor will report and provide advice directly to the Prime Minister and at the same time provide input to the MOSTI on implementation of S&T related policies and strategies.

- **Other Ministries**

There are several other ministries in the Malaysian cabinet that involved in the development of S&T activities. As part of the Malaysian NIS, the ministries provided assistance and support in the development of S&T matters in the country. Table 2.20

summaries the ministries with their specific assignment in relation to S&T policymaking and support.

Table 2.20: Ministries and Assignment

Ministry	Assignment
Ministry of Finance (MOF)	Provide financial assistance and incentive to new technology based companies. Provide exit mechanism for newly based high-technology companies
Ministry of Science, Technology and Innovation (MOSTI)	Formulate and implement S&T policy. Oversee the co-ordination and supporting S&T activities. Provide research funding to public research institution.
Ministry of International Trade and Industry (MITI)	Formulate industrial technology policy to integrate with the S&T activities.
Ministry of Higher Education (MOHE)	Formulate and implement higher education policy. Oversee public and private higher education institutions.
Ministry of Domestic Trade and Consumer Affairs (MDTCA)	Protection of IPR issues. Provide entrepreneurial training.
Ministry of Human Resource (MOHR)	Responsible for human resource development in supplying skilled-worker through funding a number of training courses for the public and private sectors.

Sources: Compilation by the author.

The Ministry of Domestic Trade and Consumer Affairs (MDTCA), through its agency, the Malaysian Intellectual Property Corporations (MIPC), is responsible for the approval and granting patents, trademarks and industrial design. The Ministry of Higher Education was created after the separation from the Ministry of Education in 2005.

- **Other Agencies**

There are also several other quasi-government agencies that support the S&T related activities in the country. For instance, MTDC, MIGHT, MESDAQ and MAVCAP are a few quasi-government agencies that play important part in supporting Malaysian S&T development. Malaysian Technology Development Corporation (MTDC) was established in 1992 as a public-private initiative, with an objective to spearhead the development of technology business in Malaysia. Its initial role was to concentrate on the promotion and commercialisation of local research and invests in new ventures. MTDC also allocates public funds for local research results commercialisation and

technology acquisition by private firms. In a way MTDC can be claimed as government-backed venture capital company.

Malaysian Industry-government Group for High Technology (MIGHT) was set up in 1993, an agency under the purview of the MOSTI, representing the ministry in interfacing with the industry to promote technology uptake in business. The main role is to enable a consensus building and coordination for industry-government partnership in high technology industries. MIGHT also carries out a series of 'Prospecting' activities, the Malaysian version of UK's 'Foresight' exercise, to measure the level of achievement of S&T activities in the country.

Another support mechanism for newly high-tech companies to find external sources of funding is through listing on the MESDAQ market. The Malaysian Exchange of Securities Dealing and Automated Quotation (MESDAQ) were launched in 1996, is to provide access to capital market to facilitate rising of funds. It is also an exit mechanism for the new technology-based companies to go for listing –IPO.

The Malaysian Venture Capital Management (MAVCAP), set up in 2001, is a fully funded by the government, managed by a team from the private sector to provide venture capital fund in promoting techno-preneurship and technology start-up in the country.

2.6.2 Funding mechanism for S&T development

Since the traditional source of funding is difficult to obtain, as the financial institutions might be less interested in intangible product (e.g. patents, intellectual property) than tangible product (Goel and Hasan, 2004), in order to boost the technological development and S&T activities in the country, the government has set up a number of public grants for Government Research Institutions (GRIs), Universities and industry (see table 2.21).

Table 2.21: Government Funding Mechanism for R&D and Technological Innovation

Programme	Year Introduced	Objectives	Targeted Sector
Intensification of Research in Priority Areas (IRPA)	1987	To promote public sector R&D in priority areas. To encourage public-private R&D linkages.	HEIs and GRIs
Industrial Technical Assistance Fund (ITAF)	1990	To promote technological development and R&D in Small and Medium Industries	Industry
Industry R&D Grant Scheme (IGS)	1997	To promote collaboration between industry and university/GRIs	Industry
Multimedia Super Corridor R&D Grant Scheme (MGS)	1997	To Promote R&D in ICT industry	ICT industry
Commercialisation of R&D Fund	1997	To promote commercialisation of research results	HEIs, GRIs and industry
Technology Acquisition Fund (TAF)	1997	To promote innovation activities for local companies through technology acquisition	Industry
Demonstrator Application Grant Scheme (DAGS)	1998	To promote R&D in local ICT industry	ICT industry

Sources: Compilation by the author.

- **The Intensification of Research in Priority Areas (IRPA)**

Introduced in 1987, IRPA grants scheme was the first initiatives introduced by the government for research in universities and GRIs. The IRPA grants scheme was managed by MOSTI and NCSRD, where NCSRD is responsible in the screening and evaluating IRPA applications to avoid redundancy and made it easier to form a collaboration of research activities between different research institutions.

The private sector can participate in the programme through joint research with universities and GRIs was introduced in 1996 following the revamp of IRPA grants scheme. A fully owned corporatized government institutions and Private Institution of Higher Learning (IPTS) can also be eligible for IRPA funding, subject to the approval by MOSTI, was also made available in the same years.

To date, IRPA is still the main grant scheme for research in universities and GRIs. Given to their important role as the main sources of funds for S&T activities, the amount of budget have increased significantly in each five-year Malaysian plan (See Table 2.22).

The National Directorate Oceanography (NOD) was established in 2000, under the recommendation of NCSRD, was committed to spearhead marine science and oceanography development in Malaysia. The NOD received their first grants under the Seventh Malaysian Plan to promote quality research, human development in utilizing marine resources and the commercialisation of oceanography R&D output.

In the development of biotechnology industry, the National Directorate Biotechnology (BIOTEK) was created in 1995, with a mission to spearhead the biotechnology development for wealth creation and social well-being through R&D, international bridge for local industry, human capital and resource planning, public funding and research funding.

Table 2.22: Funding Mechanisms in Public Sector

Malaysian plan	IRPA Amount approved (RM)	NOD Amount approved (RM)	BIOTEK Amount approved (RM)
5th (1986-1990)	413.58	-	-
6th (1991-1995)	629.0	-	-
7th (1996-2000)	755.0	-	33.7
8th (2001-2005)	883.9	3.6	134.1
Total	**2681.7**	**3.6**	**167.8**

Sources: Various Malaysian Plans. Compilation: by the author.

- **Industry Research and Development Grant Scheme (IGS)**

The IGS was established with aims to foster strong linkages between industry and public universities and GRIs. This is a matching grant where the government will fund up to 70 percent of the project cost and the remaining will be funded by the firms. This is another example of government initiatives to promote linkages between public universities and GRIs with the industry.

- **Multimedia Super Corridor (MSC) Research and Development Grant Scheme (MGS)**

The aim of MGS is to help innovative local companies, including joint venture, to develop multimedia technologies and applications that will contribute to the overall development of the Multimedia Super Corridor (MSC). This is a matching grant that is available to the company that is within the MSC or those with MSC status.

- **Demonstrator Application Grant Scheme (DAGS)**

The purpose of DAGS is to spur the growth of bottom-up innovations, which are indigenous in design, contain local content and culturally relevant to meet the demands of the Malaysian community. This is another matching grant scheme for industrial R&D in the country.

- **Industrial Technical Assistance Fund (ITAF)**

The ITAF was established in 1990 with the aim to provide financial assistance to Small and Medium Scale Industries for consultancy, product development and design, market development and productivity improvement.

- **Commercialisation of R&D Fund (CRDF)**

Introduced in 1997, by the government through MTDC, this grant is to encourage the commercialisation of university and government research institutions. The fund provides partial grants to qualified R&D project for commercialisation, up to 70 percent or a maximum of RM2 million for product development, prototype design, market survey and intellectual property protection.

- **Technology Acquisition Fund (TAF)**

The aim of this fund is to provide financial assistance, up to 70 percent or RM2 million of the total cost, to local manufacturing companies to purchase technology,

patent rights, prototypes or designs. This fund was set up in 1997 under the management of MTDC.

2.6.3 Fiscal incentives for industrial R&D

In addition to funding mechanism provided by the government, a number of fiscal incentives were also introduced by the government to stimulate R&D activities in the country.

As general rule income derived by pioneer status companies for promoted product or services, the companies will receive 70 percent tax exemptions. Only 30 percent of the income is subjected to tax. The exemption is generally granted for a period of 5 years. However these were the general rules for companies with 'pioneer statuses'. For companies involved with R&D, such companies were given full tax exemption on statutory income for a period of 5 years.

A company can also apply for double tax deduction on its revenue for non-capital expenditure for research undertaken by research institutes subject to approve by the Ministry of Finance.

2.6.4 Public Programmes and Incentives for Commercialisation

In order to further encourage commercialisation activities in the country, the Commercialisation of Research and Development Fund (CRDF) was introduced in 1997 to encourage commercialisation of academic research. The funds provide partial grants to qualified R&D projects for commercialisation up to a maximum of 70 percent or a maximum of RM2 million for product development, prototype development, standard and regulatory compliance and intellectual property. Beside that tax incentives were also available for start-up companies (See Table 2.23). In addition, the infrastructures such as the incubator facilities were also provided by the government to stimulate commercialisation of research product.

Table 2.23: Fiscal Incentives for Research Results Commercialisation

Introduced in Annual Budget 2004
Tax deduction for individual researchers
Tax deduction 50% for five years for researchers commercialising research results

Introduced in Annual Budget 2005
To encourage commercialisation of R&D findings, the incentive packages is given as follows:

i. A company that invests in its subsidiary company engaged in the commercialisation of R&D findings will be given tax deduction equivalent to the amount of investment made in the subsidiary company.
ii. The subsidiary company that undertakes the commercialisation of R&D findings be given Pioneer Status with 100% tax exemption on statutory income for 10 years.

The incentive is provided on the following conditions:

i. At least 70% of the company is owned by Malaysian
ii. Company which invests should own at least 70% of the equity of the company that commercialises the R&D findings
iii. Only resource-based R&D findings are eligible
iv. The commercialisation of the R&D findings should be implemented within one year from the date of approval of the incentive

Introduced in Annual Budget 2006
To increase the number of scientist amongst Private Higher Education Institutions (PHEIs) it is proposed that the Investment Tax Allowance of 100% on qualifying capital expenditure incurred within a period of 10 years to be set off against 70% of statutory income be extended to:

i. PHEIs in the field of science
ii. Existing PHEIs in the field of science that undertake additional investment to upgrade equipment or expand their capacity.

The qualifying science courses are as follows:

i. Biotechnology
ii. Medical and Health Sciences
iii. Molecular Biology
iv. Material Sciences and Technology
v. Food Science and Technology

Source: Minister of Finance Annual Budget, various years, available at http://www.treasury.gov.my

The IGS grant scheme was introduced in 1997 with the objective to increase private sector R&D and to promote closer links between universities and public research institutions. However, the programme was rather limited in budget compared to IRPA as illustrated in the Table 2.24. Furthermore, the programme had also been limited only to local SMEs.

Table 2.24: Amount Approved (IGS) on each Malaysian Plan

Malaysian plan	IGS Amount approved (RM)
5th (1986-1990)	-
6th (1991-1995)	-
7th (1996-2000)	124.9
8th (2001-2005)	127.1
Total	**252.0**

Sources: Various Malaysian Plans. Compilation by the author.

2.6.5 Government as R&D Performer

Malaysian government plays a direct role as an R&D performer by setting up a number of Government Research Institutions (GRIs). The GRIs plays an important role in performing agricultural R&D before and in the early years of the country's independence. Even though a few universities had been setup, their main focuses were on teaching activities. The GRIs was superseded by the universities in the later years.

In 2004, there were 43 GRIs in the country. Out of these only a small number of institutions actively involved in R&D. According to the 2002 National Survey on R&D there were only five major institutions: MIMOS, MPOB, FRIM, MARDI and SIRIM, which constituted 83 percent of GRIs' RM507.1 million on R&D expenditure (see table 2.10), are actively involved in R&D activities in the country. However the total expenditure for GRIs showed a significant decline, from RM507.1 million to RM296.9 million, marking a decline of 41.5 percent and was the lowest compared to other R&D performers (see table 2.10). In relation to the number of manpower, MARDI still maintained being an agency with the largest number of research personnel (inclusive of foreigners), counted as headcount, of 2040 research personnel in 2000 (see table 2.25 and table 2.26).

Table 2.25: Number of R&D Personnel (Headcounts) in Malaysia

	Industry		GRI		HEI		Total	
1994	1416		2054		1075		4545	
1996	1342		1524		1377		4243	
1998	2287	(130)	1987	(532)	1975	(824)	6249	(1486)
2000	2304	(67)	3809	(1049)	8909	(3043)	15022	(4159)
2002	3349	(81)	3914	(947)	10527	(4410)	17790	(5438)
2004	5940	N/A	4347	N/A	12805	N/A	23092	N/A

Source: Malaysian Science and Technology Indicators Report, various years
Note: Figures in brackets are the number of R&D personnel with PhD

Table 2.26: Total Full-Time Equivalent (FTE) of Researchers*

	1994	1996	1998	2000	2002	2004
Government Research Institute (GRIs)	768.0	471.9	740.9	1297.27	1203.49	2130.8
Institution of Higher Learning (IHL)	383.2	395.4	677.85	3141.39	3186.95	6434.4
Private Sector	1116.7	1026.43	1996.93	1982.99	2767.1	4104.3
Non-Profit Organization	18.8	-	-	-	-	-
Total	2286.7	1893.73	3415.77	6421.65	7157.54	12669.5

Source: National R&D Survey (various years). Compilation by the author.
*Note: This figure does not include the technicians and support staff. The figure counted is the number of researchers.

2.7 Conclusion

Malaysia certainly had its interesting success story. Malaysia's economic experiencing a shift from modest industrial economy to a high value-added-based economy; without compromising the country's main problem of poverty and racial imbalances. This economic success can be attributed to the ability which it had shown in formulating policies and the mechanism of implementing them. As a small-open economy, in the new world economic order characterized by the internationalization of product and globalization, Malaysia did not isolate herself but rather making a stance to respond to the international front by formulating a number of policies that contribute to the success of the story.

This chapter has presented the evolution of the Malaysian industrialization and technology development since its independence in 1957. The phases of industrialization presented in the beginning part of the chapter showed an attempt to understand the transition process from agricultural-based industry to manufacturing-based industry. This transition process showed that in the beginning, technology development was not the main agenda in Malaysia. At the time Malaysia focuses were on the development of agricultural product as the main source of national income.

The most significant development in technology development started in the mid-1990s (See Table 2.27). This was the main agenda under Mahathir's administration which saw a huge revamp in the country's S&T system. The government implemented a number of initiatives and measures towards improving the

technological capabilities in the country. This was done through the implementation of appropriate policies, the development of human resource and infrastructure. The interesting part was where the literature showed the influence of the Prime Minister in fostering and motivating technological development in the country.

The review of literature in this chapter also showed that the government implementation of a number of initiatives and measures to develop country's S&T and innovation capabilities. The initiatives and the measures showed that the government stressed on research activity rather than commercialisation. This shortcoming of study on commercialisation activity makes one wonders why commercialisation did not attract research interest earlier since commercialisation is considered as one of the factors that contribute to the economic growth in a country. Given the gaps in literature on commercialisation activity in Malaysia, this study explores the nature of commercialisation activity in Malaysian higher education institutions.

It is also indicated in this chapter that the country's achievement in technological development is rather modest compared to other neighbouring countries. The comparison of GDP, for example, clearly showed that Malaysia is still behind a numbers of countries in terms of R&D expenditures. The government initiatives and support mechanism are really important for technological development to take place. It is, therefore, the role of government in commercialisation becomes the interest of this study. The other factors that contributed significantly towards technological development i.e. university and academic will also be discussed in the next chapter. It is apparent in the next chapter that the role of university and the group of people who are actually *doing* it received a greater attention from the government in fostering commercialisation activity.

Table 2.27: Evolution of Malaysian NIS

Phase 1 (1957-1970)	Phase 2 (1970-mid 1980s)	Phase 3 (mid 1980s-mid 1990s)	Phase 4 (mid 1990s-present)
• No specific S&T Policy • Research was limited to main commodities: rubber and timber • Basically a continuance from the British colonial government • Two universities were set up focusing on teaching rather than research activities	• No specific S&T policy • The government established NCSRD (1975) and MOSTE (1976); minimal role • Private/industry participation were minimal • A number of universities were set up focusing on teaching rather than R&D activities	• Introduced the first S&T policy (1986) • Introduced Action Plan for Industrial Technology Development (1990) • Fully recognized the importance of S&T • Ministry were given more important role • Integrated S&T policy with industrial policy • Appointed science advisor to Prime Minister • Encouraged R&D in higher education institution and government research institutions	• Introduced Knowledge –based Economy Master Plan (2001) • Introduced the second S&T policy (2002) • Introduced IP Commercialisation Policy (2009) • Encourage proactive role of university in technological development; commercialisation • Encourage private and industry in S&T activities • Promoting university industry links

Chapter 3

University and Academics

3.1 Introduction

The concept of the triple helix introduced by Etzkowitz explained the link between government, university and industry. This concept shows the evolution of university role from the traditional task of teaching to research and increasingly utilizing their research and teaching capabilities in advance areas of science and technology to form new firms. This chapter will discuss the concept of entrepreneurial university in the light of the triple helix model. However, for the purpose of this study, one of the components in the triple helix model i.e. industry will be substituted with academics. The main rationale is to understand academic involvement in commercialisation activity rather than understanding the industrial links in technological development. Furthermore, the implementation of policy and initiatives by the government and university is meant for the person who is actually doing it, which is the academic. It is, therefore, important to understand from an academia perspective rather than that of the industry in terms of commercialisation activity in the university.

The next section will present the role of university in R&D and commercialisation. Section 3.3 will give an overview of the emergence of knowledge-based economy that sees the university plays a greater role in economic development. This section will also present two models that are related to the creation and utilization of knowledge; Mode 2 Knowledge Production and the triple-helix model. Section 3.4 presents the concept of entrepreneurial university and the formation of spin off companies in the light of the triple helix model. Section 3.5 will discuss the attitude and factors that motivate academic to do commercialisation. The last section will conclude the chapter.

3.2 The Importance of University in R&D and Commercialisation

The increasing importance of universities' contribution towards economic development, technology development and social development can be acknowledged

by the growing interest in academic literature. This phenomenon, claimed by Eztkowitz and Leydesdorff (2000) as an 'academic revolution', has witnessed a tremendous effort by the government and university in facilitating the transfer of technology to the society. Indeed, the university's contribution has enormous contagious effects not only for economic development but also for competitive advantage (Mowery, 2007; Godin and Gingras, 2000; Etzkowitz and Leydesdorff, 2000, Shane, 2004; Saxenian, 1994).

The government initiatives and support programmes have been studied by many scholars. For example, the allocation of resources for facilitating technology development, the formation of spinoffs companies (Lockett and Wright, 2005; Smith and Ho, 2006; Ndonzuau et.al. 2002) and the funding initiatives for high-tech ventures (Vavakova, 2006; Goldfarb and Henrekson, 2002; Tesfayohannes, 2006) have been largely debated in the literature.

More recently, the government has realized the important role of entrepreneurial universities in creating and diffusing knowledge and eventually becoming an agent of industrial innovation. Following the report by OECD entitled 'Fostering Entrepreneurship', the report stressed that the university should develop structural and formal policies to facilitate the transition from research to the creation of new ventures (OECD, 1997). The Bayh-Dole Act 1980 and 1986 Technology Transfer Act, for example, were the initiative of US government in encouraging entrepreneurship culture among academics.

At the university level, a number of supporting programmes and initiatives have also been introduced to show the significant contributions and the growing importance of university's research towards local and regional economy as well as country's development (Lockett et.al., 2003). The changing role of the university from an 'ivory tower' to research and entrepreneurial university can be observed through numerous programme and supporting facilities made available in sharing the 'laboratory life'.

Some universities have already altered their policies to create incentives for researchers to commercialise their research (Lockett et.al. 2003). A range of

initiatives have been introduced at the university level which included technology transfer offices (Guston, 1999), incubators (Lee and Osteryoung, 2004), entrepreneurship centres (Klofsten and Jones-Evans, 2000), university spinoff companies (Smith and Ho, 2006; Ndonzuau et.al. 2002; Barnes et.al. 2002) and student involvement (Rasmussen and Sørheim, 2006). These supporting units and incentives showed that the role of university is changing. It is also an evidence of an extension of the traditional task of teaching and research and becoming more involved with entrepreneurial activities. The emergence of this new 'type' of university is primarily because of the changing perception on knowledge created in university. Knowledge is seen as a driving force for economic development and subsequently university is considered as an economic actor.

3.3 The Rise of Knowledge Economy - Emergence of Entrepreneurial University

Universities form an important part of a country's education system. Besides being a premier institution for knowledge production, a university plays a significant role in supplying highly skilled labours into the market. Occasionally, over the years, the importance of universities in economic development is seen as one of the main factor in developing a nation.

Traditionally, the university focuses only on the traditional academic practices of teaching and research. The knowledge contribution towards the society in which they are functioning was hardly recognized. However, with the emergence of knowledge-based economy, the role of university has drastically changed. The type of knowledge they produced and the way the knowledge was being used received greater attention in the middle of 1900s. Universities are now being seen as a driving tool for innovation and other creative disciplines.

According to Neef (1998), the emergence of knowledge-based economies stems from a unique combination of focused market incentives that have led to immense technical progress that affected the industry and fostered dramatic changes in the way which economies, organizations and governments will function in the future. During the past several years there had been a major switch from conventional industry to more

sophisticated and integrated industry. The low-skill labour market is disappearing, especially in developed economies, and it has been transformed into high-skill services. This phenomenon is due to the increasing 'value' of knowledge produced in the university and that this knowledge creates new technology that affects almost every aspect of life. The main supplier for such technology is from the university. Therefore, the university plays an important role in a country's national innovation system.

On the macro perspective, a university is cited as a critical institution in the national system of innovations (Nelson, 1993; Edquist, 2007). Literature on NIS emphasized strong linkages between a number of institutions; government, university and industry and will improve the national innovative and competitive performance of a country.

One conceptual framework for analysing the changing role of the university in the NIS is the 'Triple Helix' concept, introduced by Etzkowitz and Leydesdorff (2000). The concept emphasized on the increase interactions among the institutional actors in industrial economies' innovation system. Furthermore, the focus of the concept is on the interaction between different institutional actors that will be resulted with the creation of hybrid institution; incubator, spinoff companies. However Etzkowitz et.al. (2000) suggested that the adaptation of the triple helix concept in the developing countries and to less favoured regions requires a broadening concept of the 'university', which includes technical institutes, research centres, colleges and other institutions of knowledge production and diffusion.

Another conceptual framework that has been applied in describing the role of academic institution is the 'Mode 2' the production of knowledge. This framework, identified by Michael Gibbons and colleagues, reflects the increasing scale and diversity of knowledge inputs required for scientific research. The 'Mode 2' production of knowledge studies the inter-institutional collaboration and interdisciplinary research among research communities. The two concepts will be discussed in detail in the next section.

The 'Mode 2' production of knowledge

The Mode 2 knowledge concept was introduced by Gibbons and his colleagues in their book entitled 'The new production of knowledge' published in 1994 (Gibbons et al., 1994). The concept conceptualizes the knowledge production in terms of: 'knowledge produced' (i.e. academic or application-based; disciplinary or Trans disciplinary), 'heterogeneity of the people, organization and skills in the knowledge production', 'accountability and reflexivity' and 'quality control'.

In Mode 1, problems were solved within the particular academic and discipline. In other words the Mode 1 did not involved different disciplines, multiple skills, people or location i.e. it was characterized by homogeneity. The organization of knowledge production tends to be hierarchical and follow the codes of practice to a particular discipline within the particular organization. The knowledge produced was also relatively less socially accountable and reflexive. Much of it was meant for the academic community only. In assessing the quality of the research, the Mode 1 was determined essentially through the review of peer rather than from the industry. Hence knowledge produced in Mode 1 needed further combination of research to become marketable.

In Mode 2, by contrast, knowledge resulted from a broader range of disciplines, people and skills. The production of knowledge was intended to be useful for someone else in the society. As said earlier the Mode 2 was characterized by its: transdisciplinarity; heterogeneity, social accountability and reflexivity, and quality control which emphasizes context and user; supply and demand in the market. The quality of the research was judged by the society in relation to addressing the current problems in the market or society. Thus the Mode 2 implies the changes in academic based research, where the later was focused on self-interest; the Mode 2 is based on the 'client' needs. In fact the Mode 2 put an emphasis on turning knowledge into wealth (Gibbons et al, 1994).

The Mode 2 thesis was further elaborated by the co-author of the first book 'the New Production of Knowledge', entitled 'Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty' (Nowotny et al., 2001). In this book, Notwotny tried to fill the gap on the relationships between 'science' and 'society' and contextualization of

knowledge. She introduced the concept of 'agora', or the public space in which 'science meets the public' and the introduction of the concept of 'Hybrid Flora'. The concept, which was the elaboration of the Mode 2, focused on the meeting of a range of diverse players in the production and shaping of knowledge was published in the first book (Gibbons et al, 1997). She also claimed the validity and usefulness of knowledge is negotiated in the encounter between science and public in this so-called 'agora'. Table 3.1 illustrates the comparison of Mode 1 and Mode 2 production of knowledge.

Table 3.1: The Differences between Mode 1 and Mode 2 Knowledge Production

	Mode 1	Mode2
Context of Knowledge Production	Research and agenda setting, problem solving focuses on academic context.	Focuses on the application in the broader context. Knowledge produced in the context of application.
Transdisciplinarity	Knowledge produced largely in single discipline.	Characterized by transdisciplinarity. Multiple disciplines in its research methods, theoretical structures and modes of practices.
People and organizational involves	Homogeneity.	Heterogeneity. Knowledge production involves multiple skills, experience and sites.
	Organizational tends to be hierarchical. Specialized institutions set for specific production of knowledge.	Knowledge produced tends to be flat and flexible. Transfer and collaboration can exist anywhere; inter-organization.
Accountability and social reflexivity	Low level of reflexivity and accountability.	High level of reflexivity and accountability. Subject to multiple accountability i.e. academic, social.
Quality control	Quality control done by peer reviewed in academic community only	Quality control done by various institutions.

Source: Summarized from Gibbons et al., 1997.

The 'Triple Helix' Model

The 'Triple Helix' concept, introduced by Etzkowitz and Leydesdorff (2000), illustrates the increasing role of university in innovation activities in increasingly knowledge-based society. The concept is different from the NSI and Mode 2 Production of Knowledge; given that the latter concept has been criticized as vague (Edquist, 1997) and the Mode 2 was challenged on the ground of its validity, novelty and significance (Godin and Gingras, 2000). The 'Triple Helix' highlighted the

university's important contribution and its leading role in the society towards economic development. In contrast to NIS, Lundvall (1998) and Nelson (1993) considered firm as having the leading role in innovation and a model introduced by Sàbato (1975), cited in Etzkowitz and Leydesdorff (2000), the Sàbato's triangle, claimed that the government have the privilege.

Triple Helix I (Figure 3.1) is the statist model of university-industry-government relations. In this model the nation state encompasses academia and industry and directs the relations between them. Former Soviet Union and in Eastern European countries are examples of a stronger version of this model. On the other hand, the weaker version of this model can be found in many Latin America countries and some of the European countries such as Norway (Etzkowitz and Leydesdorff, 2000).

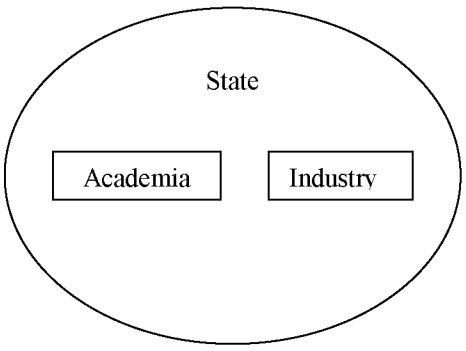
The second model is a 'laissez-faire' model of university-industry-government relations, known as Triple Helix II. The model consists of separate institutional spheres with strong borders dividing them and highly confined relations among the spheres (Fig 1). The first two models, Triple Helix I and Triple Helix II, failed to harmonize each sphere to the highest level of collaboration given that there was too little room for 'bottom up' initiatives. Innovation was discouraged rather than encouraged (Etzkowitz and Leydesdorff, 2000).

The Triple Helix III model was introduced to overcome the previous models' setbacks. The Triple Helix III is the core thesis of Etzkowitz and Leydesdorff's 'Triple Helix of university-industry-government relations' (Fig 3.1). This model consists of overlapping institutional spheres, taking the role of the other and with hybrid organizations emerging at the interface (Etzkowitz and Leydesdorff, 2000:111). The objective of the model is to encourage an innovative environment consisting of tri-lateral initiatives for knowledge-based economic development and strategic alliances among the institutions (firms, government research laboratories and academic research groups) (Etzkowitz and Leydesdorff, 2000:112). These arrangements are often encouraged with minimal intervention by government (example the Bayh-Dole Act in US), the direct and indirect financial assistance and the setting up of science parks.

Mowery and Sampat (2005:214) argued that there was a growing interaction between universities and industry within these two concepts. However, the Mode 2 claimed that the role of universities is decreasing as research and knowledge producing centres. The Triple Helix, on the other hand, recognizes the growing importance of universities in innovation activities in the growing knowledge-based economies and society (Etzkowitz and Leydesdorff, 2000:109). The NSI also suggests the significant role of institutions in research and innovation although the Triple Helix focuses on the three main actors: university, industry and government.

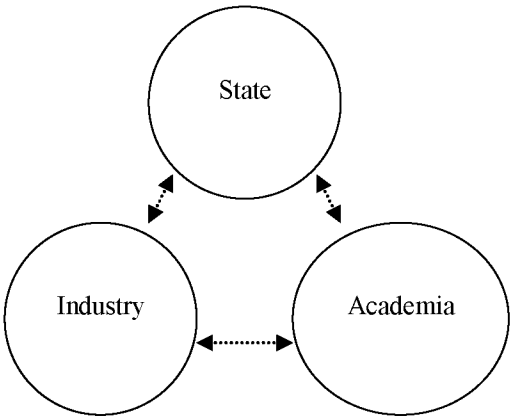
Figure 3.1: Triple Helix Models of University-Industry-Government Relations

Triple Helix I



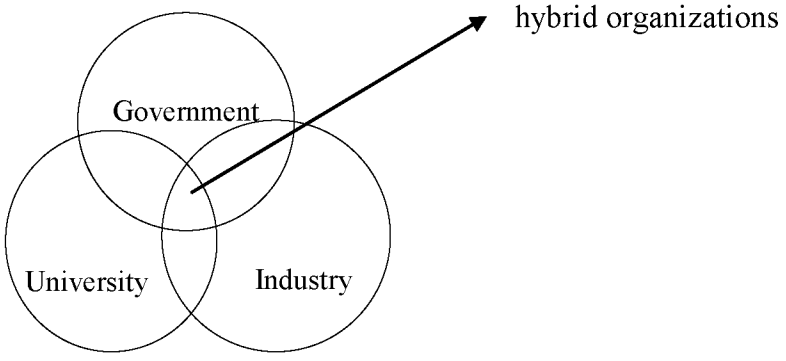
The statist model of university-industry-Government relations

Triple Helix II



A 'laissez-faire' model of university-industry-government relations

Triple Helix III



The Triple-Helix Model of University-Industry-Government relations. (Eztkowitz, 2000)

Evidence of Application of Triple-Helix Model

The changing role of universities from knowledge production centre to research and to entrepreneurial activities have been discussed in several studies among researchers, academics and governments (Etzkowitz and Leydesdorff, 2000; Nelson, 1993; Godin and Gingras, 2000). Besides their fundamental mission: teaching and research, the increasing importance of universities' contribution can be seen from many spectrums. Their contributions included enhancing local economic development, job creations, and supplying high-skilled workers to market. The changing role of universities from the 'ivory tower' into the entrepreneurial paradigm can be best illustrated with the emergence of science parks such as the Silicon Valley in San Francisco, Route 128 in Massachusetts and Cambridge Science Parks in UK.

- **Route 128 Massachusetts, Boston**

The establishment of Massachusetts Institute of Technology (MIT) in 1861, as a first technical university in the region, had a significant impact towards Eastern Massachusetts's local economy which later turned the region into one of the first technopoles in technology evolution – the Route 128. Massachusetts has a long industrial tradition. Since the nineteenth century the economic activity around the region has been based on producing textile, armaments and machine tools for industries. Later, during the first half of the twentieth century, the local economic activities shifted to the automobile industries because of the loss of their traditional manufacturing industries to New York.

The contribution of MIT towards industrial development can be traced back with the establishment of technology plan to encourage large corporations to have a direct link with the university. MIT created a Division of Industrial Cooperation and Research (Technology Transfer Office) to strengthen the institutions linkages. However in 1930, the Division of Industrial Cooperation and Research was discontinued and the Office of Sponsored Projects was set up to maintain its capacity to solicit and managed corporate contracts (Saxenian, 1994).

MIT's research funding mostly came from the local large firms in the area but was significantly shifted to government funding in the 1940s when Vannevar Bush, a Dean in engineering faculty in MIT, who served under Roosevelt, became the director of the newly formed Office of Scientific Research and Development (OSRD) in Washington. He revolutionized the relationship between science and government by encouraging the government to fund universities' research rather the government laboratories. This resulted in MIT becoming the nation's leading military research centre during the war. To some extent he also used his influences to tie a bond between MIT and Washington and ensuring that the committee members of the OSRD were MIT graduates (Saxenian, 1994).

The influences and the government funding resulted in the development of a number of laboratories that in the mid 1960s, employed more than 5,000 scientists and engineers. In addition to the establishment of laboratories, the government constructed the first twenty-seven miles stretch of highway which linked twenty towns in the greater Boston – the Route 128 and created a space for technology firms to operate. Within few years of its completion in 1951, the Route 128 attracted a diverse mix of research and technology firms. By 1961, there were 169 firms creating more than 24,000 jobs and the number doubled in the following eight years.

The local industries were also affected with the establishment of Route 128. Between 1940 to1945, small companies' sales grew from $3 million to $173 million, while the employment was drastically increased from 1,400 to 16,000. In 1946, the first venture capital finance was introduced by a group of New England financiers and academics to invest in technological development. The American Research and Development Corporation (ARD) had successfully funded a number of technology firms until its operation was ceased in 1955 due to its high risk ventures. Despite of its closure, a number of banks and insurance companies in the region as well as private investor had started investing in technology firms (Saxenian, 1994).

- **Silicon Valley, San Francisco**

Silicon Valley, a 40-mile by 10-mile strip in the peninsula south of San Francisco (on the east side of US) has become the popular avenue of entrepreneurial culture. It is a

place where new ideas are born and become a living proof of a fundamental relationship between science and economic development, a process that emphasizes the role of universities and research as driving forces of human progress (Castell and Hall, 1994).

Frederick Terman, a Professor of Radio Engineering at Stanford University, is said to be the founding father of Silicon Valley. Convinced the need of critical link between university and industry, he used all his connections and ability to encourage his students to set up a high-tech company in the 1920s and 1930s. Persuaded by Terman's dream of a 'community of technical scholars', in 1951, he created the Stanford Industrial Park with the first company-Varian, a spinoff company from Stanford University, to start their business in the park. Later, Hewlett-Packard and several other spin-offs companies established their firms in the Stanford Industrial Park. By the end of 1980s, 90 companies have fully operated with about 25,000 workers (Castell and Hall, 1994).

From the mid-1970s, Silicon Valley became the world's future technopoles with a self-sustaining innovative milieu of high-tech manufacturing and services. Universities, including Stanford, San Jose State, Santa Clara and Berkeley, continued to be critical in providing the labour market with highly skilled and well-trained engineers and scientist. However, their roles as a source of R&D has substantially declined as most of the R&D and innovation activities were conducted within the Stanford Industrial Park. Nonetheless, the main factors that triggered the establishment of spinoff companies as well as their business achievement in Stanford Industrial Parks were historically stemmed from the university's initiatives (for example Terman was a Professor in Stanford University).

- **Cambridge Science Park (CSP)**

Cambridge Science Park (CSP) was first proposed at the end of 1969. It was developed and managed by Trinity College, University of Cambridge following a report from the East Anglia Economic Planning in 1968, to further support the city and university to develop the region and becoming a research-based industrial region. According to Carter and Watts (1984), the CSP was established in 1881 by Horace

Darwin and Dew Smith, (both Trinity College graduates), founded the Cambridge Instrument Company to produce instruments for experimental research and other laboratories. Then the company moved into designing and developing communication equipment and later into electronic products (Carter and Watts, 1984).

The area offers a variety of employment environments for high technology firms. The 'Cambridge Phenomenon', a term applied to the concentration of high-tech firms, established a number of spinoff companies which eventually made the Cambridge's economy a self-sustaining economy in the country at the time. After ten years of its establishment as a science park, CSP has more than twenty high-tech firms incorporated in the area.

Before 1969, Cambridge economy was consistently unstable, with unemployment rates being about half of the national average rate. However, after the establishment of CSP, the unemployment rate dropped drastically and according to Carter and Watts (1984) in their report, the CSP managed to create jobs more than the country as whole particularly in service industries. By 1978, 77.4% of employments in the Cambridge Service Area were in service industries compared to 64.8% in Great Britain (Carter and Watts, 1984).

The three mini cases of Science Park in the above shows the evidence of role shifting of universities from 'ivory tower' to 'entrepreneurial universities'. Without compensating their traditional role (teaching) the effect of the 'academic revolution' is enormous and can be seen through the regional and economic development in the area. It can be argued that each Science Park developed is located around a university. Besides supplying technology and knowledge, the university also supplies highly-skilled manpower.

From the three cases, there are evidences that despite of the government involvement in providing funding, there is a connection from the university itself that triggered the link with the government. For example, in the case of MIT-route 128, the majority of the funding came from the government to conduct military research during the war because one of the university professors was working with the government. In another words, the professor became a liaison between the university and the

government. The Cambridgeshire Science Park was developed following recommendation from the government report to support the city and to develop the local vicinity. It can be argued that the existing business ran by Cambridge University students in 1881 is eventually becoming the trademark of Cambridge University commercialisation activity and might have the influence for the government to intervene in local economic development. It is believe that the Cambridge Instrument Company contributes significantly to economic development in the region. Hence it can be implied that the university plays a huge role and to some extent has a direct impact on the economic and regional development.

3.4 Entrepreneurial University

The increasing importance of universities' contribution towards economic development, technology development and social development can be acknowledged by the growing interest in the academic literature. This phenomenon, claimed by Eztkowitz and Leydesdorff (2000) as an 'academic revolution', has witnessed a tremendous effort by the government and university in facilitating the transfer of technology to the society. Indeed, the universities' contribution has enormous contagious effects not only for economic development but also for competitive advantage (Mowery and Sampat, 2007; Godin and Gingras, 2000; Etzkowitz and Leydesdorff, 2000, Shane, 2004; Saxenian, 1994).

The changing role of a university from an 'ivory tower' to research and entrepreneurial university can be observed through numerous programmes and supporting facilities made available in sharing the 'laboratory life'. More recently, the government has realized the important role of the entrepreneurial university in creating and diffusing knowledge and eventually becoming an agent of industrial innovation.

Following the report by OECD entitled 'Fostering Entrepreneurship', the report stressed universities to develop structural and formal policies to facilitate the transition from research to the creation of new ventures (OECD, 1998). The Bayh-Dole Act 1980 and 1986 Technology Transfer Act, for example, is an initiative of US government in encouraging entrepreneurship culture among academics.

The increasing interest in academic entrepreneurship has stimulated a broad and interesting debate especially in the formation of academic spinoffs, the most visible form of commercialisation. Academic spinoff plays an important role in transfer of technology from the university into the private sector. The technology transfer involved formal factor (i.e. the patent license) and an informal factor (the transfer of tacit knowledge-human capital or ongoing relationship between firms and university).

3.4.1 Definition of spinoff companies

This section will be discussing to what extend does the definition of spinoffs companies are covered in the literature. In a broader context Smith (2006) defined spinoff companies as an organization created by another organization in order to exploit the technology. The exploitation means to commercialise the research results from the university or research institutes.

Steffensen et al. (1999) however, in a less broad sense, defined spinoffs companies as a company that is formed by individuals who are the former employees of the organization, involved the transfer of technology from the main or parent organization with the purpose to commercialise the product.

In a much similar theme, Pirnay et al. (2003) defined the university spinoffs as a particular type of company that is created for the purpose of commercially exploiting knowledge, technology or research results developed within a university (Pirnay et al., 2003).

Shane (2004) in his book of Academic Entrepreneurship defined spinoff companies in a much narrow way. He defined spinoffs as a new company founded to exploit a piece of intellectual property created by the academic institution (Shane, 2004:4). He made a thorough distinguish by claiming that even if the companies established by current and former university staff, which did not commercialise their intellectual property created in the academic institutions, are not included in the definition. By that Shane (2004) stressed that without intellectual property and companies created from the academic institution; it will be excluded from this definition (Shane, 2004:4).

Nevertheless, academic spinoff is a part of university action or activity to exploit intellectual property created by the university personnel. It is an efficient mode in turning academic research into a commercially value product. Moreover the formation of Spinoff Company encourages inventors' involvement in the operation of the business. Other important feature of spinoffs is that the company operates a direct transfer of technology from the university to the society. It does not involve any intermediaries in commercialising their research products.

3.4.2 University spinoffs in historical perspectives

Academic research has always had a practical side. Researchers and engineers believe that the research results have a significant commercial value. This section will explore the history of academic spinoffs since the first establishment of academic spinoffs in 19th century in Germany. Cited by Shane (2004) on the work of Gustin (1975), he identified several university professors in the 19th century German universities who founded companies on the basis of their technological developments and knowledge (Shane, 2004:41).

Spinoffs in US

In the United States the commercialisation activities were only spurring in the early 20th century. However the early initiative of the government was rather limited. The introduction of The Hatch Act of 1887 signified the first initiative of technology transfer in the US. The act did not directly encourage the establishment of spinoff companies but rather an initiative to give a land grant to state universities which called upon universities to develop and disseminate knowledge that resulted from academic research focusing on agricultural experiments (Rosenberg and Nelson, 1994).

During the 1930s, several initiatives were introduced to support the commercialisation process and activities within the US universities. Among others was the establishment of a policy that required academics to disclose their research and the establishment of technology transfer units (Mowery et al., 2001). Throughout the 1900–1940 period, U.S. universities, especially public universities, pursued extensive research collaboration with industry. Indeed, the academic discipline of chemical engineering

was largely developed through collaboration between U.S. petroleum and chemicals firms and MIT and the University of Illinois (Rosenberg, 1998). However these initiatives were still indirect and rather limited, especially in conjunction with the effort of forming academic spinoffs (Mowery and Sampat, 2005).

Besides government funding, the first modern venture capital was developed at MIT. The establishment of American Research and Development Corporation (ARDC)[9] was another initiative by the university with the main purpose to commercialise military research within the MIT laboratories. The ARDC provided a great deal of support to the formation of companies to commercialise university inventions (Saxenian, 1994). It is worth to mention that after the First World War, MIT received a substantial amount of funding from the government for military research.

The introduction of Bayh-Dole Act in 1980 and the Federal Technology Transfer Act witnessed another major initiative by the US government in supporting technology commercialisation and the formation of academic spinoffs companies. The provision of the act gave the property right to the university inventor of federally funded inventions. In short the act gave the universities greater incentives to license their technologies (Shane, 2004).

The Bayh-Dole Act led to a rapid development and growth in the infrastructure for technology transfer and commercialisation in the US. Many universities previously did not engage in commercialisation of academic research has started to developed the research capabilities and start to patent their research, licensing and establishing spinoffs companies (Mowery and Sampat, 2005). Nevertheless licensing survey conducted by the Association of University Technology Managers reported that there were 5,724 new spinoffs established from fiscal year 1980 to fiscal year 2006 in US (AUTM, 2006).

Spinoffs in UK

In the UK, the academic revolution can be dated to the early 1980s where UK universities started to establish technology transfer offices. Following the accession

[9] American Research and Development Corporation (ARDC) was established in 1946 by a group of university staff in supplying funding assistance (venture capital) towards academic research results.

of the Labour Party in 1997, the government has increased the research funding and support for entrepreneurial activities which has resulted with a number of initiatives for university commercialisation activities. Table 3.2 presents UK government's commercialisation initiatives.

In order to further develop the innovation landscape in UK innovation activities; in 2001 the Public Sector Research Exploitation Fund was introduced as an additional funding assistance towards innovation activities. The financing alongside other supporting programmes has resulted in the increase in number of spinoffs companies. A survey by Higher Education Business Interaction (HEBI) showed a rapid increase in the number of spinoff companies from 1999 to 2002 which total more than 600 spinoffs companies established in that year (Smith and Ho, 2006).

Table 3.2: UK Government Commercialisation Initiatives

Year	Initiative	Purpose	Details
1998	Higher Education Reach Out to Business and the Community (HEROBaC).	Funding to support activities to improve linkages between universities and their communities.	£20 million per year is allocated to provide funding assistance in open up corporate liaison offices.
1999	University Challenge Fund (UFC)	Seed investments to help commercialisation of university IPR	£45 million was allocated in 1999 and £15 million in 2001. 57 HEIs involved in the competition
1999	University Science Enterprise Centres (SEC)	Teaching entrepreneurship to support the commercialisation of S&T	Initially provides £28.9 million with an additional of £15 million resulting 60 HEIs participate in the programme.
2001	Higher Education Innovation Fund 1	Single and long-term commitment to support universities in S&T activities	HEIF was launched in 2001 to bring together previous funding sources and extended to HEIF2 in 2004 with £185 million awarded.

Adapted from: Smith and Ho, 2006:1557

3.4.3 The Importance of University Spinoffs

The success story of Silicon Valley and Route 128 (Saxenian, 1994) and Cambridge Science Park (Carter and Watts, 1984) can be best representing the systemic effects of spinoff companies in developing the economic development in the region. As Mian (1997) stated:

'Spinoffs represent one potential mechanism for technology transfer from university, as they increasingly seek to contribute to their region's economic development' (Mian 1997).

Steffensen et al. (2000) argued that the regional impact of spinoffs comes in many different ways for example spinoff companies create jobs and taxable wealth for the local community. It also contributes to the university by providing jobs for its graduate and in some cases generates revenues for the university. In addition to that they also argued that in a place where entrepreneurial activities are lacked, spinoff companies serve as role models for developing the entrepreneurial culture.

Shane (2004) in his book entitled the Academic Entrepreneurship stated that the university spinoffs are valuable in at least five ways. Similar to Steffensen (2000) Shane argued that Spinoff Companies encourages economic development through;

1. Creating significant economic value
2. Creating jobs
3. Inducing investment in university technologies
4. Promoting local economic development.

Secondly, he argued that spinoff companies are an effective commercialisation vehicle for uncertain technologies developed in the university laboratories and it also encourages the involvement of inventors in the business. Thirdly, spinoffs indirectly help universities with their main mission by providing additional support for academic research as well as training and exposing the students with the 'current market'. Besides its high performing companies (Shane, 2004; Golfarb and Henrekson, 2003; Dahlstrand 1997; Mustar 1997), spinoffs are more profitable than licensing to established companies (Bray and Lee, 2000; Wright et al., 2002; Shane, 2005).

The value added by spinoff formation should not be denied. In Silicon Valley, for example, besides being the main mechanism in commercialisation activities, the previous established spinoff firms proved to be a fund provider for a new start-up

company (Saxenian, 1994). Acting as an internal venture capital[10] company, the established spinoff firms may overcome the *new* spinoff firms' main constraints in business formation, which is to get finance. Conventional financing only interested in tangible product and in some circumstances requires collateral, which the new spinoff companies may have difficulties to provide. Besides funding, the new spinoff companies may also receive other types of assistance from the established spinoff firms; management assistance, marketability of the product, assessing the product and basic operation of a business (Dubini, 1989).

University spinoffs are also important to universities in the sense that it creates good reputation for the university. Good reputation means that the tendency of getting additional funds from the government and industry are much greater compared to the university who are not committed to entrepreneurial activities. Reputation will help the university to obtain private funding at times of uncertainty as investors will be able to rely on the universities' past ability to succeed (Di Gregorio and Shane, 2003).

Sharing resources within the research community is a key role for technology transfer. Building on this relationship will help to foster a greater alliance between different academic disciplines and universities. Setting up of spinoff companies requires not only the product but also other skills such as management, marketing and operation management. Different faculties, with different academic disciplines, may contribute their expertise in the creation of spinoff companies. These create another window of opportunity for other academics to engage themselves in the commercialisation activities of university research. The importance of the formation a spinoff companies is summarized in the Table 3.3.

[10] Venture Capital – is a type of private equity capital providing assistance for immature, high potential growth business in return for share in the invested company. For venture capital financing, see Chris Bovaird (1990).

Table 3.3: The Benefit of Spinoffs Formation

Activity	Benefits
Effective means in technology transfer	Product developed is specifically to cater the need of market
Economic development	Regional and local economic development: basic infrastructure, university, housing projects
Job creation	Create jobs for local residents, students become entrepreneur, graduates employment
University reputation	Represent Entrepreneurial culture, produce high standard research, outstanding researchers
Increase funding availability	Able to secure funding from industry, internal venture capital, increase government grants
Foster entrepreneurial culture	A role model for entrepreneurial activities

Sources: Shane (2004), Mian (1997), Saxenian (1994), Di Gregorio and Shane, (2003) Golfarb and Henrekson, (2003), Dahlstrand (1997), Mustar (1997). Compilation by the authors.

3.4.4 Spinoff: barriers and challenges

Even though spinoff has shown a significant importance towards regional economic development and up bringing universities' reputation, some barriers and problems have been pointed out in the literature. For instance, some scholars argued that the direct involvement of academic in commercialisation activities will rectify the imperfect transfer of knowledge and it will also motivate academic research to carry out projects with greater economic and social relevance (Gibbons et al. 1997, Zucker and Darby 1998, Ezkowitz et al., 2000). However some scholars argued the ability of academics to manage commercial activities on the ground that there will be a conflict of interest with the rules and mission of academia (Dasgupta and David, 1994; Nelson, 2004). Besides, being an academic in the morning and entrepreneur in the evening, some academics will find some difficulties in allocating their time between the two jobs (Etzkowitz and Leydesdorff, 2000; Etzkowitz et al. 2000).

The traditional academic freedom was also being challenged by the establishment of spinoff companies. It is a norm for academic research or an invention to take a longer period to have a commercialised value and often this invention needs further development to become marketable. However, with the formation of spinoff company, the time flexibility is off. Invention needs to be speeded-up in order to satisfy the market demand. To some extent, basic research in some universities had declined due to the eagerness of researchers to fulfil the market needs (Nelson, 2004).

Another barrier of spinoff formation is the lack of entrepreneurial spirit and activities amongst academic researchers. Entrepreneurial activities should be developed, not only by practical and organizational arrangement, but also by motivating staff and student in becoming an entrepreneur. Self-initiatives amongst the researcher to commercialise their research finding are extremely important (Makati, 2003; Meyer 2003).

It is a fact that most basic research and R&D innovation activities conducted in the public research institute and university received substantial amounts of government funding. The fact that high-tech firms are a high risk business; it has made the investment less favourable to other kinds of funding mechanisms for example financing facilities from financial institutions. There are two issues worth mentioning in regards to academic research funding facilities. Firstly, different government have different focus areas and different national agenda. This means that the academic research is directly influenced by the government into what type of research they should conduct and what research projects will receive government incentives favourably. The government actions and interventions might distort or hinder the *real* interest of the academic researcher.

Secondly, raising capital in the early stages remains a challenge and the biggest hurdle for many new high-tech company, especially in the early stage financing (Akhtar , 2000; Goel and Hasan, 2004;). Since the traditional source of funding is difficult to obtain, as the financial institutions[11] might be less interested in intangible product (e.g. patents, intellectual property) than tangible products (Goel and Hasan, 2004), academics have to turn to venture capital financing.

Venture capital financing is suitable to assist new high-growth potential technology companies with limited credit history. This new high-growth technology company also prefer venture capital financing because company finds it difficult to raise capital in the public markets. On the other hand, venture capitalists (VCs) prefer investing in new high-tech firm because the VCs usually get a significant control over the

[11] A bank normally charge interest and under certain circumstances requires collateral. Banks will only finance if the return on the investment is more than interest paid by the lender.

company. In exchange to the high-risk venture, they receive a significant portion of the company's ownership.

However, in scholarly debate, Robinson (1987) found that venture capital firms differ significantly in the stage of financing[12] of new ventures. According to Bygrave and Timmons (1992), the difference between the early stage financing and late stage financing is so great that most venture capitalist tends to finance the later stage. Early stage financing is generally associated with management, market and technological uncertainty. As a result, venture capitalists are reluctant to finance early stage businesses as the risk of loss is much higher. Ruhnka and Young (1991) also found that the venture capitalists are very concerned with the risk of management failure in the early stage of financing. For instance in Malaysia[13], financing for development of early stages of businesses, especially seed capital is lacking. Table 3.4 summarizes the total amount of funds invested by the venture capital companies in Malaysia.

[12] Venture capitalist distinguished a number of stages in funding processes. For more see Chris Bovaird (1990)

[13] In Malaysia, Venture Capital was defined in the 1989 Finance Bill as:
A venture capital company refers to a company incorporated in Malaysia holding shares in companies involved in high risk ventures and new technology which would promote or enhanced the economic or technological development of Malaysia and which is approved by the Ministry of Finance.

Table 3.4: Statistics Of Venture Capital Companies (VCCs) in Malaysia

	1992	1997	1998	2000	2001	2002	2003	2004	2005
No. Of VCCs	13	22	23	31	41	38	43	38	48
No. of Investee Companies	32	259	246	159	235	183	298	332	380
Total funds mobilized (RM million)	360.8	1124.4	1000.3	n.a.	2497.7	1953.1	2118.1	2266	2589
Cumulative investment made (RM million)	64.6	904.9	952.1	n.a.	968.5	n.a.	n.a.	n.a.	n.a.
During the year									
No. of investee companies	17	92	65	35	47	80	115	139	101
Profit before tax	5.3	-58.1	-39	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total investment during the year by VCCs	**26.4**	**200.8**	**152.5**	**131.3**	**118.7**	**191.4**	**227.2**	**289.3**	**431.5**
By Sector (RM million)									
Manufacturing	0	139.4	99.3	25.4	51.8	42.7	59.29	36.5	65.6
ICT	0	n.a.	n.a.	53.1	20.2	67.6	103.8	137.4	213.1
Life Sciences/Biotechnology	0	n.a.	n.a.	3.5	5.7	52.4	60.8	49.8	91
Others	26.4	61.4	53.2	49.4	41	28.7	3.31	65.6	61.8
By Type (RM million)									
Seed Capital(*1*)	**0**	**0**	**0**	**1.3**	**0**	**1.4**	**19.9**	**16.1**	**11.6**
Start-up(*2*)	**3**	**81.1**	**32.2**	**19.7**	**23.74**	**47.5**	**47.9**	**19.3**	**25.1**
Second Stage(*3*)	10.1	4	21.4	15.8	49.8	67.9	98.6	154.7	168.7
Management Buy-out(*4*)	4.7	67.7	43.4	65.7	30.8	1	28.5	19.2	44.3
Bridge financing(*5*)	8.6	17.5	5.3	14.4	14.4	41.8	20.3	67.2	162.2
Other	0	30.4	50.3	14.4	0	31.8	12.1	12.8	19.3

(*1*) Stage where relatively small amounts of capital are required; Intellectual capital.
(*2*)For investee companies with complete business plan seeking funds to launch product development and marketing.
(*3*) Refers to the period during the expansion stage when the investee company requires assistance in the production and distribution of the product while the production is growing.
(*4*) For investee companies seeking money for plant expansion, marketing and increasing working capital.
(*5*) Involves venture capital when synergistic partners are sought for the investee company.
n.a. Data not available

Sources: Various Bank Negara Malaysia and Securities Commission Annual Report. Compilation by the author.

3.5 Motivational Factors and Personality Type

Despite the increasing studies in commercialisation activities in the university, there are very little prior research on the individual motivations that lead to the decision of business start-up formation. The existing body of literature mostly focuses on the institutional factors, specific research fields or research organization (Casper 2000). Among the institutional factors are the role of technology transfer offices (Jones-Evans, et al 1999); (Chapple, et al. 2005), incubator facilities (Mian 1997), the technology itself (Jain and George 2007) and university incentives system (Golob 2006).

3.5.1 Motivation

Motivation is the driving force for human beings, animals and living organisms to conduct certain cause of action to achieve intended goals. This motivation can come from within the individual itself (intrinsic) as well as from outside of the individual (extrinsic). Intrinsic motivation is driven by the enjoyment of completing a task by him/her. Extrinsic motivation, on the other hand, is an action driven by the external force such as environment, reward and punishment.

The theory of motivation, which stemmed from the human needs theory, can be traced back from the infamous Maslow's need theory. Since then the human need theory has received substantial attention from the academic world. Among other theories; Herzberg two-factor theory, Alderfer's ERG theory, Edward Deci and Richard Ryan, McClelland's need theory and McGregor's Theory X and Y. The latest theory of motivation is introduced by Ritchie and Martin (1999) when they published their book entitled *Motivation Management*. They argued that the employer should know what motivate their employees in everyday work. In the book, they hierarchically listed down 12 motivational drivers based on the importance on 1,355 professionals (See Table 3.5).

From the research, interesting work and need for achievement were found to be the most influential factors that drive someone to do a task. Surprisingly, money and tangible rewards found to be the 9th place in their hierarchal motivational drivers.

Table 3.5: Ritchie and Martin Motivational Drivers

1. Interesting work/Interest	7. Influence
2. Need for achievement	8. Social contact
3. Self development	9. Money and tangible reward
4. Variety	10. Structure and rule
5. Creativity	11. Long-term relationships
6. Power	12. Good working condition

Sources: Sheila Ritchie and Peter Martin (1999)

In academic entrepreneurship there are various interrelated motivational factors that encourage academic to venture in entrepreneurial activities. Krabel and Mueller (2009) for example, studied the driving factors of a scientist in engaging commercialisation; found out that academics heavily depend on entrepreneurial experience, patenting activities and close personal ties with the industry. They argued that a close tie with the industry established through joint ventures in R&D and prior founding experience is more likely to initiate entrepreneurial activity. They also found that an academic who holds a patent is four times more likely to become an entrepreneur. Another catalytic factors affecting entrepreneurial activity is a peer effect. Azoulay et al. (2007) found that academics who work closely with other academics that have already participated in commercialisation of research output will encourage entrepreneurial activities.

Meyer (2003) studied four cases of histories of spin off formation and concluded that most of the researcher's intentions were to build up their research reputation rather than to build up high-growth technology firms. He also argued that business supports i.e. connection with industrialists, access and integration with established business network, are crucial for the survival of business formation.

Research by Landry et al. (2006) in Canadian universities found that academics are more likely to form a spinoff company if the research was funded by the government, not from the industry. The academics believed that if they launch spin off companies using funds provided by the industry, they will be seen as a rival to the industry that support their research activity.

In other instances, there is evidence that some of the academics *do* have 'entrepreneurial type' characteristics. They have a high desires for spin off formation and doing business. Shane (2004) found that the reason most of researchers in MIT founded a spinoff company is because they felt that having a company is always their main goals. This finding is consistent with McQueen and Wallmark's (1982) survey on the founders of spin off from the Chalmers Institute of Technology of which the main reason was the desires to commercialise their research output, not for wealth creation. Financial reward was the secondary motive for them to commit in entrepreneurial activities. This was also supported by Shane (2003), Blair and Hitchens (Blair and Hitchens 1998) and Smilor et al. (Smilor, Gibson and Dietrich 1990).

Shane et al. (Shane, Locke and Collins 2003) commented on the previous research conducted using qualitative approach and identified three motivational drivers that motivate entrepreneur: independence, drive and egoistic passion. The most interesting findings were the passion to do something or simply love to do something. Apparently, according to them, research on the effect of passion in entrepreneurship was still lacking. They believed that an entrepreneur having a strong passion in entrepreneurship is very unlikely to fail.

On a broader context, changes on policy have a major impact on entrepreneurial activity in the university. The implementation of Bayh-Dole Act, for example, shows a growth in patenting and licensing in the US research activity landscape (Etzkowitz 2002). However Mowery et al. (2001) found evidence that policy changes did not have a major impact on commercialisation activity. Rather they believed that the rise in biomedical research and the growth of its associated activity was the reason such phenomena occurred.

There is also evidence that the role of faculty and department motivate academic to commercialise. Thursby and Thursby (2002) provided evidence that the increase in numbers of licensing is due to faculty's willingness to license their department members' invention. Furthermore, a favourable environment and the institutional norms may also be considered as one of the motivating factors for academics to actively get involved in entrepreneurial activities (Stuart and Ding 2006, Bercovitz

and Feldman 2008). Reduction in academic workload and administrative work provides a facilitating environment for commercialisation to take place (Jain, George and Maltarich 2009).

Questioning as to why academic wanted to start their own businesses, research by Roberts (1989) found that independence, being their own boss and continuing search for new and bolder challenges were the reasons. His research also pointed out that a financial gain was not the primary motivators in doing commercialisation.

3.5.2 Personality Types

There is substantial research conducted in psychology studies on determination of one's personality types. Researchers' tried to understand the existence of certain personality features or traits that were associated with entrepreneurial activities (McClelland 1961). Others did on different characteristic such as gender, age, origin, education background and etc. (Storey 1994) (Robinson, et al 1991). One of the most influential theoretical works was introduced by Carl Jung in the 1920s. He believed that people are different in fundamental ways depending on how they perceived to behave. According to him, there are four dimensions to psychological types:

1. Extroversion/Introversion,
2. Sensation/ Intuition,
3. Thinking/Feeling
4. Judging/Perceiving

Among these four dimensions, the most popular types were the extroversion and introversion personality type. Almost all models in personality research used this concept; for example Jung's analytical psychological, Eysenck's three factors model, the Five Big traits and etc. In terms of definitions, there was quite a considerable number of definitions on extrovert and introvert. Given the robust definition in the literature, for simplicity, an extroverted individual is exemplified as an outgoing person, sociable, easy and enjoys talking with other people, up for a challenge, talkative and etc. Whereby introverted individual is reserved, less outspoken in large

crowds and prefers solitary in social activities (Ciavarella, et al. 2004, Moon, et al. 2008, Llewellyn and Wilson 2003).

Crant (1996) in his research stated that extroversion is important in encouraging proactive personalities of an individual that have an intention of becoming an entrepreneur. This will bring the charismatic feeling and vision when the person starts doing business. Robert (1989) found that (from personality perspectives) technical entrepreneurs are found to be more extroverted, more intuitive and more thinking-oriented than their less entrepreneurial engineering and scientific colleagues. It is believe that entrepreneurs should possess this type of characteristic as it is crucial for them to be able to communicate well with their customer. It also creates confidence in entrepreneur's locus of control as some of the businesses are risky and how they perceive the degree of risk of the businesses (McCarthy 2003). Besides, it has demonstrated to generate a positive attitude towards the need for achievement (McClelland 1961).

3.6 Conclusion

This chapter discussed the role of two main actors in the conceptual framework: university and academic. In the first part of the chapter, it explained the triple-helix concept, from which the conceptual framework was based on. The triple helix model explained the interaction of university, government and industry without compromising their primary roles in economic and technological development. The university is taking the role of facilitating the formation of new firms by fostering the commercialisation of knowledge. The knowledge capitalization, introduced by Etzkowitz, explained the extension of university roles and the emergence of entrepreneurial university. Entrepreneurial university is no longer seen as an institution for knowledge creation but also as a driver in economic and regional development. This also means that the knowledge industry in modern society is expanding and becoming more significant to the country. The introduction of knowledge-based economy is a good example of government initiatives to encourage universities' participation in economic development.

The literature also shows that there are several reasons that are deemed to be the motivational factors for academics into venture in entrepreneurial activities. These factors are important for universities in a way that necessary programmes can be developed to promote commercialisation activities. In terms of personality types, literature suggested that academics who are involved in entrepreneurial activities possess extroverted types of personality. Extroverted personality is normally associated with outgoing, proactive, creative and passionate types of persons. Identifying the motivational factors amongst academics in Malaysian universities will be interesting given that it will shed some light on motivational factors in the context of developing economies.

The next chapter will continue with the discussion on the method employed in conducting the research.

Chapter 4

Research Design and Methodology

4.1 Introduction

This chapter will discuss how this study is constructed, planned and executed. In the simplest terms it will discuss how the researcher carries out the study. Section 4.2 presents the justification of using specific research philosophy that forms the base of the study. This will be followed by a discussion on the choice of the research method and strategy highlighting the selection of the universities in Section 4.3 and 4.4. Section 4.5 overviews the selection of respondents for the study while Section 4.6 explains the data collection process. Sections 4.7 and 4.8 present sources of secondary data and data analysis techniques. Section 4.9 and 4.10 will discuss research trustworthiness and the limitation of the study. Section 4.11 will conclude the chapter.

4.2 Justification of the Research Philosophy for this Research

A clear understanding of the research philosophy before designing a research design can help to clarify the choices and uses of methods in any research projects (Guba and Lincoln, 1994; Hussey and Hussey, 1997). According to Easterby-Smith et al (2002) understanding the philosophical issue is essential because it will help the researcher to clarify which research strategy will work and which will not for the research project. It can also help the researcher to create a research strategy based on his/her past experience.

Moreover, Easterby-Smith et al (2002) found that choosing research philosophy may well also help the researcher to identify what kind of evidence he/she needs to gather, how such evidence needs to be interpreted and how this interpretation can provide good answer to the basic questions being investigated in the research. It is important to avoid blind alleys and assist the researcher in adapting different research design when there is a constraint emerges (Easterby-Smith et al., 2002).

The term philosophy also refers to the research paradigm. The term paradigm gained popularity among social scientists particularly through the work of Kuhn (1970) who used it to explain the progress of scientific practice from the 'doing it' practical point of view rather than from the text book and academic journals approach. However the term paradigm is used quite loosely in academic research and to some extent it can mean different things to different people (Hussey and Hussey, 1997). This study will use the term research philosophy to also refer to research paradigm.

There are other views expressed on the types of research philosophy in the literature. For example, Healy and Perry (2000) identified four aspects of research philosophy; positivism, realism, critical theory and constructivism while Easterby-Smith et al. (2002) suggested positivism and social constructionism. Veal and Ticehurst (2005), on the other hand, proposed two types of research philosophies; positivist and critical interpretivism. Hussey and Hussey (1997) suggested positivist and phenomenological. According to Hussey and Hussey (1997), some authors prefer to use the term interpretivist rather than phenomenological because it suggests a broader philosophical perspective. Veal and Ticehurst (2005) also refer to phenomenological as creative interpretive. Habermas (1970) cited in Easterby-Smith, et al. (2002) claimed that social constructionism is referred to as interpretive methods.

Table 4.1: Contrasting Implications of Positivism and Social Constructionism

	Positivism	**Social Constructionism**
The observer	Must be independent	Is part of what is being observed
Human interests	Should be irrelevant	Are the main drivers of science
Explanations	Must demonstrate causality	Aim to increase general understanding of the situation
Research progress through	Hypotheses and deductions	Gathering rich data from which ideas are induced
Concepts	Need to be operationalized so that they can be measured	Should incorporate stakeholder perspectives
Unit of analysis	Should be reduced to simplest terms	May include the complexity of 'whole' situation
Generalization through	Statistical probability	Theoretical abstraction
Sampling requires	Large numbers selected randomly	Small numbers of cases chosen for specific reason

Source: taken from Easterby-Smith, Thorpe and Lowe (2002)

Table 4.2: Features of the Two Paradigms

Positivism	Phenomenological
Tends to produce quantitative data	Tends to produce qualitative data
Use large samples	Uses small samples
Concerned with hypothesis testing	Concerned with generating theories
Data is highly specific and precise	Data is rich and subjective
The location is artificial	The location is natural
Reliability is high	Reliability is low
Validity is low	Validity is high
Generalises from sample to population	Generalises from one setting to another

Sources: taken from Hussey & Hussey (1997)

Healy and Perry (2000) commented on the issues that links ontology, epistemology and methodology. They claimed that these elements can be used to identify suitable philosophy for a particular research problem and it can also be used in determining the quality of the research. According to Healy and Perry (2000) the ontology is the 'reality' that researchers investigate; epistemology is the relationship between that reality and the researcher; and methodology is the technique used by the researcher to investigate that reality. Table 4.3 provides a relevance usage of these criteria and the characteristics of quantitative and qualitative research.

Table 4.3: A Comparison between Quantitative and Qualitative Research

	Quantitative (positivism)	Qualitative (interpretive/phenomenological)
Line of enquiry	What and Who	How and Why
Literature	Explanatory	Exploratory
Ontology	Reality is real and apprehensible	Reality is 'real' but only imperfectly and probabilistically apprehensible
Epistemology	Possible to obtain hard, secure objective knowledge	Understood through 'perceived' knowledge
Methodology	Focuses on description & explanation Deductive process	Focuses on understanding and interpretation Inductive process
Method	Survey or experiment	Case study research or action research
Researcher	Researcher is independent from that being researched	Researcher interacts with that being researched

Sources: Adapted Creswell (1994); Carson et al (2001); Healy & Perry (2000)

The idea of choosing different philosophical stand and methodology is to provide the researcher with a choice of understanding of the real-world practice about the research subject. The type of data collected is important in order to achieve the intended aims

of the research. Given the features of the research philosophy in Tables 4.1 and 4.2 and the distinction between quantitative and qualitative research in Table 4.3, this study will adapt the interpretive philosophy and adopt the qualitative research approach. Based on the current study, exploring and interpretation of government and university initiatives towards commercialisation is warranted to give an insight into the current trend of commercialisation activity in the university. The interpretive stand also to suggest the use of small number of sample in order to conduct an in-depth investigation and can be done within a limited time. In this study the researcher uses three Malaysian universities, suggesting a small example consistent with the use of interpretive research.

4.3 Selecting Research Strategy

From the previous section, research philosophies highlighted on how a research should be conducted. It allows a researcher to discover the reality of the phenomena under investigation. This section will give a justification of chosen methodology and why it was chosen based on the research questions put forward in Chapter One.

One way of determining which research methods or strategies should be used in the current research is by referring to the work of Yin (2003). Yin (2003) provided a useful summary of research strategies with three conditions that explained the characteristics and suitability of the methods for various situations. Table 4.4 shows the research strategies for relevant conditions in a study.

Table 4.4 Relevant Situation for Different Research Strategies

Strategy	Form of Research Question	Requires control over behavioural events?	Focuses on contemporary events
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how many, how much	No	Yes
Archival analysis	Who, what, where, how many, how much	No	Yes/No
History	How, why	No	No
Case study	How, why	No	Yes

Sources: Yin (2003)

The experiment and survey strategy is used to explain certain phenomena or situation that the researcher requires to control over the events. It is normally conducted in unnatural location, needs a huge sample to establish the causality and usually concerned with hypothesis testing. For this study, the main objective is to investigate

the current trend of commercialisation and understand the phenomena as a whole. There is absence of any hypothesis to test, the research involves a sample of small size i.e. three universities in Malaysia, and there is every possibility that the data collected will be rich. Therefore, a qualitative research would be the most appropriate approach, given that the study is exploratory in nature. It requires an in depth understanding of current scenarios in university's' commercialisation activity in Malaysia. Furthermore, the intention of this research is to develop a contextual understanding in which the researcher seeks to understand the values, belief and practices in the research conducted.

Based on the research questions outlined in Chapter 1, this study sought to understand current trends of commercialisation of academic research in Malaysian technical based universities. Based on the conceptual framework, the intersections represent the issues that this study will address. There are two research questions put forward in this study:

1. What is the nature of commercialisation of academic research in Malaysia?
2. What factors motivate academics to venture into commercialisation?

The first research question is to explore the Malaysian government and institutional initiatives employed to promote commercialisation of academic research. This question seeks to identify the analytical description of university-government support, initiatives and links in Malaysia. Two secondary research questions can be put forward:

1. What is the status and current trend of commercialisation in Malaysian higher education institutions?
2. What are the government and university initiatives in promoting commercialisation activity in Malaysian higher education institution?

The second research question seeks to address the motivating, facilitating and impeding factors in establishing and maintaining commercialisation activities in Malaysia. There were two secondary research questions put forward in order to answer the second research question.

1. How do factors within the institutional and the external environment facilitate or impede entrepreneurial activity?
2. Why do academics in Malaysia choose to venture in entrepreneurial activity?

The first research question sought to identify the trend of commercialisation among the academics. The 'what' line of inquiry will describe the phenomenon under study with the problems and challenges that the academics encounter in commercialising their research results. According to Yin (2003: 5), some of the 'what' question are exploratory in nature. This type of question is a justifiable rationale for conducting an exploratory study, with a goal to develop hypothesis and propositions for further inquiry (Yin 2003). The second research question seeks to describe the phenomenon and the cause and effect of collaboration between government and industry in commercialisation activities. The case study research strategy is best suited to research questions of the "how" and "why" type line of inquiry, where the researcher has little or no control over actual behavioural events and the data can be used in exploratory, explanatory or descriptive research studies (Babbie, 1998). Furthermore, the need to understand complex issues calls for a more flexible research design to be adapted. This gives an opportunity for the researcher to gather different types of data compared to the survey method (Robson 2002).

4.3.1 Qualitative-interview based research

The use of interview based research in the present study is to explore the current trend and process of commercialisation of academic research in Malaysia. The main rationale for the use of this strategy is because there is a significant lack of studies in the literature especially in the context of developing countries. Furthermore the use of interview based research is to explore the complex scenario of commercialisation activity in Malaysia. This is because Science and Technology scenario in the country keeps on changing. Therefore, understanding the current trend on commercialisation is important for the study.

The qualitative-interview based research will also give an opportunity to understand and critically evaluate how the process of commercialisation developed in Malaysian

universities. Besides, it will give an in-depth understanding of factors that influence the innovative culture and the beliefs of academia towards academic commercialisation, specifically on the obstacles in establishing spin off companies.

Using a qualitative interview research in this study has a number of advantages. The interview enables the researcher to obtain an in-depth understanding of the overall phenomenon under research. Besides, the qualitative-interview research allows the use of other sources to support and to probe further in understanding by using other resources such as documentation evidence and observation (Stake, 1995). This is important in answering the first two secondary research questions put forward in the earlier section. Multiple sources of evidence need to be gathered to understand the current scenario of commercialisation activity in the three case studies.

An interview is the primary method used in the study that can provide crucial insights of the subject studied. Interviewing also means that additional data can be gained (Hussey & Hussey, 1997; Stake, 1995; Yin, 2003) and it can provide better explanation and richness of data which is not available in mail survey or secondary data (Harrigan, 1983). Thirty interviews were conducted in the study. They are the academic/researcher (which refers to bottom level), university administrator (middle level) and government officer (upper level). By having diverse views from different levels and perspectives, an in-depth understanding of a whole *picture* of the current trend in commercialisation activity can be gained so as to answer the second research question on factors that promote commercialisation and factors that affect the choices of doing commercialisation.

4.4 Rationale behind the Selection of Universities

As of September 2008, there were 20 public universities in Malaysia. These public universities are under the purview of the Ministry of Higher Education (MOHE). Based on the area of focus and the objectives of the universities, public universities in Malaysia can be categorised into a number of groups. These are Apex Universities, Research Universities, Teaching Universities and Vocational Universities.

Apex Universities (Accelerated Programme for Excellence) programme was introduced in the National Higher Education Strategic Plan to promote Universities in Malaysia to achieve world class status. The chosen Universities will receive extra funding from the government and will be given additional assistance to compete with top-ranked global institutions. On 3rd September 2008, Universiti Sains Malaysia was declared as an Apex University by the Ministry of Higher Education in Malaysia. There are also five universities in the category of Research Universities. These Universities allocated a huge percentage of research activities compared to teaching. The Teaching Universities, on the other hand, stress on knowledge distribution whereas the Vocational Universities are similar to the teaching Universities but they employ a practical hands-on approach.

Out of the total number of universities in Malaysia, one-third (seven) of the universities are science and engineering based university. Out of the seven universities, three universities were chosen for this study. These are Universiti Teknologi Malaysia (Research University), Universiti Malaysia Pahang (Vocational University) and Universiti Teknikal Melaka (Vocational University). These universities represent universities that are actively involved in science and technology research which can be the starting point for commercialisation activity. Given the three universities' leading role in engineering and technology development, it is believe that it can provide a representative insight into the current Malaysian situation on commercialising academic research.

4.5 Selection of Respondents

This study involved thirty respondents. Twenty three out of 30 were from academia; six respondents were university administrative staff and one government officer. For each case study, the technology transfer office is contacted to provide a list of academics for the interviews. The selected academics were selected based on the assumption that they have the intention to commercialise their research output. There are also a few respondents selected based on the recommendation of peers. From the list of academics, all the respondents were from science and engineering faculty. It is obvious that science and engineering disciplines have relatively more potential to commercialise their research output than social sciences background.

The selection of university administrators was conducted prior to carrying out the fieldwork. The university administrators were selected based on their position in the University. University Administrators on this study are responsible for patent and commercialisation activities in the university. Out of the six administrators are academics, engineering lecturers, who are currently holding administrative positions.

An officer in charge of the UTM-MTDC incubation centre was selected to represent Government views. The officer was responsible for overseeing the incubation centre and for commercialising academic research output from the universities. The views from an outsider on the commercialisation activity in university are crucial because such views may present a significantly different perspective on the current trend of commercialisation activity. This will also give a greater understanding on the issues that influence commercialisation activity especially issues in spin off formation.

4.6 Data Collection

Semi-structured interviews were used as a principal instrument in the present study. Interview protocol representing lists of questions posed to each group of respondents was developed prior to fieldwork (refer to Appendices1and 2).

Letters requesting interviews were sent to potential university administrators and government officials prior to the start of fieldwork. Interview questions were enclosed along with the requests for interview. This enabled the respondents to have advance information about the issues to be address, allowing them to prepare any necessary documents and answer to the responses. This also gave the organizations the opportunity to find the most suitable respondents for the interview.

During the interviews, the question wordings were not the same as in the interview protocol and certain question were to be modified according to the respondents' responses. Additional follow up questions were often asked. All interviews were conducted in Malay language. The interviews were tape recorded using an Olympus Digital Voice Recorder and transcribed by the researcher. Permission to tape record the conversation during the interview was first sought from the respondents before

each interview. Some interviews were conducted by the phone if there is a difficulty in scheduling the interviews with the respondents. However, it is expected that respondents might not get a chance to answer all question in one session. Therefore, follow up inquiries through telephone and email will be made if such situation happened.

In order to cross-examine the interview evidence, a documentary source was used. The documentary sources were in the form of written report, agendas and letters. The use of documentary sources gave the researcher an advantage to review the document repeatedly, it has a broad coverage (long span of time) and exact (contain exact names, references etc.) (Yin, 2003).

Undeniably the use of observation is as much important as the other sources of evidence. By using this technique one is able to experience an event in 'real' scenario or situation. It is useful in providing additional information about the topic being studied.

4.7 Secondary Data Research

Secondary data research was mainly used in answering first research question. Reports i.e. documentary sources and statistics were drawn from the Malaysian government publications such as the National Survey of R&D, National Innovation Survey and Malaysia Science and Technology Indicators. In addition to the government publications, some of the reports were also available to be downloaded from the online sources of the Ministry of Science, Technology and Innovation (MOSTI) official websites.

A number of databases provided by the Nottingham Trent University such as Science Direct©, Social Science Citation Index©, Emerald Fulltext©, Business Source Premier©, were used to examine the trend and status of innovation activities in universities and public research institutes. Additional documents and reports were collected during the fieldwork, such as the universities and department's publications, and were used as supplementary materials for the study.

4.8 Qualitative Data Analysis

Data collected during the fieldworks were largely in the form of qualitative interview materials. According to Miles and Huberman (1994) *analysis* is defined by three concurrent flows of activity: data reduction, data display and conclusion drawing/verification. These three major stages of qualitative data analysis were used in the present study.

In the data reduction stage, a content analysis were conducted to excavate the underlying understanding and idea of university's researcher and people who are involved with commercialisation about the prospect of doing academic commercialisation. The data collected through the interviews was coded and categorised according to the theme for analysis. This can be identified based on the number of words and/or issue mentioned by the respondents. The words and/or issue will be given a specific colour code for the purpose of analysis. Once the colour coding is completed, the theme identified from the interview scripts will be grouped accordingly. The interview data is used to support archival/document evidence in making an assumptions and clarification of the findings. The theme is then grouped into two sets, to answer the two main research questions.

A table is produced to display the number of theme mentioned by the respondent. The high occurrence or repetition of theme shows the importance factors in doing commercialisation. Once the theme is plotted in the table, the researcher is able to identify which theme shows a significance importance in commercialisation.

4.9 Research Reliability

In contrast to experiment and survey research design, the 'validity' and 'reliability' of the study is more straightforward than in flexible research design. Nevertheless it is very important to ensure that research is conducted with thoroughness and findings and conclusions derived should be trustworthy. In fixed research design the 'validity' and 'reliability' issues are normally dealt at the beginning or prior to data collection whereas in flexible research design these issues are dealt with during and after data collection (Robson 2002).

Several measures were taken in the project to make sure the 'validity' and 'reliability' issue were not ignored. In order to enhance the thoroughness of the study, the use of more than one method and data collection technique was employed. As earlier discussed (see sub-section 4.3.1), case study research is capable of providing various sources of data and information using a multiple methods of data gathering in the study.

During the fieldwork, efforts were taken to tape-record all interviews besides note taking by hand was used as a safeguard against equipment failure. Tape recording reduces threat of not providing a valid description (Maxwell, 1992; cited in Robson, 2002: 171). For telephone interview (if necessary), notes will be taken during the conversation and the interview report will be written immediately when the conversation is still fresh in researcher's memory. Subject to availability, speaker phone will be used and it will be tape-record for analysis.

Promise of anonymity for the respondents in this research encouraged their participation. According to Robson (2002) anonymity will help to encourage the respondents to give a candid view on the issue and therefore would reduce potential respondents' bias in the form of information withholding.

In order to enhance the validity of the research, the researcher conducted the practise of 'member checking' (Robson, 2002) or having the respondent check the interview material (Yin 2003). This practise will help to reduce potential researcher bias towards the data collected. Efforts were taken to summarize the interview notes and sent back to the respondents for review and for additional feedback at the end of each fieldwork.

Records of all activities during the fieldwork were kept including the interview and field notes. This enhances validity and ensures reliability of the research. Case study protocol and interview guidelines were developed prior to fieldwork as a guideline for the researcher and also this helps to ensure the study can be repeated with similar results and thus increase its reliability (Yin, 2003).

4.10 Limitation of the approach

The approach used in the present study has its limitations which in this case is the semi-structured interview. It should be noted that this is the main data collection employed for this research.

Comments from university administrators and senior academic respondents are important for longitudinal information in describing the development of commercialisation activities among the academic. Such comments can also be used to compare the present situation with the past in regards to the university motivation in facilitating commercialisations of academic research results. However, there might be a chance that the information supplied by the respondents is not accurate due to human error. Therefore, in order to overcome this problem, a cross-check of the information obtained with secondary sources such as universities' institutional report and publications was carried out.

Another limitation of this research is the number of respondents. According to Robson (2002) the ideal number of semi-structured interviews is important (around 30 to 60) in order to achieve 'saturation' (when further interviews add little or nothing to what have gathered). It has been argued that limited number of interviews might result an incomplete or shallow set of data and may affect the research 'validity'. However, the number of respondent in this research is 30 respondents. It is not possible for the present study to obtain more than 30 respondents due to financial and time constraints. However data gathered was sufficient enough to provide meaningful outcomes.

4.11 Conclusion

In this chapter, the researcher has described and explained the philosophical stands of the research, choosing qualitative approach and using semi-structured interviews and documentary materials for data collection. The reasons for choosing specific epistemology and ontology stands in this study have been explained. The choice of respondents and the sampling techniques used has been made, expressing their suitability in the present study that enables the researcher to generate logical

explanations of current trend of commercialisation in Malaysian universities. The next chapter will discuss the empirical findings based on the methodology and method discussed in this chapter.

Chapter 5

The Three Malaysian Universities

5.1 Introduction

This chapter presents the three universities to explore factors that promote commercialisation activities in universities. The main purpose of this chapter is to understand the university background and institutional setting in fostering technology transfer and giving an overall dimension of university initiatives towards commercialisation activities. Three Malaysian technical-based universities will be used to form the basis of the discussion. These are Universiti Teknologi Malaysia (UTM), Universiti Malaysia Pahang (UMP) and Universiti Teknikal Melaka (UTeM). This chapter will start with a brief background of Malaysian higher education system in Section 5.2. Section 5.4 and 5.5 will discuss factors that promote academic commercialisation in UTM. The subsequent Sections 5.4 and 5.5 will respectively discuss UMP and UTeM. Section 5.6 summarizes a brief discussion on these three universities and a brief conclusion to this chapter is provided in Section 5.7.

5.2 Malaysian Higher Education System

Education is considered as one of the important ingredients in attaining Malaysia's National Vision of 2020 of becoming a fully developed country. Greater emphasis has been put on strengthening the country's education system. This is reflected through the pursuit of a knowledge-based economy (k-economy), focusing in upgrading the education system in the country.

During the colonial era, there were two main higher education institutions situated in Singapore. These were the King Edward VII College of Medicine (founded in 1905) and Raffles College (founded in 1928). The King Edward VII College of Medicine is the first higher learning institution established in Singapore. In 1949, the merger of these two prestigious colleges led to the founding of Universiti Malaya. Two autonomous divisions were set up, one located in Singapore and other in Kuala

Lumpur. In 1960, following the decision of Singapore and The Federation of Malaya, the status of the two autonomous divisions was changed into national university. On 1st January 1962, Universiti Malaya was established in Kuala Lumpur. This was followed by another four universities in the late 1960s and early 1970s. These five universities were considered as the backbone of Malaysia higher education system.

During the earlier years of its establishment, each university had its own focus area. The idea was to support the government's national development agenda. For example, Universiti Pertanian Malaysia was founded to support agricultural-based industry whereas Universiti Sains Malaysia focused on science related industry. However, in the beginning, Universities in Malaysia primarily concentrated on teaching. Research activity in the country was limited and it was monopolised by the government research institution i.e. FRIM and MARDI.

With the increased number of Universities in Malaysia, the first University and University-College Act, 1971 was implemented to govern the higher education institutions in Malaysia. The University act was designed to govern students' activity and operational aspects of the Universities.

In the mid 1990s, the Malaysian higher education system underwent the first liberalization with the amendments of the University and University-College Act 1996 by giving more autonomy to the universities in terms of programmes offered and establishing private higher education institutions. The Private Higher Education Institutions Act (1996) was introduced as a means of authorizing private companies to set up higher education institutions. These private higher education institutions included Corporate Universities established by government-linked companies such as the PETRONAS (Oil And Gas Company), Telekom (Telecommunication Company) and Tenaga Nasional (Electric Company). The idea is to increase the number of skilled workers especially in supplying engineers and technicians for technological development in Malaysia.

Another significant progress in Malaysian education system was the establishment of University Colleges (UCs). Five UCs have been established since 2000 following a proposal for a new technical education system, presented twice to the Minister of

Higher Education (at the time was the Minister of Education) for its approval. This new education system was called the National Technical University System and was based on the model of other countries such as Germany (Fachhochschule) and France (the IIUT system) where the 'hands-on' approach was adopted. Students are required to undergo intensive practical sessions where they are expected to work directly without having to undergo a long and rigorous training once they graduate. The new education model prepares students with application-related training for professions that require more application and practical orientation. In 2006, the UCs status was upgraded to that of full university status by the government along with the establishment of few other public universities in the country. This is in line with the government's aim of having one public higher education institution in each of the thirteen states in Malaysia. The main motive behind the establishment of new universities is to increase the supply of skilled workers in the market (See Table 5.1) besides promoting regional economic development.

Table 5.1 Technical-based Graduates from Public Higher Education Institutions

Degree	2002	2003	2004	2005	2006	2007
Bachelor	4106	4178	7405	8920	9818	11720
Master	698	452	870	1157	888	1086
PhD	140	144	51	64	72	102

Source: Adapted from MOHE. Compilation by the author.

With the increased number of public and private higher education institutions and Universities, the Malaysian Government has taken another step by setting up a specific ministry to oversee the Malaysian educational system. Previously higher education institutions were under the purview of the Ministry of Education, of which, a specific division was responsible for monitoring higher education institutions. In 2004, the Ministry of Higher Education was established to strengthen Malaysia's higher education system. This ministry is responsible for enhancing research capabilities, innovations and intensifying internationalisation in line with the governments' national vision of becoming a fully developed country by the year 2020.

5.2.1 Science and Technology Based University

The demand for Science and Technology grew significantly right after Malaysia was hit with the first recession in the mid-1980s. Due to the deficit burden and overspending in heavy industries, the Malaysian government was forced to implement privatization on a number of government-owned enterprises. With the privatization programme in full force, the demand for local technicians and engineers as well as industrial technology was on the increase.

It should also be noted that in the early 1980s, the process of industrialisation had gradually started taking place in the country. Even though agricultural industry still remained the main contributor to Malaysians economy, the manufacturing industry started to become the main industry under the implementation of Malaysia's First Industrial Master Plan (IMP1 1985-1995). Under the IMP1, the Malaysian economy and industrial policies exhibited further liberalization. This export-oriented industry had a number of products that managed to penetrate the international market. The share of manufacturing in GDP rose by 7% from 20% in 1985 to 27% in 1990. Because of the demand in the manufacturing sector, the need for high-skilled workers became critical in sustaining current market demand. At that time, Universiti Teknologi Malaysia was the only higher education institution that produced qualified engineers and technicians for the country's need. As such the Universiti Teknologi Malaysia plays a major role in meeting the market labour requirements.

Under the IMP1, one of the key objectives was to develop Malaysia's technological capabilities. The formulation of the first Science and Technology Policy (STP1) in 1986 was an indication that Malaysia was taking its first steps in realising the national interest in Science and Technology matters. This implied another leap in Malaysia's quest for economic transformation from an agricultural based economy to an industrialized economy. The STP1 provided general guidelines in an effort to promote Science and Technology in the country. It also provided guidelines in preparing a strong platform for R&D. This included a centralized system of management of Science and Technology and the acquisition of a strong base for industrial diversification. However the first science and technology policy was mainly drawn to support the country's basic infrastructure. There was no evidence on

the development of local capabilities in technological development at the time. Most of the technology was brought in from other countries and was in the form of machinery and equipment. This type of technology transfer amounted to a situation where emphasis laid in how to use the machinery and equipment rather than how to develop or to manufacture it. This was not ideal. The need to develop local capabilities in technological development was crucial, given that the country's initiative to develop their technological capabilities.

5.2.2 Summary

As of 2008, with a population of 28 million, Malaysia boasted 20 public universities, 15 private universities, more than 500 colleges and over 20 polytechnics. Malaysia has shown a huge interest in developing the country's higher education system. However, in the early 1980s the development of the educational system was rather modest until the country revamped its industrialisation strategy in the middle of 1980s. It can be argued that the shift in the industrialisation strategy from agricultural-based economy to manufacturing-based economy calls for a more demanding role from the higher education institution in Malaysia.

The most significant action began in the mid of 1990s and in early 2000s when the higher education system in Malaysia became more liberalized. The amendments of higher education policy, the establishment of private higher education institutions and the setting up of university colleges are few examples of the Malaysian government's initiatives to assert Malaysia as a knowledge-based economy. The country is preparing to shift from a knowledge based economy to a high technology based economy and this is evidenced by preparations to increase the supply of a qualified and adequate work force especially in the areas of Science and Technology. Therefore, the role of higher education has becoming increasing important in Malaysia's national innovation system.

5.3 Universiti Teknologi Malaysia (UTM)

UTM was the first technical based University set up in Malaysia. The history of UTM can be traced back from 1904 when at the time it was just a technical school

located in Kuala Lumpur, the capital city of Malaysia. The School, Treacher Technical School, (was named after Sir William Treacher, Resident General at the time) was responsible for teaching technical assistant for the Federated Malay States Department of Railways, Survey and Publicwork. In 1941, upon the recommendation of the Advisory Committee of Technical School and the Education, Treacher Technical School was elevated to college status. During the Japanese occupation, the technical college continued to operate and after the liberation, the Technical College was moved to a new place in Gurney Road, Kuala Lumpur. The Technical College was officially opened in 1955 by Sir Donald MacGillivray, the then British High Commissioner to Malaya. The School focused on engineering courses to serve the local government especially for the development of basic infrastructure.

The status of the Technical College was upgraded into the National Institute of Technology (ITK) in 1972 when a committee was formed by the Ministry of Education that recommended the upgrading. In 1975, ITK went through tremendous changes when it was declared as Universiti Teknologi Malaysia. In 1977, the first batch of 65 graduates was conferred with their degrees in the first UTM convocation ceremony in Kuala Lumpur. Because of its expansion, His Majesty, Sultan of Johor graciously granted 2,400 acres of land to build UTM main campus in Skudai, Johor. It was 150 miles to the south of Kuala Lumpur and that Johor is close to the neighbouring country, Singapore. The relocation was also partly due to the expansion of city, the southern gateway to Malaysia. Furthermore there seems to be a pattern in the location of universities. The Universiti Sains Malaysia for example, is located in Penang, in the northern part of Malaysia. Three other universities are located in Kuala Lumpur, the centre of Malaysia. The construction works started as early as 1978 and was completed in 1985 when it was officially opened by His Majesty, Sultan of Johor.

On its establishment, UTM was founded to produce technicians for the country to serve in the Federated Malay State Department of Railways, Survey and Roadwork. Technical courses were offered such as civil, mechanical, electrical and radio engineering at Diploma level. Because of the country's expansion in terms of infrastructure, the numbers of students enrolled increased from 320 in the academic year 1958/1959 to 682 full time students in 1965/1966 academic session. Even

though the number of students doubled, the student enrolment was still considered to be low. Prior to 1969, the Government had not paid any serious action to develop the country's education system. Instead the government focused on the development of basic infrastructure for economic development. However for the academic year 1969/1970, the number of applications was overwhelming; a record of 1,300 potential students applied while the college intake could only absorb about 280 students. The increased enrolment was due to the implementation of two government policies: The 5-year Malaysian Plan and The Outline Perspective Plan 1 (0PP1). These policies were implemented right after the racial riot in 1969 which stemmed from the socio-economic imbalance between the native Malay and other communities in Malaysia. The new policies called for the government to create more jobs in order to bridge the gap (income disparity) between the *Bumiputra* and the *non-Bumiputra* in the country. This led to a demand for specific skills for the growing job market in the country.

5.3.1 UTM – a Campus University

UTM is a gated campus university, surrounded by a scenic view. The University's building pattern was based on the university logo with the mosque being the focal point of the university. This can be clearly seen from an aerial view. Adjacent to the mosque is the administration building, library and the Sultan Iskandar Hall. The Sultan Iskandar Hall is the location of all official ceremonies held within the university. Opposite the administration building is the Sultan's helicopter pad and the Sultan of Johor is the Chancellor of the university. The main buildings are located on the highest ground in the University. This area is considered as the centre of UTM.

There is a mixed concept in the building design of UTM. The old building took the concept of a traditional Malay architectural building. The interior design of a traditional Malay building contains many small rooms a means of creating privacy. It also signifies the superiority of the head of the unit. This room is separated from the main office area by several small corridors. The administrative building, the academic faculties, the library and the Sultan Iskandar Hall are examples of buildings depicting the traditional Malay concept. Most of the new office buildings are more contemporary in design. Even though the new office block uses the open office concept, there are still private rooms reserved for senior management.

With student accommodation situated within the University compound, the students get a chance to experience campus life as most of the accommodation are situated within walking distance of the lecture halls. For students who live at a distance from the lecture hall, shuttle buses are provided, ferrying students from one point to another. At night, the university is lit up with students' activities and night lectures.

Besides office and faculties buildings, UTM has a number of interesting places within the university itself. A deer park, botanical garden and equestrian centre are among the few attractive places located in UTM. A natural stream runs through the University with a man-made lake which welcomes all who enter the university gate. The *Lingkaran Ilmu* (knowledge circle) is the busiest road circling the university, providing access to the centre of UTM. Since UTM considers religion as an important aspect of the university life (reflected by the university logo), the entire university falls quiet when the *azan* (call for prayer) from the mosque sounded. Meetings are briefly halted and lectures paused to show respect for the prayer time. An Islamic religious school is also located within the university compound. Other religions also accorded similar honour. Each religious festival is celebrated amongst the students and staff all year around.

A majority of the faculty buildings are located around the university centre. Buildings are interconnected by corridors adorned with student facilities to have small group discussions. Students can also walk between the faculties under the shade of trees scattered around the faculties. A number of wooden sheds and canopies are situated along the paths. The corridors are equipped with free access to *wifi* making the corridors lively with student discussions. Lecture rooms are provided with state-of-the-art equipments and are fully air-conditioned. The University also provides mass lecture halls. These lecture halls are situated near the students' residential halls and are usually used as academic examination centres.

At the moment, UTM has more than 16, 000 undergraduate students. Out of this, more than 70% are science and engineering students. The huge proportion shows UTM's serious commitment to become the major producer of engineers and technicians in the country. This also means that the traditional role of UTM is changing. UTM is now focusing on strengthening the university's research

capabilities. As such, the university's plan is to reduce the number of undergraduate students and increase the number of postgraduate students. Reducing the number of undergraduate students means that the academic staff will require less lecture time and get more time in doing research. The shift from teaching to research intensive were mainly because of the research university (RU) status introduced by the government in the early 2000s. The RU status means that the weightage in terms of responsibilities will be more on research activities than teaching activities. Moreover, it is also about recognition and prestige of the university achieving. This phenomenal change is also partly due to the new university top management that strongly believe in developing a research culture among the university staff. Besides, the university also implemented several initiatives to foster and create a research culture in the University such as the University research grants, promotion, reward and incentives that are strongly linked with research-related activities.

The expectation of academic staff is also changing. Traditionally, staff at UTM has a 'teaching' mindset. This means that, the majority of them believed that their main task was to teach and nothing more. This was true in the early years of its establishment when UTM was deemed as a learning centre, not as a research centre. Most of the Universities in Malaysia were considered as 'teaching universities'- universities that focused on knowledge generation or teaching. It was only in the late 1980s that the importance of research and development was recognized by the Government and the University. The introduction of the Intensification of Research in Priority Areas (IRPA) funding in 1987 was an indicator that the government was taking proactive action in encouraging research and development activity especially amongst the public HEIs and Government Research Institutions (GRIs).

The recruitment policy in UTM is strictly based on academic qualifications. The majority of the academic staff possesses at least an undergraduate degree with limited industrial experience. This limited industrial experience has resulted in the academic staff depending heavily on formal knowledge. The curriculum is mainly based on theory rather than practical. Because of the academic background and reliance on the type of formal knowledge, the majority of the academics have developed a 'teaching' mind set. However, the change in university management team in 2007 saw the importance of research activities brought to the forefront.

In 2007, under the new university top management, a strong emphasis was put on research and innovation in the university. The directive, under the new Vice-Chancellor, was presented in the UTM Strategic Plan of 2008. The strategic plan identified five major areas that needed UTM to develop or enhance and one of them was research and innovation. By way of creating research and innovation culture in UTM, the top management implemented a new reward system in the University. Publication and IP numbers are the two main items that received the highest recognition in the university. For example, publishing in a prestige academic journal carries greater weightage when promotion is considered besides getting a financial reward from the university. This has created an intense culture of 'publish or perish' in UTM to the point that people will look down on one as an academic staff member if one do not have any research project or did not publish any academic paper.

From the beginning of its establishment, UTM has emphasized on the engineering disciplines. However, in 1990s the University diversified its teaching and research activities to include non-engineering subjects such as management, education and language disciplines. At present UTM consists of 13 faculties (Table 5.2) out of which 9 are based in the science and engineering faculties. Table 5.2 clearly demonstrates that UTM is predominately an engineering university.

Table 5.2: Faculties and Schools

S&T	Non-S&T
Faculty of Science	Faculty of Built Environment
Faculty of Electrical Engineering	Faculty of Management & Human Resource
Faculty of Civil Engineering	Faculty of Education
Faculty of Chemical & Natural Resources	Faculty of Islamic Civilization
Faculty of Mechanical Engineering	International Business School
Faculty of Geoinformation Science & Engineering	Science, Technology & Innovation Policy
Faculty of Bioscience & Bioengineering	Language Academy
Faculty of Biomedical & Health Sciences	
Faculty of Computer Science	
Business & Advanced Technology	
Informatics & Virtual Security	
Petroleum Engineering & Renewal Energy	

Sources: UTM official website. http://www.utm.my

The engineering courses offered in UTM continue to diverse since its establishment. Previously there were only seven engineering faculties. In 2007, UTM approved the setting up of two additional engineering faculties that are related to medical research

and biotechnology. For this purpose the Ministry of Higher Education allocated more than RM68 million (GBP 13.6 million) for both the faculties. These faculties provide biomedical engineers and biotechnologists who support the increasing demand in these two areas in the country. UTM, on the other hand, intends to provide university expertise in medical research.

Putting research as their main priority, UTM has 22 centres of excellence (COE) (See Table 5.3 in which the majority of the centres are engineering based research centres. Previously there were more than 30 research centres in UTM. However, after the organization restructuring took place, the number of research centres was reduced to 22. The shrinking number was not due to the university not recognizing the research centres rather it was because the university had difficulties in monitoring the centres. Furthermore, the University identified a numbers of COEs that have serious problems. In some cases, for example, the centres lacked adequate funding and other necessary resources. Some centres lacked of supports from the academic faculties, had no clear objectives and targets and exhibited territorial attitudes and duplication. As a result, the University reduced the number of COEs by merging them. With the restructuring exercise undertaken in UTM, the COEs are now more manageable and organized.

Table 5.3: Research Centres in UTM

Institute for Environmental & Water Resource Management (IPASA)	Wireless Communication Centre (WCC)
Chemical Engineering Pilot Plant (CEPP)	Marine Technology Centre (MTC)
Ibnu Sina Institute for Fundamental Research (IIS)	Centre for Advanced Software Eng (CASE)
Automotive Development Centre (ADC)	Gas Technology Centre (GASTECH)
Institute of High Voltage & High Current (IVAT)	Composite Centre (CC)
Centre for Artificial Intelligence & Robotics (CAIRO)	Institute for Geospatial Science and Technology (INSTEG)
Institute of Coastal & Offshore Engineering (COEI)	Institute of Noise and Vibration (IKG)
Centre for Real Estate Studies (CRES)	Centre for Rural Development Study (PKPLP)
Institute of Advanced Information Tech (AITI)	Centre for Malay Achitecture Study (KALAM)
Steel Technology Centre (STC)	Centre for Tech Policy & International Study (CENTEPIS)
Photonics Technology Centre (PTC)	Centre for Lipids Eng. Applied Research (CLEAR)

Sources: UTM official website. http://www.utm.my

Interestingly, research centre in UTM is more than a research centre. Some of them provide training and postgraduate courses. They can also be product developers,

provide consultation and have their own spin off company (See Box 5.1). They are also active in research collaboration with international universities.

Box 5.1: Chemical Engineering Pilot Plant (CEPP)

Chemical Engineering Pilot Plant (CEPP) is a research centre under the Faculty of Chemical and Natural Resources Engineering. Granted in the middle of 1990s, this research centre has built up its good reputation amongst the local industry as well as receiving international recognition. It is supported by the National Scientific Research and Development Council. With more than 30 staffs, CEPP is considered as one of the pioneers in biotechnology research in the country. CEPP is actively involved in research that focuses on the Nutraceuticals, Herbal and Phytochemicals, food ingredients, Biopesticides and Biofertilizer.

CEPP has its own building equipped with basic facilities such as cafeteria, meeting room, discussion room and research staff room. Example of herbal trees used in the research is planted around the building. The centre also has its own beauty centre where they provide services such as massaging and aromatherapy using natural and herbal product.

Declaring them as research and business development centre (R&BD), CEPP provides a range of assistance to local SMEs. This assistance comes in the form of training and short courses; given an opportunity for the SME to develop their business. The centre also provides technical assistance such as product testing, product development and reference advice.

With a state-of-the-art research lab, the centre also has a designing and manufacturing workshop and packaging facilities to cater for local industry businesses. CEPP also believes that it is its responsibility to create opportunity and to provide assistance to the local SMEs. For them creating the needs and opportunity are really important and stands as the fundamental principle of the centre.

Another interesting feature of CEPP is their active involvement in organising exhibitions. For them it is a way to show their expertise to the public. It also helps them to attract potential customers. CEPP believes that attracting new customers means creating a new need. And this is how the centre is able to create new business collaborations and brings in new research projects to the centre. And also this will create an opportunity for the customers to expand their business with new technology provided by CEPP. Most of their customers are amongst the SMEs. They claim that the SMEs are their main business target. For them without SMEs, the centre could not survive.

A spin off company was set up in 2004 to provide the means to sell their research products. The company's name – Phyto Biznet Ptd Ltd (PB) was taken from the scientific name of plant. As had been noted earlier, CEPP is focusing on herbal plant research. Their main focus is in the development of products or services for the wellness of the soil and ecosystem, human, animal and plant. PB is a subsidiary company of Uni-Technologies Sdn Bhd which is the ultimate holding company of UTM. Even though PB is the commercial vehicle for CEPP, the idea of setting up spin off company was not profit oriented instead it is used as a proxy in facilitating business transactions with industry. This is because CEPP does not want PB to be seen as a competitor among their customers. In fact the company does not have any showroom except few products displayed in the display cabinet.

According to respondent 7, research conducted in CEPP is totally different from other research conducted in the university. This is because normal research is required to produce new findings (system, algorithm, product etc.) and it is not well-defined, meaning they do not have specific clients or end-users. Whereas research conducted in CEPP is targeted to produce products that satisfy customer requirements or specifications. Therefore according to him their research is much more focused and specific and well defined. He said, "*like I said we have to secure with the company first, we won't do research just for pleasure. We only do when there is a demand.*" Because he said in commercial research the focus is totally different than academic research.

In academic research researcher have their specific research objectives whereas in commercial research the objectives is to produce a product. This does not end here.

He added, "*This product doesn't stop there. Each product has its own legislation. For example in cosmetics, in Malaysia we have legislation on the product. So we have to complete the entire legal requirement. If food... they have their own legislation. So basically your research is to overcome that legislation...satisfy the restriction. Not like just now, hypothesis...postulates and all that. So it is totally different*."

He said further "*So commercialisation actually shouldn't be an issue in research because your client, your research shouldn't be done without any so called end user. So like in here, we only do when there is a demand.*" He admitted that commercialisation is really important for CEPP to stay operational and stressed that their model of commercialisation is different from other commercialisation in the university. He conceded "*So what I can say is that the commercialisation activity is considered priority to us. Except that our model of commercialisation is the other way around. We find the customer then only we develop and produce*".

He added, "*We are not going to produce first then only we find them. First ...wasting time and second what we are doing maybe is not to what they expected or want. They must have their requirement or specifications. So from the beginning we have already identified what is their need. So almost all the projects we did like that*".

Another interesting characteristic of the centre is that even though they have a spinoff company and a number of customers, they are not profit oriented. For them money or profit was not a primary objective. Their main objective was to solve human problems and second was to create opportunities.

Because they believe that with the knowledge and expertise that the centre has, it is an obligation for them to serve the public.

This explains that the faith reason, which is the *Barakah* and reward from God, is more important than monetary reward. This is in line with the institutional motto in the University logo: From God To Human Being.

When doing business, CEPP prefers and always has, to deal directly with customers. Even though they are aware that the university has a unit that is responsible for assisting business formation and that the normal protocol was to liase with BIC for business joint ventures, they decided to go on their own. According to respondent 7, he believes that by having a few layers (RMC, BIC and UTSB) this will slow down the process of ventures. Instead, they choose to deal directly with the customer and cut down the time frame.

The case study above shows an interesting unit within the university. The centre is actively involved in research and commercialisation activities. Two(Three?) points worth highlighting first is the types of research conducted, second; the type of commercialisation activities carried out in the centre and third the operational aspect of commercialisation.

In terms of research activity, CEPP will only conduct research when they have already identified their potential customers or the end users. This means that the unit will not conduct research for other purposes such as publication and promotion but for problem solving. Unlike normal research activity conducted in the university, most research conducted without identifying first who is the end user or the customers. Most of the research conducted in the university is meant for publication and for promotion purposes.

CEPP also has a different approach to commercialisation. They identify their customer first and then carry out the research activity. This means that they have secured a customer beforehand. By securing a customer first, the bulk of funding comes from the industry, not from the university.

The centre also shows that minimum intervention by the university in its operational activity gives them a better chance to commercialise. The centre believes that directly dealing with their customer can reduce the bureaucratic issues and hence shorten the time frame in doing business.

This can be presented by the number of students, locally and internationally. Unfortunately, the percentage of engineering students is not available. However more than two third of the students are engineering and science students (See Table 5.4).

Table 5.4: Students and Academic Staff

Local Academic Staff	1,996
International Academic Staff	68
Local undergraduate students	16,036
International undergraduate students	700
Local postgraduate students	6,350
International postgraduate students	1,784

Sources: UTM official website. http://www.utm.my

Several initiatives have been put in place for managing the university's R&D activities. This includes research facilities such as research labs, workshops, a technovation park and a research pilot plant. There is also a unit/centre that is responsible for research management and IP exploitation activity in the University. These are: Research Management Centre, Bureau of Innovation and Consultancy and Uni-technologies Ptd Ltd.

5.3.2 University's Logo

The University's logo (Figure 5.1) demonstrates that the University is placing emphasize on the Science and Technology discipline. The shape of the flask in the UTM's logo symbolizes that science forms the backbone of University's curriculum. This is reflected by the number of science and engineering faculties in the University. Besides faculties, the university also has a number of research centres, research labs, pilot plant and other infrastructures that support R&D activities in the University. This indicates that the university is focusing on becoming the main player in technological development in the country. The university philosophy clearly states that the divine law of Allah is the foundation of Science and Technology, in which, UTM strives with total and unified effort to attain excellence in S&T for universal peace and prosperity in accordance to His will. This is in line with the university motto: In the name of God for mankind.

Figure 5.1: UTM Logo

The Universiti Teknologi Malaysia – Logo and Motto

The open book-like in the university's logo symbolises that the Quran (as the source of knowledge) supplies the knowledge to the whole universe (the golden circle). The golden crescent is the symbol of Islam and the round-bottom flask is a symbol of science which forms the basis of technology. The golden circle symbolises the magnificent universe entrusted upon mankind. The maroon colour symbolises the essential traits of the Malay race maturity and the gold colour symbolises high standards as well as the noble values. The university motto: 'In the name of God for mankind'. UTM tagline: Inspiring Creative and Innovative Minds.

5.3.3 Summary

The history of UTM can be traced back to 1904 when it began as a technical school. After more than 50 years, the technical school was eventually recognized as the first technical university, focuses on science and engineering. Being one of the pioneer universities in Malaysia, UTM has undergone a number of changes from a teaching based University to a research-intensive University in the area of Science and Engineering.

The intensification of research activity in the University increased significantly when UTM embraced a research university status. In addition to this, the role of top management in University in encouraging research activity through the implementation of reward and incentives is important in developing the research culture in the University. However, the commercialisation activity was rather modest even though the University has provided basic infrastructure for commercialisation to take place. This is due to the University's' focus on developing research rather capabilities than commercialisation.

With a multi-disciplinary background (social sciences, science and engineering) and the fact that it is already established for more than 30 years, UTM has developed its own culture. The 'teaching' culture and the complacent mind set are still dominated amongst the academic staffs. However, there is strong evidence that University action and initiative is able to change the existing culture of the academic staff (this will be discussed in depth in Chapter 7).

5.4 Universiti Malaysia Pahang (UMP)

Universiti Malaysia Pahang (UMP) formerly known as University College of Engineering and Technology Malaysia is located at Gambang in the State of Pahang. The University, is about 160km from the capital city of Kuala Lumpur and is connected by the East Coast Expressway. The capital city of Pahang, Kuantan, is the 9th largest city in Malaysia and it is about 30 minutes' drive to the town of Gambang.

Historically, UMP was founded when UTM opened up their branch in Kuantan in 1999. The UTM Pahang-branch (UTMP) offered computer science and engineering courses. At that time, UTMP was the only public higher education institution that offered engineering and computer science courses in the state. Somewhere along the line, the Minister for Education (the current Prime Minister of Malaysia) voiced the intention of establishing a University in Pahang. The idea was to develop the local capabilities in Science and Technology as well as encourage regional economic development. Opinions have been expressed that the establishment of higher education institution in Pahang may have had a political agenda[14] behind it.

On establishment, UTMP offered limited technical and engineering courses. The focus was more on offering computer based engineering courses. As with a student enrolment of just under 1000 students, the curriculum adopted a more hands-on approach. Two years into operation of UTMP, the government decided to institute another public university in the state of Pahang. Since UTMP had already operated in Pahang, the government upgraded the status of the UTMP to that of a College University, converting it into the University College of Engineering and Technology

[14] The Honourable Dato' Sri Mohd Najib Bin Tun Abdul Razak is the 6th Malaysian Prime Minister is the eldest son of the second Malaysia Prime Minister. He started his political career when he was elected to take up his late father parliamentary seat in Pekan, Pahang. He was then been appointed as the Deputy Minister of Energy, Telecommunications and Posts and at the time he was just 23 years old.

Malaysia or KUKTEM. Under the directive of Ministry of Education, KUKTEM took over the temporary campus of UTMP and started their first academic terms with an intake of 307 students in May 2002.

Due to rapid growth in student numbers, KUKTEM was transferred to a more conducive location located near the industrial area of Gambang. This temporary campus was formerly an industrial complex owned by Malaysian Electric Company (MEC). Since KUKTEM is an engineering university, the new place benefited from the building facilities and locality i.e. workshops and office buildings. The permanent campus is still under construction in the city of Pekan.

There is a negative perception in the minds of the public that the quality of education at KUKTEM is not of university standard. This is because the institution is referred to as "*University College*" instead of university. The public believed that the KUKTEM graduates are not as competent as graduates from other public Universities in Malaysia. Therefore at the end of 2006, the government decided to rename the institution as the Universiti Malaysia Pahang. Even though the government changed the name, the university system and practices remained the same.

5.4.1 UMP University's life

As one of the campus universities in the east coast of the Malaysian peninsular, UMP's role is not limited to education. It is responsible for promoting regional economic development as well as forming a strong link with the industry. Situated near the city centre, industrial park and airport, UMP is capable of meeting its responsibilities.

The University's main building is located near the university entrance. The pathway leading to the main entrance is a continuation of the east coast Expressway. In other words, in terms of accessibility the university is just a doorstep away from Kuala Lumpur. The majority of University administration offices and university main hall are located in the main building. Basic infrastructures such as library, sport and recreation facilities, medical centre and mosque are provided. Student accommodations are scattered across the campus and some of them are close to the lecture hall. In term of security, students get a chance to have classes at night as well

as student activity in secured environment. Other security measures include gated student accommodation, curfew time for student entry especially at night and security posts at all entrances to the university.

Furthermore, the campus is located near one of the most important industrial zones in the state of Pahang. The Gambang industrial area houses a number of important industries such as chemical, petro-chemical, manufacturing, automotive and biotechnology industries. This gives UMP the benefit of forming collaborations in R&D with the industry. Besides, students get an opportunity for placement within the industry. Early student-industry collaboration has had a positive impact on students, building up their competency, reputation and confidence. One interesting observation is that UMP students as well as the staff are required to wear the 'UMP corporate shirt' during office hours. The idea of wearing a corporate shirt is to give a sense of unity amongst the students and lecturers. Besides it represents common attire worn for engineers in the industry. As one of the UMP staff claim, "*they have to get used to it as they are the future engineers in the country*".

Currently UMP has seven faculties and two centres of excellence (See Table 5.5). From the table, it is clear that UMP is an engineering based university. This is attributed to its historical background and foundation. UMP is a spin off from UTM. Therefore the courses and systems are pretty much similar to those of UTM. However UMP has a different approach when it comes to the curriculum. The University emphasis is more on a hands-on approach as the university is modelled after the 'University of Applied Sciences' in Europe.

Table 5.5: Faculties and Centres

Faculty	Centre
Mechanical Engineering	Centre of Modern Language and Modern Science
Chemical and Natural Resources Engineering	Centre for Technology Management
Civil and Environmental Engineering	
Electrical and Electronics Engineering	
Industrial Sciences and Technology	
Computer Science and Software Engineering	
Technology Management & Manufacturing Engineering	

Sources: Official website UMP www.ump.edu.my

The number of engineering students has increased over the years. Since its inception (during UTMP branch) to 1999 enrolment student was just over 300. In less than 10

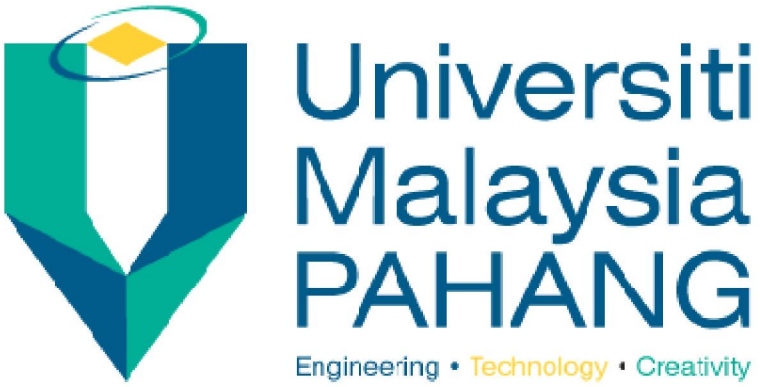
years, the number of students has increased to more than 6000 students. With the growing number of students, UMP will be moving to new campus in Pekan in 2011. The construction work of the new campus has already begun. It is expected that the new place will be more conducive for academic excellence.

The university stresses the importance of marketing by encouraging participation in science exhibitions. One benefit of participating in the exhibition is that it gives an opportunity for the university to promote their expertise to the public. The University also encourages academic staff to actively get involved in publication and consultation activities. The importance of publication and consultation in the university is recognized by an award ceremony held every year to honour those who come up with such contributions.

5.4.2 University's Logo

The university logo illustrates that the university emphasises on a hands-on approach as a method of teaching. The shield and the white pen in Fig 5.2 symbolise that these items are hand-held items which require proper knowledge for its use. The yellow colour represents the Royal colour. The blue and cyan colours are integrated signifying a unity in the University. This is demonstrated with the requirement to wear a corporate shirt amongst the staffs and the students. The pen or '*kalam*' shape symbolises the importance of knowledge. Moreover, the first verse in the Holy Quran (reveals to Prophet Muhammad PBH) is the verse of Clinging Form. The verse discusses the importance of reading and knowledge is taught by pen or '*kalam*'.

Figure 5.2 UMP Logo



The five-sided shield represents a higher education institution that possess a philosophy, vision, mission and five core values. The orbit shape circumventing a diamond represents a progressive knowledge while a combination of both the orbit and the diamond represents the graduates of the university who have a global vision. The diamond shape denotes the solidness of the administration and governance of the university based on rules and regulations. The color yellow represents the sovereignty of the university. The elephant ivory shape denotes the strength of knowledge and technical skills that will contribute to the universal prosperity. The blue and cyan colors reflect the integration of knowledge as the vessel for unity and greatness of civilization. The pen shape at the middle of the logo represents the knowledge generated by the staff and students of the university. The white color denotes the true knowledge from the God.

5.4.3 Summary

Even though UMP is considered new amongst Malaysian public universities, the university is certainly making a remarkable achievement in knowledge creation. Using vocational-type education systems as the backbone of the University Curriculum, UMP produces well-trained engineers and technician for the market. Industrial collaboration through placement of students and consultation projects with the industry is an active area especially in the field of automotive technology.

The location of the university also represents the determination of the University to become a world leading Technical University. Located in Gambang Industrial Area in Pahang on a rented factory site shows the full commitment of the university to create a conducive environment for the students to become future engineers cannot be denied.

As one of the newest universities, the majority of the staff is still young and inexperienced in the world of academic. Few have obtained PhD qualifications and a

limited number of researches have been conducted in the university. The academic curriculum, infrastructure and human capital are yet to be fully developed notwithstanding the initiative and foundation in fostering research and commercialisation activity is constantly being upgraded and monitored.

5.5 Universiti Teknikal Melaka (UTeM)

Being the second college-university established based on the model of 'vocational university' in Europe; KUKTEM plays an important role in academic excellence in the state of Melaka. Established on 1st of December 2000, KUKTEM is seen as one of the state government's initiatives to promote education industry in Melaka. In February 2007 the college university was upgraded to university status and renamed Universiti Teknikal Melaka (UTeM). This is mainly due to the government initiative of establishing one public university in each state of Malaysia. UTeM rebranding was necessitated by the wrong perception about the quality of education held by the public and industry.

Reflected by its name, UTeM is a technical-based university focusing on applied technical courses. The curriculum was on the 'vocational university' model similar to that in European countries. Students are required to have more *practice-oriented* (practical) education and working in real environment. As such collaboration with industry is crucial and becoming an important part of its curriculum. At the moment UTeM is located in Ayer Keroh industrial area.

It should be noted that besides the tourism industry, Melaka is one of the main players in the manufacturing industry in Malaysia. There are at least 23 industrial areas, mostly consisting of light and medium industries in Melaka, with over 500 factories operating in the state. Considering the infrastructural set up and economic activities in Melaka, UTeM is seen as an important component in bridging between the academic world and the industry.

Previously UTeM had three campuses namely; the industrial campus, the main campus and the city campus. However in 2009, the industrial campus was suspended its operation (it was a temporary campus) and was moved to the main campus which

is situated in the sub-district of Durian Tunggal, 20 minutes drive from Ayer Keroh City Centre. The industrial campus was rented until the construction of the main campus is completed. It was not until 2009 when the second phase of the main campus was completed and the university instructed the industrial campus to move to the new place. The main campus in Durian Tunggal is more conducive and completed with basic facilities. Currently there are five faculties in the main campus besides university administration offices, these are the

1. Faculty of Electrical Engineering
2. Faculty of Electronics and Computer Engineering
3. Faculty of Mechanical Engineering
4. Faculty of Manufacturing Engineering
5. Faculty of Information and Communication Technology

The city campus is located in Melaka city centre. Previously these departments were operated at the industrial campus in Ayer Keroh. There are four departments currently operating in this campus; Institute of Technology Management and Entrepreneurship, University Publisher, Centre for Teaching and Learning and Centre of Quality Assurance and Accreditation. There are few motives behind the move of the city campus to the town centre. It is believe that the city campus is another way of the university to educate the public by offering management courses. This was achieved by locating the institution near the public. Furthermore, it is another marketing mechanism for the university to attract local people to get involved in university-industry collaborations. However, on account of its distance, there might be issues in regards to coordination and/or monitoring.

In terms of manpower, the university has more than 700 academic staffs. More than two-third of the academic staff are qualified engineers. The majority of them are young and hold postgraduate degree. Currently the university has more than 6 800 undergraduate students and less than 1000 postgraduate students.

5.5.1 A day in UTeM

Situated on the 725 acres on the edge of the city, the main campus provides a better and more ideal location for learning. The campus, which was completed in 2009, is equipped with a sport complex, mosque, library and grand hall.

As it was declared, 'the signature building' of UTeM; it consists of the Chancellery, Registrar, Bursary and Alumni Affairs Offices; these buildings are located in the centre of the campus. This symbolises the authority of the University in decision making on university related matters. The building concept adopted the traditional *Malay* courtyard house with few modern designs. Opposite the building is a beautiful man-made lake with plenty of greenery. The University centre is surrounded by four faculties.

All residential students have access to basic facilities located near the faculties. Each residential area provides a laundry service, a small convenience store and a common hall. The University also provide bus shuttle services from the residential area to other buildings in the University. The services begin at 6 am till 11 pm on weekdays.

With an Asian style on the exterior and Middle East style in the interior, the university mosque can accommodate 4000 people at one time. It is situated near the university centre completed with an administrative room, reading room and prayer hall. The university also has a sport complex complete with an athletic track, a football field and an Astro turf hockey arena. The sports complex can accommodate up to a maximum of 500 people. UTeM also has a grand hall, where the university ceremony is currently held, computer centre, student health centre and a library.

The city campus is located in the centre of Melaka city. It is just 10 minutes away from the famous world's historical fort, A'Famosa, hotel, bank and Banda Hillir attraction centre. The city campus houses the Faculty of Technology Management and Technopreneurship, the University Publisher, the Centre for Teaching and Learning and the Centre for Continuous Learning. Besides that the city campus also has its own library and convention centre. Since it is in the city centre, there are no specific accommodation facilities provided. Even though the city campus is

completed with basic infrastructures, the distance between the two campuses may incur present problems such as additional costs to the university, possible administration problems and a burden to monitor.

In terms of research and innovation activity, UTeM has established a unit that is responsible for monitoring R&D activity. The Centre for Research and Innovation Management (CRIM) is a unit under the purview of the Deputy Vice Chancellor (Research and Innovation) to monitor and to encourage R&D activity in the university. Under the unit, there are four divisions

1. Operation, Promotion and Exhibition
2. Grant Management
3. Commercialisation and Innovation
4. Financial Management

The CRIM was founded as a University-Industry Centre (UNIC) in 2002 with the sole purpose of forging the transfer of technology and enhancing smart partnership between the University and Industries. It was later in 2009 that the unit were renamed CRIM to further enhancing R&D activity in the University. The University also offers research funding (Short Term Research) for academic researchers to conduct research projects.

5.5.2 UTeM university logo

As in most Universities in Malaysia, the University logo has meaning that forms the basis of the university policy and practices. The Q-shape in the university logo symbolises the importance of quality in education. The square with a stack of 9 lines represent the book where the knowledge originates from. The combination of two triangle stack together represents the importance of collaboration between industries and the general public. The white point in the middle of the circle represents the sources of knowledge from the Almighty God to the whole universe. Each colour in the university logo carries specific meaning. The blue colour represents the environment (blue sky and ocean), the white colour represents sincerity, perfection and the colour platinum signifies the new millennium technology of the highest

quality. These colour codes symbolize the university thrust area; green technology (blue), human technology (blue), system engineering (platinum) and emerging technology (platinum).

Figure 5.3: UTeM Logo

5.5.3 Summary

UTeM is a recent university that focuses on vocational type of education. The University focus is on manufacturing engineering, which explains the location of the University in an industrial area of the State of Melaka. The Ayer Keroh Industrial Area concentrates on manufacturing industries.

The University stresses the importance of hands-on approaches by having strong industrial links. Even though research is still at its infancy, the strong links between the industry and the university suggests that the future of commercialisation and commercial activities is bright.

5.6 Discussion

The three universities presented in this chapter show that these are technical based universities. The main reason for choosing these universities is due to the idea that commercialisation widely occur more in science and engineering disciplines than in

humanities/arts disciplines. As such, Science and Engineering research output is more likely to produce intellectual property which can easily be patented.

Even though the three universities are similar in terms of background i.e. science and engineering, UTM is much more established than UMP and UTeM. Therefore, it should be expected that UTM are better off in terms of research and academic commercialisation than the other two universities. Indeed UTM achieved some remarkable milestone when the university was ranked as the fifth research-intensive university in the country. However, the number of academic commercialisation activities is still small given the fact that the university is focusing on developing its research capabilities. Historically UTM focused on teaching and carried out little research activity. The intensity of research activity in UTM just came to force in 2007 when the new university management team was appointed.

UTeM and UMP, on the other hand, has a limited history in research activity. Both universities are vocational universities emphasising on the hands-on approaches in their academic curriculum. They both have strong industrial links given that both universities are located in industrial areas. In terms of research and commercialisation, there might not be much research conducted but commercialisation and commercial activities are anticipated. It can also be argued that both universities have different types of commercialisation compared to UTM. In UTM, research is conducted to produce intellectual property whereby in UTeM and UMP, the type of commercialisation is more resemble knowledge transfer.

There is also a difference in terms of the specialisations of each case university. For example, UMP specialises in automotive technology whereby UTeM specialises in green technology and Human-Technology Interaction. UTM, on the other hand, has no specific field of specialisation. This is because UTM is one of the pioneer universities in the science and engineering disciplines and it is quite impossible to identify UTM specialisation in science and engineering as UTM has diverse engineering courses. However, there seems to be some evidences that the university is moving into specialising in bioengineering and biotechnology. This is an extension from the three prominent faculties in UTM; the Faculty of Science, Faculty of Chemical Engineering and Faculty of Mechanical Engineering. The two new

faculties are the Faculty of Biosciences and Bioengineering and the Faculty of Biomedical Engineering and Health Sciences. UTM is also known for biotechnology research under the research centre CEPP.

It can be argued that the type of industry situated near the University has an influence on the specialisation of the university. For example, UMP is specialising in automotive technology because there are two automotive assembly plants located in Pahang. UTeM is focusing on Human-Technology Interaction because the university itself is located in the Melaka's main industrial area concentrating in manufacturing consumer goods. For UTM, specialising in medical and bioengineering technology is partly due to the absence of a university hospital in the Southern part of the country. UTM is trying to fill in the gap by providing an expertise in bioengineering and medical sciences to the government hospital located in the State of Johor. Furthermore, through state development, a few international universities are planning to establish a medical school in the State of Johor. This can be seen as an opportunity for UTM to expand their research capabilities in this particular area.

5.7 Conclusion

The three universities presented above show the different characteristics of each university in terms of culture, the types of university and this chapter shows that the three universities are technical based universities that focus on Science and Technology. The main reason for choosing these universities is that technical-based universities are more likely to produce IPs compared to universities that focus on Social Sciences. A majority of the faculties are Science and Engineering faculties each completed with its own infrastructures such as research labs and workshops to facilitate research activities in the University.

In terms of research and commercialisation, each university has their own styles of promoting their activities. Some of the universities encourage their staff through the implementation of rewards and incentives; whereby others use promotional schemes and specific type of support such as financial and infrastructure.

The three case universities also show that Universities recognise the importance of commercialisation activities. Each university has its own technology transfer office that is responsible for assisting academics to commercialise their research output. However, the type of assistance offered by TTO varies among the three case universities. This chapter also identified differences between the three case studies in terms of University age, university specialisations and focus and university culture. The university specialisation and culture is strongly influenced by external factors such as the locality of the university and historical background of the University.

The next chapter will present the findings and analysis based on individual perspectives of the respondents.

Chapter 6

Individual Perspectives

6.1 Introduction

This chapter discusses the findings on the academic perspectives concerning commercialisation activities. The objective of the study is to understand the experience and involvement of academics (a bottom-up approach) in commercialisation and identify issues that are associated with the commercialisation activity. This chapter seeks to answer the second research question put forward in this study;

1. What are the motivating, facilitating and impeding factors in establishing and maintaining commercialisation activities in Malaysia?

It is important to understand commercialisation activities from an academic perspective because it is the academics are actually responsible for carrying them out. Furthermore, policies and initiatives implemented by the Government and the University are actually aiming at them. Questions such as; what makes academics desire to exploit their research output? What hinders academics from commercializing? What drives academics to commit themselves to entrepreneurial activity? What are their perceptions about commercialisation? This chapter hopes to provide answers to such questions.

Since this chapter analysis is based on individuality i.e. academic perspective, the findings of this chapter will not be presented according to each case study rather all such views from the respondents have been grouped together and reported here. It should therefore be noted that the focus is on the perception and characteristics of the academics that are doing research and commercialisation. The main reason of grouping these findings is that it is assumed the academic respondents from the three case studies are similar in terms of designation (lecturer), employers (public universities), academic responsibilities and salary (salary of civil servants).

Furthermore, anonymity would be lost if the respondents views are presented on each case study.

One important finding in this chapter is about the motivation to commercialise. Various factors have been identified from the case studies i.e. financial, personal satisfaction, religion, peer effects, family background, university initiatives, experiences and government support that motivate academics to commit themselves to commercialisation activities. This chapter also intends to seek the types of personality that contribute to commercialisation.

This chapter will be organized as follows: section 6.2 discusses motivational factors that have been identified in the case study followed by a discussion on the identified factors in section 6.3. Section 6.4 discusses the personality types of the academics and section 6.5 will conclude this chapter.

6.2 Motivational Factors

There were several reasons why academics in the University decided to venture in entrepreneurial activity such as carrying out commercialising research. This section has identified eight reasons that motivate respondent to explore their research areas (See Table 6. 1). Based on the analysis, the summary of findings is presented in Table 6.2. This table shows that 23 academic respondents and six administrators (five of them are academics who holds administrative position) participate in this study (Sample biographical details can be found in Appendix 3). The academics come from different disciplines and have different years of working experience. From Table 6.2, financial reward is the main motivator for academics to do commercialisation. This is followed by personal satisfaction and universities initiatives. The least motivation factors are religion and family background. Each factor, identified in the case study will be discussed thoroughly in the next section.

Table 6.1: Motivational Factors

Financial reward	Respondent is looking forward to getting a return in terms of salary, royalty or corporate shares.
Personal satisfaction	The sense of satisfaction knowing someone can benefit with what the respondent has produce is their greatest achievement.
Religion	The sense of obligation and responsibility towards God and the humankind.
Peer effect	Surrounding environment that influence respondent to follow suit.
Family background	Involved directly or indirectly with family business.
University initiatives	The university provides substantial initiatives and facilities to the respondent.
Experiences	Previous working experience gives an insight of what is expected from the market.
Government support	Initiatives and policy that facilitate commercialisation activity amongst the respondent.

Table 6.2: Respondent Motivational Factors

Factors	Respondent																												Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Financial	●	●	●	●	●	●		●		●	●	Administrator		●	Administrator		Administrator	●	Administrator	●			●		●	●		Administrator	Administrator	15
Personal Satisfaction						●	●	●	●					●		●				●	●	●					●			10
Religion							●		●					●						●										4
Peer Effect	●			●				●		●	●			●						●						●				8
Family Background					●			●	●					●																4
University Initiatives	●	●												●		●				●	●	●	●		●		●			10
Experience		●	●			●								●		●		●		●			●				●			9
Government Support			●			●		●	●					●		●				●				●						8
Total	3	3	3	2	2	4	2	5	4	2	2		0	8		4		2		7	2	2	3	1	2	2	3			

6.2.1 Financial Rewards

More than 60% of the respondents believe that financial return is an important factor in persuading them to participate in commercialisation. They believe that whatever knowledge or technology they have, they should find a way to turn it into money.

One of the respondents claimed that he participates in commercialisation activities because he believes there must be a return in terms of money. He said:

> "*It is about exploiting your knowledge. You have knowledge but if you don't know how to get money out of it ...it is not a commercialisation. Of course salary is there. If you have knowledge and give it for free... that is not commercialisation. There must be a return in terms of money.*", (Respondent 3).

Another respondent stated that after she read a book on how to become a millionaire, it gave her inspiration that whatever she put her hand to should turn into money. She said:

> "*I want to make money out of this. Maybe I have already gone to all this work and I want to challenge myself venturing into this activity*". (Respondent 11).

Respondent 19 asserted that commercialisation is about money. Once you manage to penetrate the market the money will definitely come in. He said: "*Because normally commercialisation involves money. All researchers need money. [laugh] If you ask all researchers in the university, they want their product to be commercialized*".

Financial reward would therefore seem to be the main motivator for researchers in the three case studies as indicated in Table 6.2. A majority of the respondents were at the opinion that academics should receive monetary reward from their research output. However most of the respondents claimed that they would choose to sell their patent (licensing) rather than forming spin off companies as licensing is associated with less risk.

6.2.2 Personal Satisfaction

Another motivation to commercialise is driven by the desire of academics to have their invention being used by the public. They believe that if the public can benefit in any way from their research that in itself, it will be a great achievement. Personal satisfaction appears to be a stronger factor than financial reward. According to Respondent 7, his main priority was to solve human problems before receiving the monetary reward. Moreover he believes that whatever services an individual renders will always be rewarded at the end of the day. In the same vein, respondents 21and 22 claimed that the main reason they commercialise was to help certain groups of people to have a better and more meaningful life. They said,

> "*Personally I can say it's about feeling satisfied to know your product is in the market and someone is using it and benefitted from it*", (Respondent 21).

> "*Yes, it does change someone's life. Because this product is for disable people and when you see them make such improvement, that's more than anything. Money becomes a second priority. In terms of satisfaction, In fact for the motivation why we are so into this is because we want that person to get a better chance or improve their quality of life*", (Respondent 22).

The interview evidence above clearly shows that some of the academic respondents believe that money is not the main reasons for involvement in commercialisation. They strongly believe that just knowing someone is using and benefiting from their inventions makes them feel satisfied. However academic respondents who choose personal satisfaction as their main motivational factor were involved in similar research related with consumer products and/or medical products. This shows that the kind of research conducted and the type of product produced may have a significant impact on the inventor. It is less likely to have personal satisfaction as the main motivation if it is dealing with industrial products.

6.2.3 Religion and Spiritual

Another reason that motivates the respondent to commercialise their research output is the sense of *Barakah*. Academic respondents believe that it is their responsibility and obligation to help the public with what God has given to them (i.e. knowledge, job, money). One way to pay back is to serve the community with whatever knowledge or expertise they have. They strongly believe that reward and blessing from God is more important than anything else (See Box 6.1).

Respondent 7 asserted that research conducted by his team is based on acquiring wisdom or *Hukum* which seek to solve human problem. In other words using God's given knowledge they are meant to use them and to help in solving human problems. They also emphasize on creating an opportunity so that the company can provide services or sell the product to the public as a whole. In other word the public can benefit the knowledge generated from the University. He said:

> "*We just focus on the Hukum or Hikmah or wisdom that solve problem of human being. So our research focuses on the solving problems of human being. Second our research is focused on creating opportunity for individuals. So from the start our research is already focused, we are not just doing research for the sake of research. Research must be one to solve a problem and second to create opportunity. So what is our definition of money...simple...money is a reward for service rendered. Once you provide a service...God permitting...you will have your reward. That is why ...what we did here is...we develop a product or project mainly to satisfy our client*".

Box 6.1 Vignette 1

Respondent 14…

Respondent 14 stated that one of his main motivations, besides his parents and family, is by knowing God is there for him. He believes that whatever job he did, it should be done sincerely or *Ikhlas*. It is then he believes that God will reward him with goodness.

"*I believe God is with me. Whatever I did at the end of the day I will pray to God to make it happen. I always pray whatever effort we put in, God will grant it and bless it. We have to pray to God on everything that we do. That is why I told everybody God will reward us based on what we actually did. It is God that gives me the strength to continue with what I am doing now. Thanks to God, even though my product looks simple but it has been recognised locally and internationally*".

The strong feeling towards religion shown by respondent 14 is because as a Muslim, one of his/her obligation is to work hard and has full submission to God. The sincerity of doing something is important and that humankind should benefit from the outcome.

In terms of responsibility respondent 9 claimed that

> "*What is PhD? I believe it is just an award given by God which comes with great responsibilities. In the Spiderman movie, his Uncle mentions great power comes with great responsibilities. Lets change to knowledge, power comes with great responsibilities. And what is your responsibility now? You have to pay back to the community*".

In the same vein, respondent 20 commented:

> "*Second is about responsibility as an academic. We have to do research and produce something that can be used by other people. Of course when we conduct a research it also means we want to get promoted. Sooner or later we need that promotion. So when we do a research technically we will receive funding. This funding is actually a responsibility for you to use it wisely and at the end of the day; it should contribute something to general public*".

The sense of responsibility and the obligation of doing something good for the community became the driving factors to do commercialisation. Respondents believe that whatever knowledge they possess and the product they produced belongs to

everybody; not to themselves solely. This is based on belief of the importance of brotherhood.

6.2.4 Peer effects

Peer pressure has a significant influence on the motivation of academics to do commercialisation. Working with someone who has already commercialised and succeeded can influence someone to follow that person. To another extent it can also be someone in the same organization that has proved to be successful. This person is usually an icon or an idol in that organization.

In UTM there is lack of formal communication among the academic staff. Issues arising from commercialisation such as experiences of academic staff are not discussed formally amongst the academics. There appears to be a secretive culture amongst the academics in terms of patent and commercialisation activities. Most of the information is conveyed through informal communication amongst the academic. Such issues do not seem to exist in UMP and UTeM as levels of research and commercialisation are still low.

Referring to another colleague, Respondent 1 wanted the University to inform the rest of the staffs who are involved in commercialisation so that new comers like herself can ask the particular person his/her experience in doing commercialisation. She said:

> "*We don't know who is doing any commercialisation. They should let everybody know that someone is doing a commercialisation so that it is easier for us to follow suit. Take the person as our mentor. Then this person can give talks to share their experiences*".

In the same vein Respondent 4 stated that he wanted to follow one of the inventor's models of commercialisation. The inventor has managed to receive a number of grants from the government and is currently setting up a pilot plant. He believes that the university should share their success stories with the other university staff and that this can be the model of commercialisation if there is anyone intended to do so. He said: "*I am hoping the project of X spin off company is a model for other research and*

inventor to follow her". He added: "*from my perspective ...I would say...If that model successful ...I want to follow to use it as a model*".

Working as a research officer and PhD student under the supervision of Professor Z, Respondent 14 considered him as his idol and mentor. He concedes that he has learnt everything from his supervisor, and never gave up trying to innovate until he is successful. He even followed his lifestyle especially when it comes to family matters (See Box 6.2).

Box 6.2 Vignette 2

Respondent 14…
The relationship between Respondent 14 and his supervisor (Prof Z) is very close; just like father and son relationship. Respondent 14 commented: "*You have to work almost 24/7 whole weekends. Sometimes people ask how I manage with my family. Well for me it is your own formula, I seek permission from my wife and we work out thing perfectly. My kid knows that I have something to do, I am not saying that I neglect my kid; no… this is another thing that I learn from Prof Z*".

The close bond between Respondent 14 and his supervisor shows a positive working attitude. This includes the initiatives to follow one's lifestyle. In the case of Respondent 14, it is important for him because he is still new and needs a lot of guidance.

He also mentioned that one of the motivational factors that encouraged him to do commercialisation is his friends. He said:

> "*My second motivational factor is my friends. Like I told you before some of them really support me and some of them want to see me going down. But I don't care about those things. People only see me when I am successful but they didn't see me crying. I cried when the top management did not help me, did not support me, when the company wanted to sue me and my friends leave the research group. Except for one person who help me a lot in terms of [giving] advice and guidance*." (Respondent 14)

Peer effects appear to be an important motivational factor for respondents to engage in commercialisation activities. Sharing an experience and learning from someone who has already successfully commercialized their product are important especially for those who lack business knowledge and experience.

6.2.5 Family Background

The case study also revealed that respondents with a background in family business is more likely to commercialise compared to those who do not. Even though the number of respondents in the study is relatively small, the effect on the initiative to commercialize is quite significant. Their business sense and entrepreneurship have been influenced by their exposure to family business. Furthermore, academics who have a family business tend to secure a range of assistance such as financing, marketing and management for their commercialisation activity.

One particular example is the case of Respondent 5 who is currently active in commercializing his invention with a local company producing medical implants. He is also collaborating with another university spin off company in dental implants. His idea of getting involved in commercialisation is triggered by the family current involvement in business. He might actually have been involved in the family business prior to joining the academic world. This has given him valuable experience and the necessary skills for doing business.

Respondent 9 also comes from a family that operates a business. Though not directly involved with the company, his family members run the business. He remains behind the scene and does not actively participate in the family business due to government policy that does not permit government officer from participating in any kind of business. His colleague, Respondent 1, mentions that Respondent 9 is fortunate because he has a large family which can run the business.

Therefore a family background of family business entrepreneurship can also serve as a source of motivation to do commercialisation. In the case of Respondent 14 (See Box 6.3), family support is a critical motivational element that has assisted him to get into commercialisation. He strongly believes that support from his entire family has had an impact and influence his achievements in commercialisation.

Box 6.3 Vignette 3

Respondent 14…

"My main motivators are my parents and my wife. My mother is a teacher and my father is an agriculture officer. He is the person who taught me to become a researcher right from the start. When I was young, we used to own hundreds of chicken and fish. And then I have two spiral things on my head which according to Islam those who have those thing, they are prone to become farmers. I don't know whether it is true but I think it is true now [laugh]. My dad raised me on a farm with a lot of domestic animals like chicken, ducks, and goats. And then my dad taught me how to grow vegetable. Everything… cucumber, tomato, green vegetable you name it.

My dad is a serious man. He shows me everything and I have to do it as quickly as possible. Sometimes it is a pressure but later I realized that is part of my training ground to be where I am right now. At the time, I can see my friend is not being pressured to look after their farms but for me it was a pressure. But later on I realised there was good in it.

After completing school, my dad did not allow me to work in factory. Most of my friends worked in a factory. My dad told me to start doing business. Because he said 9 out 10 sustenance comes from business. So at that time I'm making a net profit RM30 everyday by selling tofu. That was in 1998. I manage to save almost RM1000. My dad doesn't let me work in a factory and ask me to do business. Frankly speaking, it is a shame to sell at a night stall. Even some of my friends tease me. Really a shame (Selling tofu is not a pleasant things to do at this particular age). The first two weeks… it is horrible but later on, I get used to it. I do not feel a shame anymore.

I always work until late at night and I take the opportunity since I am a weekend husband for two years because at that time my wife is still working in UTM. So I always stay back until midnight to complete my research".

Parents are very important in Malay culture. They need to be respected and usually they are very attached to their children. This is in line with the Islamic teaching that the family institution is a sacred matters and it is an obligation for the children to respect them. In the case of Respondent 14, family has a significant impact on his attitude towards research and commercialisation. Based on his experience, his father is his source of motivation and to some extent has been his mentor. His father taught him how to do research and to get involved in entrepreneurial activity at an early age. This is the experience that he used as the foundation in doing commercialisation in UMP.

This section shows how family background influences respondents into becoming involved in entrepreneurial activity. The evidence shows that having a business background helps respondents to develop a business mind and necessary skills in doing business. It also exposes the respondent to different types of assistance such as management, marketing, financial matters as well as networking. Furthermore, it can also be a source of motivation by making the family proud of the achievements.

6.2.6 Previous Working Experiences

Previous working experience may also encourage academics to develop ideas, which can guide them to conduct research that has commercial value. It gives an insight into how businesses really work. Besides, it gives an opportunity for academics to

establish industrial networks. Strong links with the industry are important to academics in order to identify new market demand and/or business opportunities. There is also the tendency that the previous employer may require needs assistance in solving industrial problems. This is another reason for academics to establish linkages with the industry through research collaboration or consultation.

From the total number of academic respondents, nine of them claimed that the reason for them being involved in commercialisation is their previous working experience. A majority of the academic staff used to work in private companies, mainly in the manufacturing and service industry. Respondent 6, for example, was previously engaged as one of the management team in the Malaysian National Oil Company – PETRONAS. With a vast knowledge in business related works, he joined the University and was given a post of a director in university TTO. Currently he is selling his product to PETRONAS.

Respondent 14 has working experience as a researcher in R&D department in a food company. He also had the opportunity to get actively involved in research together with his supervisor. He believes that the experience of working with his supervisor gave him valuable good experience in doing research as well as the ability to establish industrial networks. A good reputation and network with industry has helped him a lot in his research and commercialisation project. For example, he managed to convince the industry to provide him with research materials at no cost and later on became his business partner (See Box 6.4).

Box 6.4 Vignette 4

Respondent 14…

Respondent 14 believes that one of his secret success ingredients comes from previous experience when he used to work with private company prior to joining the government sector. He said "*I have a diploma in food technology and started working as a research officer in Vitagen Company in R&D department. I work there for 5 years where I developed 150 formula for Vitagen. My intention is to gain experience as much as possible and another thing is getting an experience working with the Chinese. As an executive we have to finish our work before we can go home. So we have to finish the task given on that day …by all means. That is the attitude that I bring into my current position. I can see my colleagues go home at 5 o'clock. But like myself I will try to complete my daily task on the same day. Some say working with the government is not like working with the industry (private companies). For me it is still the same*".

The previous experience working in food industry has taught him to be a hard working person. Even though he is involved in food research or producing any food products, previous working experience has taught him how to conduct a good research with a potential for commercialisation.

Respondent 20 used to work with a small company that deals with military research for few years. He worked in the R&D department and occasionally became interested in research activity. He then decided to continue his master degree and joined UTeM as a lecturer. Still young (late 20s) and energetic, Respondent 20 is very actively involved in research and research exhibitions. He has won a number of research competitions and currently has a few potential products waiting to be commercialised. He said:

> "*My first motivational factor in doing commercialisation is… it got to do with my previous experience working with the company. In the company we had to produce something that could be sold. So whenever I conduct a research I have already set in mind who is going to use or buy my product. So what I normally do is to find the end user first then only do I start doing my research, not the other way round*", (Respondent 20).

6.2.7 University Initiatives

From the interviews there are a general perception that University initiatives play an important role in encouraging commercialisation activities to take place. The University initiatives come in many ways such policies, infrastructure and facilities. The University policy can create conducive environment to facilitate research and

commercialisation activity. The state-of-the-art facilities and equipment help researchers to conduct high impact research and produce high quality research output. The University also provide several units and departments in managing research and commercialisation activity in the university i.e. TTO.

According to Respondent 21, he believes that university policy plays an important role in encouraging and facilitating research and the commercialisation activity in the university. The University policy, which is normally in the form of funding, helped Respondent 21 to develop and fine tuning his research output until it reaches the stage where it has potential to be commercialized. He said,

> "*At faculty level, they are very supportive. Each staff is required to have a research grant. You have to be the principal researcher. At the University level, they allocate every year RM 2million as research grants. I still remember when I came back from my sabbatical leave; we have to apply for the grants. The culture is that everyone should obtain a grant. And then joint with other department, multidiscipline*", (Respondent 21).

Expressing same views, Respondent 16 said

> "*Research opportunity is huge. The university will give even a small scale research project funding assistance. The university offers a short term grant RM40K per person*", (Respondent 16).

Respondent 22 also pointed out the existing culture in the faculty that is favourable towards research and commercialisation. She said,

> "*I think the environment in this faculty is quite positive. Mostly the lecturers are quite young and very energetic. We join the service at early age and some of them wanted to establish their career in academics. We tend to do everything even though we might bum into certain things. We tend to take this as a positive thing. If you think everybody has a lot of work to do, we also have a lot of work to do. So*

everybody is doing it. I think the working culture in our faculty is the main reason for us to do what we are doing now. And I think our boss is quite successful in moulding the young lecturers to get involved in research activity. The advantage is that we all are still young so we are open for challenges and new things and ambitious. So the top management takes advantage and after few years we can see the result. One of the results is this project. That is how the culture becomes our culture now", (Respondent 22).

The role of TTO has a significant impact on commercialisation activities as the unit acts as a middleman between the University and the industry. Respondent 1 claimed that the idea of doing commercialisation started because of the proactive TTO in the University. She said:

"*When I came to know BIC, at that time the officer in charge was very active. So I felt excited to commercialise my product, get to know staff from FPPSM, discuss the method and gain experience from them*", (Respondent 1).

However, there is also evidence that the faculty did not support commercialisation activity. Respondent 14 claimed that previously he did not receive favourable support from the faculty due to a misunderstanding that arose between the respondent and the management team. He was implicitly told to stop his research activity. However, he decided to carry on with his research activity secretly because he has made a commitment with the industry. Later on, when the new faculty management took over, he received better support (See Box 6.5). As he commented:

"*Like myself with the previous management team. If the current management team where still the previous one, I don't think I could have commercialised my product. But now the hindrance is not there anymore and that is why I can go further*", (Respondent 14).

Box 6.5 Vignette 5

Respondent 14…

He believes that the university support totally depends on the faculty and university management team. For him he has experienced both situations (supportive and non-supportive) during his R&D project. This has made him become stronger and wiser when it comes to overcoming challenges in completing his work.
Supportive:
Then came a new dean. Previously last time he was the deputy dean and he knew about my problem, he told me: you should continue your R&D and I will give my100% support. He never decline by request for funding.
Non-supportive:
They said I was late. And this is because of the office politics. Last time the top management and, the dean asked me to stop R&D. So I had to slow down my research activity. That is an obstacle for researchers. We don't accept that want the product cannot be commercialized because of certain factors. Like myself with the former Dean. If the current Dean were still the previous one, I don't think I could have commercialised my product. But now the hindrance is not there anymore and that is why I can go further.

Respondents 1 and 10 shared the same views in terms of faculty assistance. They claimed that they received neither support nor recognition from the faculty. However, Respondent 10 said that even though they did not receive any recognition from the faculty, the faculty did not stop them from doing commercialisation.

Similarly, Respondent 20 commented that the support from the faculty depends on who is part of the top management. If the top management were to focus on teaching and learning activity then the faculty members should allocate more time in preparing teaching material. On the other hand, if the faculty focus was on research activity, those who are active in research activities would receive more favourable treatment. According to him, the direction of faculty rests in the hands of the management team.

At the University level, Respondent 7 commented on the academic attitudes in satisfying University requirements. With more than 20 years experience in academia world, he commented:

> "*We are actually flexible. Our work is focused on what is the requirement. Let's say our previous Vice Chancellor R, he emphasis more on corporate style, the lecturers adjust, Vice Chancellor Z leans more on fundamental science, lecturers adjust to it and now we are on to*

publication, lecturers always try to align with the management", (Respondent 7).

The interview evidence in the above clearly shows that the leadership/management of the university and faculty is a key factor in encouraging the commercialisation activity in the University. Ten academic respondents raised an issue on the importance of University initiatives and support towards commercialisation activities. Management at faculty level play vital roles in encouraging research and commercialisation because they are much 'closer' to the faculty members. Similarly, top management in the University are responsible for setting the direction that the University should go. It can be argued that appropriate University policy, incentives and practices can influence academic attitude towards research and commercialisation activity.

6.2.8 Government support

The views expressed on government support are mostly focused on funding and grants. There are three main providers; the Ministry of Science, Technology and Innovation (MOSTI), the Ministry of Higher Education (MOHE) and Malaysian Technological Development Corporation (MTDC). Besides providing research grants the Government also acts as a middleman between the University and the industry and offers advisory services to the academic researcher.

According to Respondent 15 the Government is really serious in helping the Universities to commercialize their research output. He said:

"*The government is more than encouraging. They monitor us every now and then. In fact we have to submit a report...to show them that we are doing it. They seriously monitor us.... No joke. Sometimes they organized a seminar, help us to link with European Union-Malaysia Chamber of Commerce and Industry...thing like that*", (Respondent 15).

Sharing the same view, Respondent 4 commented on the role of MOSTI in terms of commercialisation activity in the University. He said that MOSTI introduced a special grant for pre-commercialisation project (Techno-fund) and it is monitored closely by the ministry.

Respondent 21 also commented on the role of government as the middlemen besides grant provider. He said:

> "*Just now we present to MOSTI not because of research grant but to identify potential product so that MOSTI can find us industrial partners. They are going to organize an event and they are going to categorize the product to find a match for industrial partners. Then we are going to present to the industry and let them decide if they wanted to commercialize our product. They said if the university calls the industry, the impact is not big but if the government organize an event and call the industry, they will view it differently. They are more interested if the government is involved in this event*", (Respondent 21).

For Respondent 21 and 22, with the government directly involved in commercialisation activity, the chances of establishing a joint venture with private companies are much greater and the effort to commercialize their research output is more realistic. In the same vein, Respondent 19 believes that the current initiatives by the government and the effort by the Malaysian higher education system in enhancing commercialisation activity are on the right track. The Government is pushing hard in that direction. He believes it is just a matter of time before public university and commercialisation activity become a successful story.

One particular interesting initiative is the establishment of MTDC- a semi-quasi government agency that is responsible for managing special purpose grants for commercialisation activity – the Commercialisation of Research and Development Fund (CRDF). This grant is purposely setup to assist academic researchers for IP exploitation.

Based on his experience, Respondent 8 commented that MTDC is really helpful in terms of assisting academics venture into entrepreneurial activities. He said:

> "*So far with the MTDC is interesting and easy because they really want to help researchers to commercialize, a good channel for us to commercialize our research product. The government has set up a good platform to help the local researcher get involved in entrepreneurial activities. MTDC provide funding for the researcher and the timeframe for money to be disbursed or paid is fast. Provided you have to submit a good and complete proposal, they will study the proposal and conduct a market survey for us. That is why my product has secured 10 potential customers and another 120 companies have already enquired about my product*", (Respondent 8).

In terms of monitoring and advice, Respondent 14 commented:

> "*So far it is already a year, I don't find any problem of them not helping us. They always help us. Even the company also said they have no issues with MTDC. The problem that we have is from ourselves. The company CEO always receives advice from them even sometimes their officer will visit office and discuss if they have any problem with the business*", (Respondent 14).

Conversely, Respondent 6 had different views on MTDC. He claimed there is a lot of bureaucracy when it comes to implementation. According to him, the MTDC is a good idea but the system and the officer in charge are the main problem. In terms of systems, he said, the CRDF is operating based on 'matching grant'. Both parties (entrepreneur and MTDC) are required to contribute same amount of capital into the business venture. This creates a burden to Respondent 6 as the amount of capital needed for his business operation is relatively large. He also commented on the officers in charge of the CRDF. He believes the officers in charge are not supportive enough because most of them are office workers who lack the passion necessary to help academic entrepreneurs to get involved in business. This opposing view on the government support as in the case of Respondent 6 is mainly because of the type of

business he is conducting. Compared to Respondent 14, Respondent 6 businesses require a larger amount of capital to operate considering that Respondent 14 mainly uses waste product to produce his product. Therefore the 'matching grant' seems to be a problem to Respondent 6 but not to Respondent 14.

The view from the respondents implies that government support has an impact on the motivation to commercialize research output. From the three case studies, a total of seven respondents' claims that government support does influence their decision in doing commercialisation and the majority of them believe that the government is serious in helping academic to commercialize their research output.

6.3 Discussion on Motivational Factors

This section has identified eight motivating factors in regard to commercialisation activities from the three case studies. A total of 23 academic respondents were involved in analysing academic perspectives on commercialisation activities. Six academic respondents (13,23,24,25,26,28) were selected using snowballing techniques. The remainder were selected based on the list of names provided by the University TTOs. A summary of motivational factors is presented in Table 6.2 (Section 6.2) based on the frequency of each factor mentioned during the interview. Table 6.2 shows some interesting findings.

As revealed through the interviews, the main motivational factor for respondents getting involved in commercialisation is because of financial return i.e. sales profit, royalties and/or salary. These finding contradicts previous research conducted by Shane (2003), Blair and Hitchens (1998) and Smilor et al. (1990) that assert monetary reward is a secondary objective for researchers to get involved in commercialisation. One possible reason is that the majority of those involved in commercializing their research output are senior lecturers, which means the average age of the respondent are academics in their late 30s and onwards. It can be argued that financial obligations may be mere pronounced especially in preparing for retirement.

Personal satisfaction and University initiatives fall into second place as a motivator factors that encourages academics to commercialise their research output. For personal satisfaction, there seems to be a link between these factors and the type of

product produced. These products are more likely to be a consumable product and/or medical product. Only one respondent claimed that he is satisfied because his product is used by the industry.

From the interview evidence, the respondent refers the word 'University initiatives' to the Dean or the Head of Department and the policy implemented in the University. Seven respondents (14, 16, 20, 21, 22, 25 and 27) believe that support from the Dean is important. This is because the Dean represents the university management team in the faculty. Only few of them recognise the University policy as their motivational factor. For instance, in UTeM, it is compulsory for every academic to have research grant and are requires to become a research leader. In UMP, grants are much easier to get because the university provides encouragement to conduct research. However, in UTM, it is quite difficult to secure grants due to the competition amongst the academic staff.

The influence and support from family in terms of doing business are also important motivational factors. Only four respondents fall into this category. Most of them claimed that the support comes in the forms of ideas, management and financial assistance. One possible explanation is that the majority of the respondents are Malays, and historically Malays prefer to work in the government sector rather than doing business. Therefore the number of Malays families involved in business is limited.

The interview evidence also shows that besides the above factors, opportunity is another factor that motivates academics to commercialise. For instance, in the case of Respondents 14 and 20, initially their research activity was conducted to satisfy university requirement. But later on they realized that their research output have commercial value when they were given an opportunity to meet with the government agency and the industry. Respondent 14 stated that in the beginning he just concentrated on research to complete his key performance index. Making money and commercialising never crossed his mind. When he participated in screening exercises conducted by MTDC he realised his product had a potential for commercialisation. Respondent 20, on the other hand, participated in research competition and won an award. These research projects were conducted without any fund. He said, "*there is*

one product where I did my research with the students. We decided to enter into exhibition and managed to get an award. Then the top management asked where I got the funds? I told them I didn't get any, I do it on my own. Then they ask me to apply for university fund [for commercialisation]".

In these two unique cases, opportunity seems to be important factor that triggers academic to do commercialisation. The phrase "the right time at the right place" seems to be the best to explain the situation. If they were not given a chance to meet with someone, they might have end up winning the competition rather than commercialised their research output.

The case study also revealed that the reason behind the low level of commercialisation activity amongst academic is partly due to the 'comfort' found in the position held by lecturers. The main responsibility of a lecturer is teaching and research. Commercialisation is a secondary task and it does not receive as much recognition as publication. Furthermore doing business is usually associated with burden and risk. Research activity did not have any risk attached to it as most of the research funds are government grants. This strongly implies that there is a complacent culture amongst academics when it comes to commercialisation activity. The next section discusses the different types of personality of those who intend to venture into entrepreneurial activity.

6.4 Conclusion

This chapter presented findings based on the perception of academic staff members towards commercialisation activities in the University. Exploring academic perception towards commercialisation is important in the sense that it will provide an understanding concerning factors that facilitate and impede commercialisation activities. Besides, this chapter also presented the types of personalities that are associated with entrepreneurial behaviour amongst the academic respondents.

Understanding the reasons behind the transition from a purely academic role into a more entrepreneurial behaviour is important in engaging academic in entrepreneurial ventures. Furthermore, research on academic motivations leading to the decision to

start business is limited. Much of the research focuses on the institutional factors such as the role of TTO, incubator facilities and policy implementation. Research on motivations and factors that triggers entrepreneurial activity as well as impede factors on the process of business start up are still lacking.

From the case studies, the most influential factors that motivate academics to do commercialisation are financial reward. This is an interesting finding as most literature suggested that financial reward is not the primary reason for academics to do commercialisation. This is also to suggest that the university initiative in terms of financial rewards plays an important motivation factor amongst the academics.

The case study also identified the role of faculty and university in encouraging academics to conduct research and commercialisation. From the interview evidence, the role of faculty in all of the case studies plays an important factor in motivating academic to do research and commercialisation. The key person in case of commercialisation is the Dean of the faculty. The Dean has the authority and has strong influence on the faculty members. It is, therefore, important to receive substantial support from the faculty in doing research and commercialisation in the University.

In terms of personality types, the case studies identified three academic respondents (8, 14 and 20) had the highest score in terms of factors that motivate them to do commercialisation (See Table 6.2 in Section 6.2). The three academic respondents exhibited more than five factors that motivate them to do commercialisation. Interestingly, two of them (Respondent 8 and 14) have already commercialised their research output whereas Respondent 20 is in the process of commercialising his research output. During the interview session, all of them demonstrated similar characteristics, which are friendly, positive, energetic and vocal.

To conclude, financial reward, personal satisfaction and the role played by the University institution are important factors in motivating research and commercialisation activities in the Universities. The lack of academic research output been commercialised, in general, may be attributed to attitude of the academic staff,

initiatives and objectives of the University. The next chapter will discuss findings from the institutional perspectives.

Chapter 7

University Perspectives

7.1 Introduction

The perception from the bottom level (academic perspective) with respect to commercialisation activities in the university has been established in the previous chapter. Chapter 6 explained factors that motivate academics to venture into entrepreneurial activities. This chapter will discuss views from the middle level i.e. the university in particular, looking at the system and structures that the university puts in place and devise to encourage and facilitate commercialisation activities in the university. It is intended to answer the first research question on the nature of commercialisation of academic research activity in Malaysia.

The three universities employed in this study are technical-based universities where science and engineering subjects dominate the universities' academic curricula. The science and engineering disciplines are more likely to produce intellectual properties compared to humanities. There is also a significant difference between the three case universities in terms of university specialisation/focus area, years of establishment and the types of university i.e. research university and vocational university. This chapter presents the internal issues of each university and how the academics perceive institutional issues.

This chapter will be constructed as follows: The following section will discuss the university culture, looking at the types of environments perceived by the academics that occur in each university. The next section discusses the academic perception on university culture. Section 7.3 will present the universities' internal structures and give an insight into how these units assist academics in research and commercialisation activities. Section 7.4 presents the universities recognition system followed by how programmes for human capital development are run in the universities. Section 7.6 offers a discussion on the findings and the last section will conclude the chapter.

7.2 The University Culture

This section presents a discussion and findings on university culture perceived by academic respondents in the three cases universities. The culture is identified based on the university objectives, university directives and systems that mould the academic activities in the university. Summary of the findings will be presented at the end of this section.

Universiti Teknologi Malaysia (UTM)

Academic Culture: Publish… Publish… Publish...

According to Etzkowitz et al (1998), an academic that is doing business from his/her research output requires a paradigm shift from the traditional means of exploitation (i.e. Publication and for teaching purposes). According to that paradigm, the main purpose of academic research is to increase and enhance human knowledge, taking exploitation of research output as a secondary objective. There are only two ways of exploiting knowledge: (1) publications (i.e. books, articles or conferences) that contribute to the knowledge production and (2) education for students- opportunities for the students to learn new things.

In UTM, this paradigm is deeply rooted in the academic culture where according to Ndonzuau et al (2002), the notion of "publish or perish" has been popularised within the academic community. The policy of appointments and internal promotions are heavily based on the researchers' contributions to knowledge production activities. Disagreeing with the concept, Respondent 1 said "*People who publish can team up with someone who can really write. But not everybody can do this. Some people they are good at consultation, some on commercialisation so we are not using the smart way. We assume people will do the same thing and people might get lost. People who have their niche or specialty will feels that they are not appreciated. Their marks are low because they don't publish. Our evaluation is more on publication*".

Since the university stresses on publication, most academic staff tend to publish for the sake of promotion and not for knowledge creation. This is supported by Respondent 2.

> "*A lot of them when they do the research are only for publication and promotion only, for CV purposes. Not many think about commercialisation. Sometimes commercialisation is not easy right? For them getting a research grants and postgraduate students and publish the paper…that's it. If you look now, it is still the same…where output is measure from publication. If you want to buy a house for example, what is the most important thing? Location, location, and location. Same goes in university, being a lecturer what is the most important, publication, publication and publication. So now the staff, I think, they are going to that direction. You want to do research so that you can do publication for promotion. Promotion on your product being commercialise…. I don't think it is important, not so*", (Respondent 2).

In the same vein, Respondent 8 said that "*Another reason for them to do a research is not to commercialise rather there are for promotion*". Regarding publication, some of the respondents showed some concern on publication as published research results have their own drawbacks from the standpoint of their economic advantages. Once their research results are in the public domain, they lose economic values. Respondent 2 stated that "*Publication also should be patent first because people can use your findings and develop their product. Once you publish it is open, which means everyone will have access to it*". Respondent 5 elaborated his concern on the publish work; said,

> "*If you managed to produce something then it has to be patented first and then after patenting you can commercialise and maybe write papers. Right now everybody is writing papers without considering patenting their product …which is going to be too dangerous …because if someone else takes that paper and then patented them then we cannot commercialise. So that is one concern that I have. Because the university needs a lot of publication so whatever research result you have … you want to publish straight away ….but I don't think that is a good strategy because if someone else read the paper and then take something out of that paper, patent it, then they have the right to commercialised. And then once they commercialised, they have the patent, we cannot*

commercialised our own ideas, our own design, our own prototype. So I think that is the word of concern", (Respondent 5).

From the interview evidence, it is suggested that publication is the main focus of the university. The main reason is that a publication is used as a benchmark in identifying the university's ranking. The high number of publications means the university is well off compared to other universities. On the contrary, it can be argued that publications are the main reason commercialisation activities are low in UTM. In other word, the "publish or perish" is seen to be the barrier of commercialisation activities in the university. As Respondent 6 asserted:

"*From the old days to now, commercialisation is just a stigma. On one hand the government want to promote it, on the other hand, they don't know how to move it. There is a conflict of interest, you see. Conflicts of interest happened like this. Research has traditionally been fundamental research. Research that they made in the domain of the university is for the purpose of knowledge generation. Purpose of generating PhD's. That's it. So research is not done with the purview, with the mind to commercialise. That's having been traditionally that way*", (Respondent 6).

Universiti Malaysia Pahang

Academic Culture: Be a 'Teacher'

It is noted that in chapter 5 UMP is one of the vocational-type universities in Malaysia. As a new university, UMP is focusing on curriculum development and developing its teaching capabilities. Hence, the university is more focused on teaching and less focused on research and commercialisation. Furthermore, as a new university, the majority of the academic staff are young, fresh graduates and new to the world of academia. Majority of them hold a Master's degree qualification with limited industrial experience.

The analysis revealed that research activities in the university are small in number due to a number of reasons. First, the university is expanding and this means that more courses are being offered and the university's intent to increase the number of student

intake. Secondly, the university is experiencing a shortage of academic staff due to the number of them going for sabbatical leave (further study). With the limited number of staff and increasing number of student intake; academic staffs have to spend a huge amount of time for teaching rather than researching. Moreover, there are fewer academic staff holding administrative positions at the faculty and university level. According to Respondent 15, it is difficult for the academic staff to be involved heavily in commercialisation and as an explanation he said that "*you know this researcher busy with another project probably with their load of teaching*". He claimed new and young lecturers are still in the process of adapting to academic life.

> *"I hope they can adjust their teaching and learning and research activity. For the senior lecturer they feel happy because they have already established but for the junior lecturer they still trying to establish their career as a lecturer",* (Respondent 15).

In the same view, Respondent 14 mentioned his concern of academic research and commercialisation activities in the university. He said,

> "*Most of the researchers are busy with teaching and they believe that R&D should be done during office hours (only)*", (Respondent 14).

The point that he was trying to make is that most of his colleagues did not take research as a serious matter, meaning that they only concentrate on teaching and did not have the initiative to spend time in doing a research. For him, doing a research needs more than ideas, it needs passion especially when the research is time consuming.

The focus on teaching has also resulted in research activities becoming less popular amongst the academic staff. According to Respondent 16, the university should create the awareness as it is certainly lacking in this area. He pointed out that the main challenge in the university is the human resource not the facility or research funding. He said that "*research opportunity is huge. The university will give even a small-scale research project a funding assistance. The university offers a short-term grant RM40K per person. But the problem is there is no research proposal. The university*

is asking from the staff to submit proposal but then there is not many takers. To some extent, I think the university even force the academic to do research. The university are very lenient in term of research grant". Another possible explanation besides the lack of awareness is the number of academic staff that goes on sabbatical leaves. This contributes to the low number of funding application in the university. According to Respondent 15,

> "*We can understand that they are facing some academic problems. To cater the needs of teaching, they have a shortage of staff. To go for research will be a hassle to them. So they have to prioritize, first thing first. Priority to academic…teaching and learning. So they have to concentrate on that*" (Respondent 15).

Universiti Teknikal Melaka (UTeM)

Academic Culture: Be Versatile!!!

Following the "vocational university" model, UTeM emphasises more on practice oriented methods of study. Academic staffs are required not only to focus on teaching and learning but also practicing the "practical side" of the subject. Because of the university model, most of the research activities conducted in the university is more towards applied research. This has contributed significantly towards producing research output that can be directly useable and hence having potential commercial values.

As Respondent 21 and 22 commented on the culture of teaching, researching and commercialising, they said:

> "*Especially for the past few years. Like I said in the early years of university establishment they are focusing on teaching and infrastructure. So when that thing is stable, research starts to embark and now is about the time for commercialisation*", (Respondent 21).
>
> "*It happened in one shot. I can say it start in 2005/6 when we start send our product for exhibition and competition. Then we get a very good feedback and one of our visions is to become an innovation university*

and the management is really serious about the innovation", (Respondent 22).

The interview evidence showed that because of the university model and the university objectives, which focused on applied research rather than fundamental research, research conducted in the university are more useable and 'hands-on' in nature. This increases the potential of the product to be commercialised. It also suggested that universities can influence the direction of research conducted in the university according to the university's agenda or objectives. In other words, the academics are flexible; they will follow top management's directives.

7.3 University Internal Structure

It is agreed that the support in terms of policies, units and infrastructure is crucial for technology development and technology transfer to take place in the university. Research centres, labs and workshops are only a few basic important facilities that are available in the three case universities. Apparently there are some universities that provide more than basic infrastructure to encourage research and commercialisation activities to take place. This section will present supporting units in the three case universities and discuss to what extent each unit assists academics in doing commercialisation. This section will also present other supporting mechanisms in each of the case universities towards research and commercialisation.

Universiti Teknologi Malaysia

Based on the analysis, there are four supporting units identified in UTM. These are the Research Management Centre (RMC), Bureau of Innovation and Consultancy (BIC), Uni-technologies Pte Ltd and Technovation Park. Each of the units has different roles and objectives in assisting academics in research and commercialisation.

Research Management Centre (RMC)

The RMC was established in 1982 as a research arm of UTM. It was formerly known as 'Research and Consultation Unit' and 'R&D Unit' until it was finally renamed as

'Research Management Centre' in 1997. As a support unit, the RMC is responsible for IP management. Besides, the unit is also responsible in facilitating R&D activities, promoting and exploiting the university's IP through the collaboration with government, semi-government agencies, other universities, international organizations and industry.

The building is located near the main entrance of the university; signifying the importance of research activities in the university. It is a walking distance from the centre of UTM. The RMC is headed by the director of school and has more than 30 members of staff. They have a responsibility of reporting directly to the deputy vice chancellor (research and innovation) on issues pertaining to research activity in the university.

The postgraduate office is also located in the same building. This gives them the advantage to monitor postgraduate research and managing postgraduate research grants. Besides office spaces, the building also provides research student rooms completed with shower rooms, seminar/lecture rooms and small discussion rooms. The postgraduate office is accessible 24 hours a day.

One of the core responsibilities of the RMC is managing university research funding/grants. As of December 2006, the RMC had managed 308 projects under the 9^{th} Malaysian plan with an amount of RM29.11 million. However, under the new organization restructuring exercises in 2007, the RMC is no longer responsible to offer services on promotion and exploitation of the university's research. This duty was handed over to the Bureau of Innovation and Consultancy (BIC). Instead, the unit is required to focus on monitoring research-related activities such as research funding and IP management in the university. With a much focused responsibility, this has contributed to the increased number of IPs in UTM (see table 7.1).

Table 7.1: UTM Intellectual Properties

Types of IP	2006	2007	2008	2009
Patent Granted	2	8	6	6
Patent Filing	10	57	131	334
Utility Innovation	-	1	2	3
Industrial Design	-	-	1	1
Trademark	-	-	8	12
Copyright	11	48	219	574
Integrated Circuit	-	-	10	10
TOTAL	**23**	**114**	**377**	**956**

Source: www.utm.my

The numbers from the table suggested that there is a burst of research activities in the university. The table shows an increase in the number of patent filing and copyrights within a period of three years. According to Respondent 1, the current practice makes submission of patents hassle-free for her. She can now spend more time doing her research. Previously they were required to complete everything before they could submit to the RMC. This created a burden to them especially for the first time applicants. According to her, the processing time for patent application has also improved. Previously, it would take an average of 5 years (patent pending) but now it is less than 3 years. She strongly believes that the main reason for such an increase in the number of IPs is mainly because of the efficiency and the effectiveness of the RMC in managing the IP application in the university.

> "*…I was lucky when I introduced my product in 2006; there is an allocation, a budget for patenting. Previous it was very difficult, in the 1990s and before I came back from my PhDs, it was difficult. But now it is much easier, that is good; there is a change in UTM. It comes with better assistance, budget allocation and even if we want to make contact with company for patenting is also easy. This is all done by the RMC…*", (Respondent 1).

The increased number of IPs is also partly due to the monetary incentives from the university to achieve the research university status. Each patent submission also carries a major point for promotional exercise. For that, Respondent 8 believes that efficiency and effectiveness was not the main reason. According to him,

> *"Our faculty is the highest in terms of patents. That is patent filing but for patent granted so far only two. We have more than 100 research submitted for patent filing. In reality the number rose is not because of research culture but more on promotion. Staff is being asked about the number of patent in the previous promotion exercise. So they submit for patent is for the sake of promotion. That is what I see, for promotion not for the benefit of the public. We have a lot of patent but where is the product? Why didn't it been commercialise? You can ask the BIC, how many have been commercialised. [Laugh]"*, (Respondent 8).

The RMC is also active in updating academic staff with the relevant information such as exhibitions, conferences and research grants. They have their own mailing group that keeps them updated on the university's R&D activities in terms of number of publications, short courses, funding and workshops. Academic staff receives emails from the RMC almost every day updating information relevant to R&D in the university. This will eventually create awareness of the importance of research as well as the existence of the unit itself. There is also evidence that the RMC is involved in research exhibitions and competitions to support academic staff.

Previously, the RMC allocated one of their staff to work in each of the faculties in UTM. Their main duty is to monitor research related matters besides becoming the unit liaison in the faculty. However, due to budget constraints, they have pulled back their staff to their existing unit.

The RMC is also involved during the application of *Research University* status. Their main role was to supply and update the university's status in terms of research activity. The most important criteria are the number of academic publications and numbers of IP. These are the two main concerns of the university because they carry high points in the Research University status. They are also responsible for Research University document preparation for submission to the Ministry of Higher Education.

In addition, the strong influence of top management and the university's policy on R&D influences the academic culture in UTM. The top management puts a lot of emphasis on research and publication and has implemented a number of initiatives

and incentives to achieve their organizational goals. Special incentives such as financial rewards and promotion incentives are few examples of the university initiatives to encourage publication and IP application activities.

As part of the university system, the RMC is an important unit in the university's research scenario. It plays a major role in developing university 'research culture'. One way of doing it is through creating an awareness of the importance of research activity. The RMC becomes more efficient when the university undertook restructuring in 2007. This has resulted in an increase in terms of numbers of IP application. By becoming more organised and efficient after the university organisation restructuring exercise undertook in 2007 it had a direct impact on the number of IP produced in the university. Although, there are other factors that contributed to the increased number of IPs in the university, such university reward systems and incentives that the RMC has had a significant impact on the development of university's research activity.

Bureau of Innovation and Consultancy (BIC)

UTM Bureau of Innovation and Consultancy (BIC) is another important supporting unit within the R&D system in UTM. Regarded as a *One Stop Centre for the technology transfer activities*, BIC provides various forms of expertise and promotes university IPs by forming a collaboration with industry, public as well as international bodies. BIC is responsible for providing consultancy services, R&D products' commercialisation, techno-enterprise development and entrepreneurship programmes and trainings.

BIC is located in UTM Technopark; a ten minute drive from the main campus. It has a complete infrastructure and is surrounded by the MARA techno-entrepreneur complex and UTM-MTDC[15] incubator. The building, where BIC is located, is complete with office spaces, meeting room, workshop, cafeteria and a huge parking space. The office spaces are rented to private companies. Currently, there are 13 private companies renting the office spaces. These office spaces are managed by Uni-technologies Ptd Ltd (UTSB), a university commercialisation arm. UTSB is also

[15] Malaysian Technology Development Corporation – is a quasi autonomous non-government body, responsible in managing special funds for university commercialisation activities.

located in the same building. The UTM Technopark is a gated area with the security office located at the main entrance. The unit is required to report directly to the Deputy Vice-chancellor (R&I). Currently, BIC is managed by the Director of BIC and three other deputy directors with a number of officers. There are more than 38 staffs working in BIC.

BIC's main task is to forge collaboration between the university and the industry. The linkage between these two entities has a lot of spill over effects and advantages. These include attracting more funding to the university, build up university reputation and understanding the current market demand. Moreover, having a strong link with the industry may open an opportunity for university staff to do consultation work or industrial secondment. Besides that, BIC is responsible for managing government special purpose funds, the CRDF [16] for commercialisation of academic research output. The unit is also responsible for identifying research output that has a commercial value in the university.

However, based on the experience of Respondent 1, the unit failed to assist her in forging collaboration with the industry. According to her, she has to do everything such as preparing the document and setting up the meeting for the collaboration. Personally, she believes that BIC neglected their main role. She said,

> *"And then there is a meeting and BIC told to me ask from the company a letter of intention (LOI). So I call them up and they send the letter. And then BIC ask me to ask the company to send a letter of appointment to us. So what is your role? We are giving them a...hassle. They are very busy. The BIC ask a lot of document from the company, proposal and personal letter. So I did help the company to do the proposal",* (Respondent 1).

[16] The Commercialisation of Research and Development Fund (CRDF) is a grants provided by the Malaysian government for commercialisation of academic research in Malaysian university and government research institute. MTDC is responsible to manage the grant.

This gives a bad impression to industry of the university's seriousness in fostering university-industry link. Moreover, it shows that the unit did not take the matter seriously. She added,

> *"If I knew this thing will happen, it is better for me to do it without them. I feel a shame to call the company because I have to ask them to write a letter again, to be sent to BIC. I feel that it is my role of hooking up these two entities. I think the BIC should take over when I bring the industry to the university. They should make a visit and give us some information"*, (Respondent 1).

Respondent 10 had the same experience. She said,

> *"We also bring the industry to the university and the BIC should continue the process. But until today the result is unknown"*, (Respondent 10).

The interview evidence showed a frustration and dissatisfaction experience of academics in doing collaboration with the industry. Respondent 1 felt that having research collaboration with the industry is such a burden to her. Furthermore, she admited that she has a limited knowledge in business dealings in which she believes that BIC should play their role in making the collaboration work. Respondent 10 felt that BIC did not take commercialisation seriously because she claimed,

> *"When we ask with other researcher about their experience in commercialising their research output, the answer is almost the same with me. So we are now starting to question about the university vision of encouraging commercialisation through the formation of Spinoff Company for so many years"*, (Respondent 10).

In general, eight of the respondents believe that BIC is not active in commercialisation activities. Respondent 13 mentioned that he normally sees staff from the RMC in most research exhibitions but not from BIC. To him, it is important for the BIC staff to participate because of their role in initiating university-industry

collaboration. Furthermore, they are responsible to act as a university frontline in terms of commercialisation activities.

Four of the respondents asserted they are not aware of BIC's role especially when it comes to commercialisation activities. Respondent 24 said, "*I don't know what they are doing actually. I do not know what their role is. They never come here so far as I know*." Respondent 3 added, "*But I cannot comment much on BIC... like Dr N said we don't know what their main role is actually. So we use them when we need them. That's it*." Respondent 2 also had a similar say on BIC,

> *"I don't know. Maybe commercialisation's support (assistance in commercialising) ...We are not salesman, if we look at the university, generally, the researcher: he is a businessman; he is the researcher ... Everything is done by him, totally depend on him. It should be; we have something and there should be someone who is really expert in doing marketing and promotion. But that was not the case in UTM. It is more on our own initiative. So if we want to do everything ...We can't. That is what I see in UTM. It solely depends on the researcher... him or herself"*, (Respondent 2).

However, a senior officer of BIC disagreed because he said *"It is like this, some of the researcher the problem is they think .... You know... they are the superman, everybody has to respect them, we don't have time to pet them, yeah...once in a while we do it but not every now and then we have to come to them....it doesn't make any sense. And furthermore you have to be a proactive...you don't have to wait for things to happened. You know the BIC is providing the pathway...come over. Why must you wait for us to come?"*

Reinforcing this statement, another officer in BIC (Respondent 29) said,

> *"We did organise a visit to faculty and invite them to a talk, but those who come are junior lecturer...yes we organised the visit and we have the schedule but....I think now we have to knock their door or went to their research lab...more to individually"*, (Respondent 29).

University policy on commercialisation is important to enhance the effectiveness of the process. As such, TTO needs proper commercialisation policies and guidelines especially when it comes to the decision-making to commercialise. However, four of the respondents claimed that the TTO did not have a systematic commercialisation policy. Respondent 6 claimed that

> *"We did but the agreement is not strong, there is a loop hole. The agreement is loose; we did not tighten it up. I have one classic example. I have a friend Assoc. Prof Dr NK in CEPP, he develop a very good biotech product. He is now a managing director of a Biotech company in Nilai. I work with him in his project, working on his plant. He was second by BBraun. BBraun is top German scientific equipment. His product has been copied by the company and the company produce it. But he cannot do anything because the agreement is loose. Now his getting smarter, the government appoint him to head a biotech company. That was a classic example of a very good invention but our licensing agreement is very loose. So the German company can exploit that invention. End up Dr NK have to work with him, left the company and appointed by the government to head a biotech company named InnoBiologics in Nilai. So... one of the important things is the agreement. Our agreement are not strong, we have no experience, inside the agreement they spell out everything so when we want to go for legal, we can't. It is really pity. A good one, we been cheated, not a good one, we been copied [laughed]"*, (Respondent 6).

According to the officer in BIC, the commercialisation policy in the university is still in the drafting stage. Issues on the royalties, ownership, and university equity percentage are still at the developmental stage. However, the new management has already recognized the imperfection in university commercialisation system and is already in the process of rectifying it. One of the officers said,

> *"The problem also ..... There is no proper ...what you called it ...policy on this and also direction by the management. Meaning...issue no.1;*

can university lecturer create spin off? You asked ten different top managers at the university ...you get ten different answers. Because the policy has not been discuss in detail. Question no.2; what is the ratio of equity? How many percent should be given to the university? Same also you'll get 10 different answers. Why? Because this policy was never discuss and it was forever pending [laugh]. With the restructuring exercise coming soon, I think all this issues will be address, policy will be developed, system establishes and I think it wills more structural approach to developing spin off",(Respondent 12).

The lack of proper policy in commercialisation activities clearly implies that the university took a modest stand on the commercialisation activities. Even though the university provides the basic infrastructure for technology transfer to take place, the IP protection and commercialisation is still neglected (Box 7.1).

A number of respondents also claimed that knowledgeable and experienced personnel should manage the TTO. Currently, most of the positions are held by academics with limited experience in commercialisation projects. Furthermore, most of the academic officers are engineers. As Respondent 1 stated that

"There is a person from MTDC, she is an ex staff of MTDC, she told me UTM is really slow in commercialising the university product. She told me how come UTM elects a construction civil engineer become the officer who is in charge with commercialisation. Furthermore I think Dr A is still young with limited experience in commercialisation. His post is a very critical post. Frankly speaking when I went to MTDC at that time, I rely on him but I think it's like he is relying on me. Because I don't know much about the market, when SIRIM people ask me a question and he is like relying to me", (Respondent 1).

Box 7.1: The Sine-Slab®

Sine-Slab® is a special product of a revetment system developed by Coastal and Offshore Engineering Institute, UTM. This research project is funded by MOSTE under the IRPA scheme. The Sine-Slab® system is uniquely designed to work with nature's forces. It is effectively stable and durable against hydraulic loading, at the same time being effective in trapping sediment, aesthetic and environment friendly.

Based on patent licensing arrangement, the product is manufactured and marketed by Zen Concrete Industries Sdn. Bhd. for Malaysia only from February 1998-2003. However according to Respondent 6, the agreement between university and the company is not strong. The agreement has many loop holes. As a result the company takes advantage by discontinued their license and start producing their own product. He said, "*Our agreement are not strong, we have no experience, inside the agreement they spell out everything so when we want to go for legal, we can't. It is really pity. A good one, we been cheat, not a good one, we been copied [laughed]. Like Zenconcrite, took Dr N invention, the sine-slab, pay the first fee and disappeared. Producing the invention themselves in Seremban [laughed]*".

The vignette shows the lack of appropriate policy in protecting university IP. This creates an unfavourable impression and not worth doing it.

Respondent 2 believes that the TTO officer should be someone from the industry not from academia if the university intends to encourage spinoff formation. He said,

> *"I don't know. Maybe commercialisation's support (assistance in commercialising) ...We are not salesman, if we look at the university, generally, the researcher: he is a businessman; he is the researcher ... Everything is done by him, totally depend on him. It should be; we have something and there should be someone who is really expert in doing marketing and promotion. But that was not the case in UTM. It is more on our own initiative. So if we want to do everything .... We can't. That's what I see in UTM. It solely depends on the researcher... him or herself"*, (Respondent 2).

Another Respondent (9) shared the same view,

> *"And they should have one really qualified marketing man. You don't ask the engineer to do the marketing, you don't ask the professor to do*

the marketing. They have to take people from the outside, really...people from the market. They know the market, not the professor to do the marketing", (Respondent 9).

There seems to be a general view that the university lacks competent people in commercialisation activities. Although this unit is run by academics, most of them are engineers. Four of the respondents suggested that appropriate personnel with a vast knowledge in business skills should be in the team. Entrepreneurial training and courses should be provided to officers in charge especially for those involved in commercialisation activities. Staff from the business and management school should be encouraged to assist academic/scientists in commercialisation activities especially in doing market research, forecasting and cost benefit analysis. The inter-faculty collaboration – the research alliance (RA) is a university initiative to establish a link between faculties in the university. This is an excellent platform in forging a link between non-engineering and engineering faculties. However the collaboration is more on research activities rather than IP exploitation.

Uni-Technologies Pte Ltd

Incorporated in 1992, Uni-Technologies Pte Ltd (UTSB) is a wholly owned company of UTM. Acting as a commercialisation arm of the university, UTSB provides a wide range of services including consulting services, project management consultancy, property development and manufacturing. Indeed, UTSB is the premier *Bumiputra* contractor to UTM. The unit is headed by the general manager appointed by the Vice Chancellor and is responsible for over 10 members of staff.

Historically, UTSB is responsible for handling commercialisation activities in the university. The unit is responsible for assisting the formation of university spinoff companies. However, in the previous years, there was a dispute in terms of responsibility between BIC and UTSB. This disagreement resulted in the university appointing BIC to handle commercialisation activities instead of UTSB. Currently, UTSB is responsible for consultancy and project management activities. Consultancy research constitutes a major income for the unit - more than 40% from the total income.

According to the general manager (Respondent 28), UTSB is actively involved in commercialisation. However, he stressed that their commercialisation activities are different from the normal commercialisation activities of which spinoff companies were established. What they did is to take up the product and sell it to the market. Currently, they have successfully commercialised three university products.

The unit also admitted that commercialisation activity is not an interesting activity in the university. This is due to the lack of understanding of what commercialisation is all about especially amongst the academic staff. Apparently, some of the commercialisation activities in the previous years have had some bad experiences and to some extent, a number of businesses ceased to operate. One of the reasons is that most of the research output did not come with complete solutions. This, according to him, needs further refinement or further research as he believes that researchers should understand the needs of the market thoroughly. He did give an example of their product which comes with complete solutions produced by Respondent 2. The product, a Flatbed Antenna, used for wireless "bridging" comes with the software and monitoring facilities that reduces the cost of fibre optics. The cost of production is also low. Based on this product, he believes that a formal collaboration between academics and industry is critical to make sure the product is marketable.

Technovation Park (UTM-TP)

One important infrastructure in the university is the UTM's Technovation Park (UTM-TP). The UTM-TP, officiated by the Prime Minister in 1995, is a 130 acre piece of land developed with the sole purpose of stimulating entrepreneurial activities within the university campus by working closely and tapping the university's intellectual assets. UTM-TP was granted a Multimedia Super Corridor (MSC)[17] status in 2002.

One of the most interesting features of UTM-TP is that it provides incubator facilities. It is a joint management between MTDC with UTM. Currently, UTM-TP is housing 18 active incubators, mostly in life science businesses. These companies are required

[17] MSC status – benefits ICT facilitated businesses through a host of privileged such as world-class physical infrastructure, cutting-edge communication info structure, cyber laws, financial incentives and non-financial incentives. (www.mscmalaysia.my)

to have an academic collaborator; part of its major requirement. Collaborators must be academics or university researchers who act as technical consultants (Box 7.2). There is a variation in terms of funding. Most of the companies that operate in this incubator received funds from the MTDC through the CRDF grants scheme. There are also companies who received funds from other government grants as well as from private sources. In terms of manpower, there is a significant variation amongst the companies. Some companies employed 2 staff while others have more than 30 staff.

MARA or Council of Trust for *Bumiputra* houses 8 small-medium enterprises in Techno-entrepreneur Complexes in UTM-TP. The main idea of its establishment is to assist *Bumiputra* in becoming techno-entrepreneurs. The complex offers a low operating cost such as subsidies in rent, management and financing assistance. It also gives the opportunity for the companies to seek any expertise and new technology from the university. However, according to BIC, such collaborations did not exist.

On the whole, UTM-TP is a big area with a single purpose of nurturing entrepreneurial activities. However, because of its locality (i.e. far from the main campus), the place is not popular amongst the academics. The area is really quiet and calm, more like a ghost town.

Box 7.2: My Organic Mushroom

My Organic Mushroom Sdn Bhd – is a company owned by Mr MM, cultivating mushroom in Ulu Tiram, Johor. He used to work as a General Manager in an agency under the Ministry of Territory and Rural Development in Johor. Following his retirement, he decided to follow his wife to UK to continue her study.

Mr. MM was in Loughborough for 4 years, following his wife pursuing her PhD degree. His wife, Dr M was a lecturer in UTM. During his stay in Loughborough, Mr. MM is a very active person in Malaysian society. Besides he is the most senior amongst the Malaysian community in Loughborough. He is very generous and was elected as the president of Malaysian community in Loughborough.

During his stay in Loughborough, he came to know Respondent 8, who at the time were also pursuing his PhD degree in Loughborough University. Respondent 8 is a religious man and was popular amongst the community because he has six children – one big family! A similar characteristic, Respondent 8 is very friendly and very helpful. He always organized gatherings and his wife, Mrs. A, is really well at cooking.Respondent 8's house was usually packed with friends on every celebration especially for the celebration of Eid. People came to show respect and try Mrs. A's

cook. Mrs. A is a motherly type and a very talkative person. At the time, Mr. MM and Respondent 8 are two important people in this small community of Malaysian in Loughborough.

The mushroom business started in 2005 when Dr M completed her PhD and started to serve in UTM. At the beginning Mr. MM operated his business from his home. From his home to his mushroom plant will take him about half an hour driving. The business is a one man show. However due to the increasing demand and management requirement, Mr. MM has decided to employed clerical staff to help him with the office chores. The need for office space is seem to be critical at the time.

The collaboration between Mr. MM and Respondent 8 started at the social gathering in Respondent 8's house in 2006. Mr. MM was having a problem in subtracting soil component for his mushroom. It was then he sought an advice about the process using the ozone technology. This is how Respondent 8 got involved in Mr. MM mushroom business.

Later, when Mr. MM decided to expand his business, he appointed Respondent 8 as a technical consultant for his business. By appointing Respondent 8 as a technical collaborator, he was eligible to apply CRDF and eligible to rent an office space in the UTM-MTDC incubation facilities in Techno-park UTM. Renting in UTM-TP helped him with his operational cost because the rent was much cheaper than normal office space outside the techno-park. Besides it gave a chance to him to acquire expertise from the university. Respondent 8, on the other hand, saw these opportunities as an extra income to him besides proving his invention works. Furthermore, the consultation works carried points on his performance appraisal exercise in the faculty and building up his research reputation.

Other Supporting Mechanism/Initiatives

There are a number of claims that the faculty did not show any interest with commercialisation activity. Respondent 10 mentioned that the faculty neither encourages nor discourages their faculty members in doing commercialisation.

> *"Faculty ...normally is invisible. Faculty doesn't care much. Only the researcher and the commercialisation arm. It is our own initiatives. They only encourage like for example they will send an email saying "where is your project, please commercialise it" that kind of encouragement. No reward or anything...nothing. Even thank you also we didn't get [laugh], congratulations also never get [laugh]. Everything is done by us. But still they encourage us to do commercialisation, they don't make us to stop with what we are doing, they let us use the facilities in the faculty and so*

on. We feel comfortable so we continue with the research...", (Respondent 10).

Sharing the same view, Respondent 1 believes there was no encouragement from the faculty.

> *"...Encouragement? Nothing!! If from faculty...there is no motivation at all! [Laugh] frankly speaking. If we want to say it a temporary scene, I means motivation from the top management, it might be. But so far it is still the same years after years. The new management is still the same. I guess they also didn't commercialise. Or maybe simply no encouragement from the top management so the faculty just follow...",* (Respondent 1).

They also claimed that they could not spend time on research and commercialisation activities because they have to do administration works. Majority of the respondents have an administrative position in the university or in the faculty (see table 7.2).

Table 7.2: Respondents' Position

Respondent	Position
Respondent 1	Head of Laboratory
Respondent 2	Director
Respondent 3	Lecturer
Respondent 4	Dean
Respondent 5	Head of Department
Respondent 7	Business Manager
Respondent 8	Deputy Director R&D
Respondent 9	Director
Respondent 10	Head of Laboratory
Respondent 11	Deputy Dean
Respondent 12	Dean
Respondent 13	Lecturer

Source: Researcher's fieldwork

Acting as a deputy director of research centres, Respondent 8 said, "*The workload does affect my research project. So far most of the work is done by the Research assistance/research officer (RA/RO). That's it. If you expect me to do everything...it is impossible. This is one of the weaknesses of working in the university. We, as a lecturer, have been assigned with a lot of work, we have a class, we have lab session, and administration works. We can't concentrate on our research. I organized the*

research and ask the students and the RA/RO to do the work. If there is a problem, then only we came in. The rest is with the students", (Respondent 8).

Respondent 13 also commented on the administration workload that he has to do in the faculty.

> *"Another factor that impedes my research activities is the workload, administration job. Like I said, the faculty will appoint junior lecturer like me to do the admin work which I believe some of them can be done by admin officer or even a clerk. But still they will call you with a reason to fulfil your 5 Ps. At the end most of our research is conducted by our students. If we lucky enough, we get a good student who did a lot [of work] if not we has to spend more time with them"*, (Respondent 13).

Another important support is the availability of funding in UTM. The majority of grants are received from the government. According to the RMC annual report 2007, UTM received more than 87% of funding from the government. Besides government grants, academics also received research grants from the university. There are three types of government grants; Institutional Research (Academic staff), Foreign Academic Visitors R&D Fund and New Academic Staff with PhD R&D Fund. In 2007, UTM spent RM2.08 million on these special grants, an increase from RM1.16 million in 2006.

The allocation of research grants at the university level indicates that the university is making a major effort in encouraging research in the university. Even though the amount of university research grants is small (RM50 000), the idea is to encourage academic staff to get involved in research activities. This is in line with the university plan in cultivating research culture and more importantly getting a research university status.

Achieving research university status will enable the university receive an extra RM100 million from the government. This means that the university will have extra funding for the academic staff/researchers. Just like Respondent 13 said, *"Maybe if UTM get the RU status, then it will be much easier for us to buy new equipment. I heard they are going to give us RM50 000 each for research and I believe it will be a*

motivation for us to conduct high standard research". Because he believes that *"Factors that impede... I think is about facilities. We can only have the equipment based on our research fund. What we normally do is we used what we have. If we receive another grant we will try to upgrade whatever equipment that we have until it is almost perfect"*, (Respondent 13).

The academics also received a number of grants from the government. Most of the grants are for fundamental and applied research. There is only one grant that provides funding for commercialisation purposes which is the CRDF. Funding for commercialisation is not available at the university level. Therefore, according to Respondent 5, CRDF is the only option for academic to commercialise their research output. However the processing period is much longer. MTDC will conduct a thorough due diligence especially on the company to make sure the grant is not misused. Respondent 9 said, "*They know that we are capable, we have the technology. This is the government money; the company might misuse the money because after the approval, the money is pump in directly to the company*".

Even though the MTDC conducts the screening process, the industries also have their own conditions and requirements. Some companies are reluctant to undertake a joint venture with the university because of the element of risk in producing products. It is therefore, according to Respondent 4, important for the government to convince the industry to get involved with university commercialisation activities. He said,

> "*Because they are not in that culture yet. Whereby the risk taken ....because what is produced by the researcher is not a final stage where it is ready for the market. We need further development from lab prototype to commercial production prototype. So that missing part is taken by MTDC. MTDC is playing that role. Ok... but the company if they say it is a matching grant, they still evaluate the risk, what if the effort and initiative of the project is not successful? Even though it is successful in the lab but it is not necessarily acceptable in the market place. Because of that they feel reluctant and scared, so it is important to convince the industry.*", (Respondent 4).

Even though the funding support is available, the chance to secure the funding is very difficult because according to Respondent 8, it has a lot of procedures and it is very competitive. Through his experience, he said, "*I submitted three proposals; one of the proposals is rejected. They said my research has been done by many people. In fact my research on ozone... is also interested by other people. But most of them are new to this technology. Some of them have tried to conduct a research on ozone experiment. So this particular guy has managed to send a research proposal earlier than me but he is still new to this area. So when I submit the proposal, I have been rejected with a reason someone else has already apply for that research. In the end that guy appoints me as a second supervisor for his PhD student.*"

Respondent 5 also had a bad experience in applying government grants (Techno-Fund). For him, it was extremely difficult because his proposal was rejected the first time they submitted the application. Respondent 9 said, "*Tech- NO-Fund. To me I laugh at it because it is Technology No Fund because some of the good technologies were not chosen. I got an experience with that. I have submitted a proposal but was turned down, because we heard that some of the committee member felt that that person is their competitor. Something like that. So I was quite frustrated that is why I do my own commercialisation*".

They also believe that the government did not support commercialisation in the sense that they provide insufficient funds. Most of the government grants support research activities until it reaches the prototype stage. In order to commercialise, the researcher needs to find different government grants or private funding. At this particular stage, the researchers believe that government and university funding are lacking. According to Respondent 3,

> *"That's right. For example, if you have RM500 000 R&D funding...by right you need RM1 million for commercialisation...that is the minimum. So if you apply from the government, you won't get because you are technical people. Can you see the problem? There is no commercialisation fund for those who have successfully completed their design"*, (Respondent 3).

Sharing the same view, Respondent 12 claimed

> *"That is why people say that R&D is very expensive. So if you used RM10 million in R&D, you need RM100 million to commercialise. Do you believe or not? We need this two zeroes here... than only you can commercialise. People think once they finish their R&D, Hooray! I finish my R&D now I want to make money! NO WAY! You need another two zero first if you want to commercialise. You have to spent more money to bring this product to be commercial. It is not the end of the world. They (university and MTDC) think we don't need this (RM100 million). That's when they did not provide for this. This is where the venture capital comes in, the banks, whatever. This is lacking. Research provides this only (RM10 million) but don't provides the means to bring it out. That is the fact! Even in Oxford, they need some more money in enable this to be commercialised"*, (Respondent 12).

Universiti Malaysia Pahang

The availability of a supporting unit in research and commercialisation in the university shows that the university recognizes its importance. Two units are responsible for managing research and commercialisation activities in the university. These are the Research and Innovation Office and the University-Industry Centre.

Research and Innovation Office

The Research and innovation office is a department that is responsible for managing the university's research and commercialisation activities. This department is under the purview of the Deputy Vice Chancellor (Research and Innovation) and is located in the main building. In order to ensure efficiency in handling research activities in the university, the department is separated into few sub-units to look into specific matters. These include IP management, grant management, promotional unit and publication unit.

The main objective of the research and innovation office is to facilitate research activities in the university. These include human resource developments, university-

industry links and research promotional activities. Besides providing training-based support to the university research community, the unit is also responsible for managing university research grants. In terms of research grants, Respondent 16 commented that the unit is doing an excellent job. He said,

> "*Research opportunity is huge. The university will give even a small scale research project a funding assistance. The university offers a short term grant RM40K per person. But the problem is there is no research proposal. The university is asking from the staff to submit proposal but then there is no many takers.*"

The unit is also responsible in managing patent activities and processes. Respondent 14 commented on the patenting process in the university. He said,

> "*About patenting I just give to the unit in charge in patenting activity. We give the patent discourse and the will manage it. So far I can say that I don't know about the patenting but they will give me my PI number once it is completed. I have three patent/products. I don't involve with patenting. If people wanted to buy my patent, licensing, then they have to go to the unit in the university to propose a deal. I will get a portion of financial reward because when they wanted to buy my patent [and] they will call me in the meeting.*", (Respondent 14).

University-Industry Centre (UIC)

The UIC was established in 2003 with a mission to facilitate the university-industry links and commercialisation activity. In the beginning years of its establishment, UIC was responsible for focusing on the university-industry links but not on commercialisation activities in the university. However, in 2006 the university decided to merge research and commercialisation under one department. This gave a chance for the university to better monitor the activity and execute decisions much faster and efficiently. Currently, the department has 6 staff in charge of the activity.

The UIC is very active in fostering the university-industry link. According to Respondent 15, to have a good networking with the industry is really important for

commercialisation to take place. Besides, he did strongly emphasised on building up industry's confidence and strengthening personal relationships with the industry. He said

> "*If we want to have a good industrial relationship, besides a good project, We need to develop a good reputation with the industry.*", (Respondent 15).

For him, one the most important ingredients in fostering research exploitation is about human factors. He stressed this statement based on his experience in managing to get Mercedes Benz Malaysia involved with university research collaboration. Previously, the company was reluctant to form any collaboration with the university which according to him was due to human relationship issues. Somehow, when he took over the office, he managed to convince the company of the importance in having the collaboration with the university. The general manager agreed to allocate two positions for student placement in the company. To a certain degree, the general manager is agreeing to co-supervise the university postgraduate students. He said

> "*At the end of the days .... I strongly believe is about the networking.... It is a human thing. It is all human...sometimes we are working with this person, you are very comfortable and fun if you have some misunderstanding just forget about it...forgive and forget and you might build up something better.. later on. If you don't have a good relationship...a small issue may flare up and becoming a big problem. Then you don't want to work with them.*", (Respondent 15).

Another thing that concerned him the most regarding commercialisation is the need for proper market survey to be conducted prior to the product being exploited. For him, market survey is important in determining whether the product is accepted or not by the public. The current practice in the university is more of 'judgement' and 'feeling' than that of proper market surveys. This, according to him, causes the product not to be accepted in the market or it would not be 'competitive' in the market. He commented

"*In UMP it is under my department where we have a market survey department. Except that at the moment we are still in the beginning stage. We have not commissioned any [market survey]. It is just a matter of our own judgment and feeling of the market. There is only one [product] that we can see, can be successful because the product is more for public consumption. But I would like to see a proper market survey to be done. Even though this is due to the fact that we are lack of personnel to handle*.", (Respondent 15).

He added,

"*Actually... from my point of view... is how you do a business. I don't look down on the technical aspect, I am a technical man as well, but I also have a second degree in finance. So when these two areas merge....at the end of the day, people look into your business viability based on financial strength. If you combine together it will be very strong. Even if we have a strong background in technical, there are still some limitations. It is just like an expiry date on bread, after a period of time it will become obsolete. When the time come it will be not relevant anymore, a new thing is coming out. Technical issue should be more dynamic.*", (Respondent 15).

As far as UIC assistance is concerned, Respondent 16 commented

"*They are pressuring me. MTDC has approved my project. The problem is I am the only one who is doing it. I don't even have business plan. They are already asking my project. They help us. Except that we are not ready. Researcher, like me, preparing business plan, is not my area. If we ask someone else, that person doesn't understand my product. Researcher they know everything about the product. We do not know the business side, marketing, business plan. So this is the problem and always has been the problems. If we ask for help from the other guy, they also don't understand our research. So at the end we have to do it by ourselves. I think researcher have to attend courses on how to prepare business plan*.", (Respondent 16).

The experience that Respondent 16 have had clearly shows that there is an issue of personnel competencies in business set-up matters. On one hand, the issue is that the researchers certainly lack the business knowledge: preparing business plans and market surveys. Because of these lacking, the academic researchers relied heavily on the university technology transfer office to help them overcome their business-related problems. On the other hand, the technology transfer office is lacking officers with necessary skills.

Other Supporting Mechanism/Initiatives

Government and university support plays an important role in facilitating commercialisation activities in the university. This support comes in different forms. The most popular kind of support is in the form of policy implementation, infrastructure and funding facilities. In UMP, such support is available to facilitate research and commercialisation activities in this university.

One of the most important supports in research is the availability of funding. The university offers two types of research grants for postgraduate research students as well as academic staff. Even though the amount of grant is much less than the government research grants, the main objective was to encourage research culture in the university. According to Respondent 16, the university is serious in persuading research culture amongst the university research community. Even if the research is a small-scale research, the university is not reluctant in providing research funding. He said, "*The University is very lenient in term of research grant*". However, funds allocated for commercialisation are not available at the university level.

In terms of research facilities, there are few accounts that indicate the university is providing sufficient research equipment for industrial involvement, research and commercialisation to take place. For example, a number of companies have decided to use university facilities for testing and fabrication purposes. According to the officer in charge, recently there has been one Australian company that has decided to form collaboration with the University for testing their equipment and unit. The main reason for them to form the collaboration was due to the standard quality of the research lab and the cost of testing in UMP.

For research and commercialisation activities, Respondent 14 believes that the university has sufficient equipment and facilities to conduct research activities in the university. Based on his experience, Respondent 14 did not find any difficulties to produce three research outputs and has successfully commercialised (Box 7.3).

All of the respondents claimed that the government is very supportive in facilitating research and commercialisation activities in the university. According to Respondent 15, the government has a specific unit to monitor every research produced in the university closely and will identify whether it has a potential to be commercialised. However, based on his observation, there are a number of researches successfully conducted and completed in the university according to Respondent 15, there is little research in the university that are completed but failed to be commercialised. This is due to the lack of proper market surveys and limited knowledge on the market demand. He said, "*Because there are some projects, like it or not, it seems from the research point of view is very good. But when it comes to turning to business entity for commercialisation it is not very attractive. So meaning to say that it is very necessary to have a proper forecasting and market survey to be conducted prior for any commercialisation to be taking place*."

Box 7.3 Respondent 14

Respondent 14 started his career as a research officer in a Food Company. Holding a diploma in food technology, he has worked in the R&D department for more than 4 years. He really likes to do research and during his working days, he managed to produce a number of food formulas for the company. The working environment was so tense that as an executive in the company, they were not allowed to go home until they had completed their work for that day.

> "*The most valuable experience during my working years in private sector is that, as an executive you are not allowed to continue your work tomorrow. You have to finish it on that day. So everybody feels like a game where you try to beat someone else to finish first. This eventually makes you feel normal working in pressure, working with dateline*."

He still remembers the day when he decided to continue his study. It is when one of his friends became a manager. He then realized that he needed to have a paper qualification in order to be like his friend. He enrolled in UTM in the Chemical Engineering Faculty and decided to continue his second degree as well. During his student years, he was actively engaged in research activities where he was responsible for managing the funds and the MOA of few other research projects; under a number of different professors.

Right after obtaining his master's degree, he was chosen to become a research officer in one of Dr. Zaini's research projects. This research project is about water treatment and was sponsored by the EU. After a year of being a research officer and a PhD student in UTM, he decided to quit the research group as he received an offer to become a tutor at UMP.

The most interesting story about Respondent 14 is that he started his research and commercialisation without any research grants and managed to commercialise all three of his research outputs. He is not saying money is not important but there are other factors that are more important in doing a research. He said

> "*I started without any grant. I learned from my previous supervisor, Dato' Zaini Ujang, he said that first you must establish your network with industry. And if you have an idea…you have to present to that company and find out whether the company is interested with your product or not. If they interested with your product then you must have MOU with them. This is what I learn for about a year during my study with my supervisor.*"

Because he believes that if there are no funds allocated for that project, it does not mean that the idea and research cannot be carried out. He can still carry on with the research because the university has everything; research labs and workshops, facilities, staff and students. But the most important thing to him is to convince the industry that the research is viable. This, he learnt from his previous supervisor.

He said most of the industries involved in his research give him materials rather than funds. For example one company provided him with membrane for water filters which would cost him more than RM180 000. Another company lent him a piece of land for research purposes and to do some product testing. This would cost him a fortune if the company had not provided the materials. For him, the most important thing is to convince the industry and prove to them that the research is viable. He said,

> "*You can carry on with the project but you need to prove it first because the university has the facilities; research lab and workshop. Unlike the industry who does not have anything (research lab, workshop) but in university we have everything…we have lab, staffs and students …all this thing can be used to produce something and help with our research.*"

According to him, this is not the first time for him doing research and commercialisation. He started doing it at the age of 13 years old. For him, his father was the person who taught him to become a researcher.

His father was an agricultural officer. He bought him a lot of livestock and asked him to look after them. Then his father taught him how to grow plants and vegetables. It was a pressure for him to look after the farm. Right after school, his father would ask him to go to the farm and do all the normal chores. His father is a serious man when it comes

to work and chores. After finishing his high school, many of his friends started working in fast food restaurants and factories. For him, his father did not allow him to work there.

Instead his father asked him to start doing business. Because he said "*I still remember what my dad use to say, 9 out 10 sustenance comes from business*". Then he started to sell his products. At the same time, he started to learn to produce *Tofu* and started to sell them in night stall. At first, he felt shy to sell *tofu* at the night stall; even some of his friends made jokes at him. But later, he did not feel it anymore. The business managed him to save RM1 000 while he continued his diploma in food technology. For the senior project, he improvised the *tofu* ingredients; from milk to soya bean.

Doing commercialisation never occurred to him in the beginning. AS admited that he really likes to conduct research and the main reason to conduct research was to complete his key performance index. It all started when MTDC conducted a screening process and found out that the product was viable and ready for the market. This, according to him, started after two years of his research activity.

On the accounts of his experience in doing commercialisation, he admits he faces a lot of challenges. He gives thanks to God for helping him to overcome all of these challenges without much hassle. For example, as a weekend husband, he used to work until late in the night for two solid years. At the time, his family was still working in UTM and this gave him a chance to stay back to complete his research. But then in 2007, his wife managed to get a transfer and he had some difficulties adjusting his working style. But later, he managed to compromise the working hours.

Another bad experience was when the industry decided to take legal action on him because he was a bit off from the milestone. This was mainly due to the office politics that later on he understood was between him and the dean. The dean asked him to stop conducting research which he did not understand why he had to. However, he did slow down because he was pressured by the dean and his colleague. His colleague once told him to stop doing research because the dean did not like it and the dean might not confirm his position. But then he just ignored it because he had already signed an MOU with the industry. Later, he knew that the dean was accusing him of stealing his ideas and saw him as his challenger.

He admitted his progress was slowed down because the dean was reluctant to approve of any of his vote order or outing permission during office hours. Then after a period of time, a new dean was appointed. He was previously the deputy dean and this new dean knew what was going on. He told AS "*You should continue with your research and will give you my support 100%*". He really did. AS said "*If the current dean is still the previous one, I don't think that I can commercialise my product. But now the hindrance is not there anymore and that is why I can go further*".

He also expressed some concerns of this issue towards new academic staff. If there is a lot of hindrance and challenges from the top management, there is a big tendency that the newcomer would give up easily. He hopes that the top management will give a full support to any types of contribution by the faculty's staff.

Universiti Teknikal Melaka

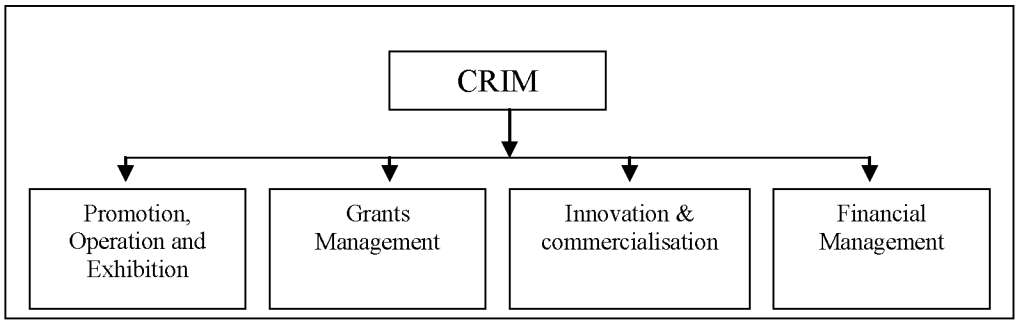
The university objective clearly highlights the importance of strategic alliance between UTeM and the industry. Such collaboration requires a full support from the university in terms of policy, facilities and services. This section will discuss UTeM initiatives in developing research and commercialisation activities and forging collaboration with industry.

Centre for Research and Innovation Management (CRIM)

The Centre for Research and Innovation Management, previously known as University Industry Centre, was established since 2002 to foster smart partnerships between UTeM and Industries. In 2009, the name of the unit was changed to CRIM when the University decided to combine UIC with research management for better coordination. As one of the universities that focus on 'vocational' type approach, the need for a technology transfer office is vital to forge a stronger link with the industry. However, the unit is considered small and it has six personnel under the unit.

CRIM is headed by the Deputy Vice Chancellor under the portfolio of Research and Innovation. Their main objective is to nurture the research culture amongst the academic staff besides encouraging the producing of high quality research and forging strong industrial linkages. Among its responsibilities are patent processes, consultation works, managing research funds and encouraging commercialisation activities. The unit has four different divisions with specific responsibilities.

Figure 7.1: Centres for Research and Management



Sources: Taken from UTeM official website

Figure 7.1 shows the organizational structure of CRIM. From the diagram, it is clearly shown that the university recognises the importance of R&D and commercialisation activities. This is because CRIM has a specific division that monitors and manages R&D activities in the university and research grants. Specific divisions ensure that tasks can be run smoothly.

However Respondent 18 gave a contradictory comment on the nature of assistance that CRIM offers. He believes the unit's personnel lack the necessary skills especially in helping academic staff to form business ventures. He said,

> "*I think we need an improvement in the sense that the unit should assist us on everything. They should construct a plan in encouraging lecturers to apply and involve with this activity. If let say we don't know how to prepare a working paper, they should help us on this. They just inform us. How to go about ... they don't show us. They assume we get all the knowledge from outsider and by ourselves.*", (Respondent 18).

The issue of lack of necessary skills is because the majority of the officers in charge in the unit are academics with engineering backgrounds. However, the officer in charge claimed that they have provided necessary support and assistance to the university's researchers in terms of R&D and commercialisation activities. Respondent 19 said that

> "*We create the awareness amongst our researchers through organizing seminar, attending workshop or IP workshop, business setting workshop*

and etc. We also educate them in terms of IP, licensing and to some extent commercialising their output. Sometime we organized the courses and sometime we ask them to attend other organizer events. In terms of funding, they can use any means of funding. Some of them they received funding from the university. We have funding facilities, which is maximum you can get is RM20-30K. They can use that money to attend courses. That is creating the awareness because not all researcher know about the importance of licensing, IP, Patent and commercialisation", (Respondent 19).

In terms of informing academic researchers about R&D activities in the university, the unit is considered active. This is agreed by a number of academic researchers. The main medium of informing academic researchers is through electronic mail. Respondent 20, for example, said that the unit will inform him about research grants from the government and other agencies occasionally. However, there are general views that the system needs an improvement especially in terms of processing timing. Respondent 20 asserted that

"*In terms of grants, they are responsible to look after. So all research grant will be under the unit, the whole university. So when it comes to claims and payment it takes too long to process because there is only one officer in charge with the task. We give them the specification and everything but it takes few months to get the invoice, just the invoice. This will affect our research.*", (Respondent 20).

In the same view, Respondent 18 claimed that the unit that is responsible is acting is too slow. This is because the unit takes substantial amount of time in processing the research grants. He said,

"*Impeding factors is the unit that is responsible in processing our grants should not be too rigid and calculative. They said they have a lot of grant and no want is seeking any research fund. But in reality there are putting a strict requirement for example, senior lecturer is not allowed to apply the grants, the new people could not have two grants.*", (Respondent 18).

Based on the respondent's comment, there is evidence of bureaucratic issues present in the university's processing system. As a government institution, the university is required to follow the government's general guidelines. The university has to follow certain guidelines in processing the research grants. This process may sometimes take a longer period of time as it needs several approvals from different departments. This part of requirement affects research milestones.

There is also a concern on selection practices in research grants and a number of participation in exhibition. There seems to be strict selection procedures that according to few respondents demoralized the researchers. Respondent 20 said

> "*The University shouldn't filter any research to participate in any research expo or exhibition. By doing this it will discourage the researcher. No point of doing research. The university is limiting the number of participants. Why is it other university have more than 100 participation? Why are we limiting our staff's participation? This will demoralized our researcher. I don't think that they understand the importance of this exhibition*", (Respondent 20).

University *they should be a little bit lenient in applying grant. Don't make it difficult for researcher to apply*". Another issue raised by the respondent was the university's policy on R&D activity. Respondent 18 is not satisfied with the current policy regarding patenting activities in the university. Based on his experience, his research output has been turned down by the university with a reason that his invention still needs further development to be commercialised. For him, the university should understand that sometimes research outputs need to develop further until it can be commercialised but for a start it needs to be protected. He believes the university did not understand the meaning of commercialisation and patenting. Patent is a researcher's idea which is important on the part of the researcher. It can also be considered as a factor of motivation in conducting more research activities. He said, "*the unit are very selective in paying the patenting process. We have put a lot of effort but at the end they don't want to patent it. So it really demoralized us because they said your product is still in*

development stage for commercialisation therefore you don't need to patent your product".

Another university initiative in forging university-industry links is through the establishment of the Industry and Community Network Centre (ICNet). Previously, it was under the management of CRIM. Conversely, due to the increasing importance of having a link with the industry and the community, the unit was separated and was administered under the chancellery department. The unit is headed by a director.

The main objective of ICNet is to develop a strategic partnership with the industry and the community as a whole. This helps UTeM to identify the current needs of the industry as well as the community especially in science and engineering related matters. The networks will be in the form of students' practical training, industrial exposure, staff industry attachment, research collaborations and other related activities.

The university also appointed six industrial leaders from different fields to provide advice to the university's management to ensure UTeM's development is in the line of the need of the industry and trying to develop high interest of industry towards UTeM. The group – the Industrial Advisory Panel (IAP) also provides advice to the university on developing the university's curriculum that is significant to both local and international needs. The IAP also guides the university in developing UTeM facilities to ensure the graduates are well trained and adapt to the industry's needs.

Other Supporting Mechanism/Initiatives

University support plays an important factor in encouraging and fostering R&D and commercialisation activities in the university. It comes in different types i.e. policy, reward, facilities and infrastructure. In UTeM, there is a substantial support from the university as well as from the faculty. However, there are mixed views regarding the kind of support respondents received.

Respondent 20 claimed that the top management is very supportive in encouraging R&D activities in the university. These include publishing academic journals, incentives in winning exhibition awards and funding support. According to him,

"*The top management is very supportive. If you want to present paper they will support you. For journal; they encourage to submit for international journal and minimize the local proceeding or seminar. The top management is really supportive in terms of publication journal with high impact factor. Recently the university has decided to allocate an award and money for those who manage to publish in high impact factor journal. They are really supportive in terms of R&D. This is like an incentive to us. So when the university decided to give money then everybody has to work to that direction. So eventually it will become more active. If we won any medal in any exhibition, the university also gives us monetary award.*", (Respondent 20).

However Respondent 18 asserted that the university is very selective in terms of patent and granting research fund. For him, the university is making the procedure and the process stricter and harder for researchers to conduct R&D. This will eventually affect the researcher motivation level. Patenting, for example, the university is reluctant to pay the patenting fees as they believe it does not have any commercial values yet. Respondent 8 admited that his research output might not have commercial values yet but still needs to be protected legally. And he believes that in future, it will eventually have commercial value. He was hoping that the university could pay his patenting fees which he believes is like an investment for the university's staffs.

Besides government research grants, UTeM also provides research grants to their academic staff. The main idea of the grant was to encourage academics to conduct fundamental research. The grants are managed by CRIM and the maximum amount of the grant is RM30 000. As one of the recipients, Respondent 20 claimed, the amount of the grant is too small to conduct a high-impact research. He claimed it is not enough to buy any equipment or employ a research assistant. The dilemma that he is having is, since he could not afford to have research assistance, he will spend more time in research. The faculty, however, expects their staff members to focus on teaching and learning rather than researching. This contradicts researchers' expectation. In terms of buying research equipment, the faculty will ask the researcher to use their research grant instead of using faculty's budget.

There is also an issue on the efficiency of the supporting unit (CRIM). There is a general view that the unit is not efficient due to the lack of officers in charge and necessary skills in running the unit. According to them, the unit should improve their processing time especially when it comes to grants disbursement and payment. The CRIM, for example, took on average one month to prepare a payment invoice to supplier. This will affect the research milestone and time.

In the same views Respondent 20 expected that the university should be more lenient in approving academics to get involved in research exhibitions. For him, it is a source of motivation for research because they can show their research output to the industry as well as the public. It will boost the researchers' confidence and also they will get a chance to get more research ideas and forms links with the industry. What the university is practicing is each application will go through the university research committee and the committee will decide which research outputs are eligible to enter the exhibition or research competition. He said, "*By doing this it will discourage the researcher. No point of doing research. The university is limiting the number of participants. Why is it other university have more than 100 participation? Why are we limiting our staff participation? This will demoralized our researcher. I don't think that they understand the importance of this exhibition*".

At faculty level, Respondent 20 claimed that the nature of support is heavily dependent on the faculty management team. If the management team emphasizes on teaching and learning, they will provide necessary support to enhance academic teaching capabilities. This goes the same with research intensity culture in the faculty. He experiences a management emphasizing on teaching and learning and consider research as a secondary objective. Academics are required to focus on teaching and learning and are evaluated based on the teaching workload and academic administrative work. Conversely, after a few years, new management teams joint the faculty. Academics with vast industrial backgrounds headed it. He is very interested with business and commercialisation activities and encourages academics to venture into entrepreneurial activities. To some extent, the dean set up a small factory in the faculty. The small factory has a complete equipment to support manufacturing. He also discourages the idea to form joint ventures with the industry because he said the faculty *is* the company. He wanted all faculty staffs involved in this project. And this

is because the dean is from the industry. Based on this, Respondent 20 believes that the level of support varies depending on the faculty management team.

7.4 Recognition

Recognising contribution of staff is important for motivational purposes. University recognition comes in different types of rewards and incentives. It also depends on the university aims and objectives. This section will present recognition systems implemented at each of the three case universities and what academic respondents perceived of its implementation. Evidence shows that there is a significant variant in terms of implementation between the three universities.

Universiti Teknologi Malaysia

Every year, UTM hosts an award ceremony to recognise all the contributions made by the university staff. The award can be divided into two categories; university and faculty levels. The university level looks at the contribution towards the whole organisation while at faculty level; it is more like individual achievement. Between these two, the faculty level is more important as it will affect staff promotion scheme.

The award ceremony- *Citra Karisma* is held every year to recognise contributions by university staff in the university. There are 13 award categories altogether, only 5 award categories are related to research and development activity. These are: research, innovation, consultancy, intellectual property and publication award. The award is based on the key performance index (KPI) set by the faculty's member at the beginning of each year. Completion of any plan work at the end of each year carries a point. The total point will be determined by the eligibility to receive the award. The award recipient will receive cash, a trophy and a certificate.

One interesting point in the university award system is that almost half of the awards focus on research activities (i.e. research, publications, patents) and none for commercialisation activities (i.e. spinoff company). This indicates that the university did not recognize commercialisation activities as one of the major activities in the university. Respondent 1 said *"In reality we have to look at our university. The encouragement is not there, we lack the encouragement. The university does not encourage us to do commercialisation"*. She added, *"Even the university award*

ceremony…the Citra Karisma….there is no award for commercialisation isn't? I don't see any award for commercialisation".

Most of the respondents agreed that the university is focusing on developing university research capabilities. This is because research activities received well recognition in UTM in terms of point system. Moreover, based on the university award system, commercialisation contributes a minor point especially in university promotion exercise.

At the faculty level, academic staffs have five major activities that they need to satisfy. Each activity carries a different point. These are teaching, research, consultancy, publications and social service. Among these five activities, publication and research carry the highest point. This also shows that commercialisation was not part of the important agenda in any faculty.

> *"Faculty …normally is invisible. Faculty doesn't care much. Only the researcher and the commercialisation arm. It is our own initiatives. They only encourage like for example they will send an email saying "where is your project, please commercialise it" that kind of encouragement. No reward or anything…nothing. Even thank you also we didn't get [laugh], congratulations also never get [laugh]. Everything is done by us. But still they encourage us to do commercialisation, they don't make us to stop with what we are doing, they let us use the facilities in the faculty and so on. We feel comfortable so we continue with the research"*, (Respondent 10).

The award ceremony gives a clear indication that the university did not put the importance of commercialisation on the same line with other activities in the university i.e. IP, publications, research and consultation. Even though the infrastructure and the policies are in place, the encouragement from the top management is still needed. This encouragement is crucial to motivate academic staff to venture into this activity.

UTM also provides special incentives for publishing academic writing and application for IPs. This incentive was implemented in 2007 when the new vice-chancellor took the office. The main reason for its implementation was to increase the number of academic publications and the number of IPs in the university. These two items are part of the main requirements to achieve a *Research University* status. It also gives an encouragement to academic staff to get involved in research activities. This will eventually create a research culture in the university. Academic staffs who manage to publish academic publications will receive monetary rewards based on the journal impact factor. For IP applications, each submission will be rewarded RM1000. Since its implementation the number of publications and the number of IPs in the university have increased significantly (see table 7.1 and 7.3). The reward system seems to give a boost in research activities in UTM.

Table 7.3: Number of Publication in UTM

	2006	**2007**	**2008**	**2009 (Oct)**
No. of Journal	98	218	210	212

Source: www.utm.my

Moreover, publishing an academic writing received greater attention when the university decided that it will be one of the criteria in promotion exercise. It carries a high point in the university KPI criteria. Beside this point, academic staffs are required to publish according to their position in the university. For example, professors are required to produce 10 academic writings per year, associate professor requires to produce 5 academic writings and lecturer position need to produce 2 academic writings.

Another interesting action taken by the university is the restriction on attending and presenting a paper at conferences. They are allowed to present only if they have already submitted their paper to an academic journal. The university believes that the conference proceedings do not have a high impact factor compared to academic publication. Part of it is because of the limited budget the university has.

Overall, it can be implied that the university is putting a huge emphasis on academic publications because of several reasons. First is for the requirement in achieving

research university status. The numbers of journals produced by the university contributes points to get the *research university* status. Second is for the promotion exercise in the university and third is to create the *research culture* in UTM. Again, it can be implied that the number of journals produced in the university resembles the number of research activities conducted in the university.

Furthermore, according to Respondent 2, 3 and 8, most academic staff prefer to publish their research output rather than commercialise it. This is because it contributes a major point in promotion and building up their academic reputation. Besides, it is much faster to disseminate their findings to public when compared to commercialisation. The commercialisation process takes a longer period of time, for example the patent granted needs few years after filing before it can be commercialised. The respondents, however, believe that they prefer their research output to be used by the public and making money out of it.

Universiti Malaysia Pahang

Every year, the university hosts an event to recognize the contribution made by the university staff towards the university. The event is called *Cendikia Bitara*; which literally means a group of knowledgeable people with outstanding knowledge. The university recognised 7 types of contributions. From the total, two of the categories are related to R&D which is patents and research outputs. Patent award recipients will be based on the number of patents granted in the same year. For the research output award; the recipient should hold a technology licensing agreement with the company that is approved by the university or have a paid-up capital of more than RM200 000. Besides R&D related activities, the university also recognises contributions in the form of publications; books and academic journals.

The university recognition system indicates that UMP recognized commercialisation activities by allocating a specific award for commercialised products. At the same time it encourages academic researchers to establish a link with the industry by requiring academics to have technology licensing agreements. This is in line with the university's mission to be more involved with the industry.

Respondent 16 showed some concerns on the university's rewarding system. According to him, the reward system failed to encourage academics to get involved in research and commercialisation activities. It does not have a big impact on developing a research culture. He said, "*Awareness of research in the university is poor but not fund. Funding is available*".

In terms of support from the faculty, all respondents agreed that the faculty plays a minimal role in encouraging R&D and commercialisation activity in the faculty. There are general views that academic staff is burdened with teaching workload and administrative work. One of the main reasons is the shortage of staff in the faculty due to the considerable number of staffs going for further study. Furthermore, the faculty is stressing more on student programmes and curriculum development.

The academic staffs also receive full support in the case of attending exhibitions and seminars as well as presenting papers at conferences. Respondent 16 claimed, "*Frankly speaking money is not a problem. If you want to present your working paper or attending research conferences and exhibition, whatever, is not a problem. The university will support you*". It is believed that there is a sense of competition amongst universities in Malaysia especially between the new universities (Malaysian Technology University Networks or MTUN) that require UMP to market themselves in Malaysian higher education institutions. Hence, in the case of UMP, there is a specific division responsible in managing exhibition and university's promotional activities.

Universiti Teknikal Melaka

UTeM organizes an award ceremony every year and there are seven awards offered. Three of the awards are associated with research and commercialisation; Research Award, Innovation and Commercialisation Award and Publication Award. However, during the interview, only Respondent 20 mentioned about the award ceremony. According to him, besides the award, the university offers monetary rewards for publications in high impact journals and winning research exhibitions. However, even though the university put in place the rewarding system, evidence suggests that it is not popular amongst the academic respondents. This is because during the fieldwork, there was only one person who mentioned it. Another evidence is the university did

not have a specific website for award ceremonies as in the case of the other two universities.

7.5 Human Capital Development

All three case universities showed that the universities provide necessary training and development programmes for university staff. The unit also provides necessary programmes such as short courses on how to conduct a research and develop writing skills for new staff in the university. This program runs continuously throughout the year and in some case studies, it is compulsory for academic staff to attend the course. This section, however, will present university programmes on developing university research capabilities and other supporting factors to encourage research and commercialisation activities in the university. This section will not discuss university programmes set by the human resource department.

Universiti Teknologi Malaysia

UTM provides a number of programmes and initiatives to develop academic research capabilities and foster research culture. These programmes include research alliances, training, workshop, and new promotional scheme. Each of the initiatives will be discussed below.

Research Alliances

Research alliances are formal groups of researchers from different disciplines working together performing cutting edge research and producing new discoveries, dissemination of knowledge and possibly commercialising the research output. Each research alliance is a combination of experts from different centres of excellence. At present, UTM has 11 research alliances, ten of which related to the science and technology discipline (table 7.4).

Table 7.4: Research Alliance

Current established Research Alliance in UTM	
Infocomm	Cybernetics
e-SciNano	Innovative Construction
Energy	Water
Sustainability	Transportation
Material and Manufacturing	Bio-tech
k-economy	

Source: www.utm.my

Student Entrepreneurship Development Programs

In a way to create the synergism of 'research culture', UTM has decided to implement a number of student development programmes. This programme is another initiative to equip the students with necessary research skills and to some extent to become entrepreneurs. There are four programmes developed for the students; Senior Project, Harvard Business School, UTM-Symbiosis and Global Outreach Program.

The senior project requires students from different backgrounds and faculties to form a research group. One of the requirements of this project is, besides producing a research dissertation; it should have a commercial value. The main idea is to give a real world exposure to the students and train them to become techno-entrepreneurs.

Another programme introduced to the students is the Harvard Business School Case Study programme. The main objective of this program is to develop critical thinking skills and to train them to become problem solvers. The case study is supplied by Harvard Business School. This programme will also help the students to identify current issues in the industry for their senior projects.

The UTM-Symbiosis Programme is a government programme to nurture the entrepreneurial culture amongst Malaysian graduates. This programme will assist students to form spinoff companies once they complete their studies. UTM and MTDC are responsible for handling the programme. The programme comes with a vast initiatives and assistance from UTM and MTDC (Box 7.4).

The Global Outreach Programme was designed to give a chance to the students to have a firsthand experience of how students from top universities such as Harvard University, MIT, Imperial College, University of Cambridge and University of

Oxford, experiencing their academic life. Students will gain valuable experience such as how the class is conducted, visiting the lab and research centre and exchanging ideas for future research collaboration. The university also host a number of business plan competitions for the university students. This is to expose the students with business knowledge and train them to become entrepreneurs.

Box 7.4: Entrepreneurial Programme in UTM

Symbiosis UTM-MTDC

UTM-Symbiosis is a joint venture programme, launched in February 2009, between UTM and MTDC to develop graduates entrepreneurial skills. This is the first MTDC collaboration programmes with higher public institutions in the country. This programme is created with an objective to motivate and facilitate the establishment of academic spinoff companies. UTM will provide a range of high potential and commercial ready technologies and MTDC will provide financial assistance, grants and incubator facilities. Apart from that, MTDC will organize necessary entrepreneurial development programmes and workshops to equip the fresh graduates with competent entrepreneurial skills and providing them more employment opportunities. Those who have been chosen will have to go through 5 phases in the programmes before they can 'graduate'. Students are required to complete each stage before they can advance to other stages. Department of Commercialisation of BIC is responsible for the programmes.

Teaching factory is another training program for part-time students in UTM. This programme is developed to encourage and facilitate transfer of technology. It is administered by the technology transfer department in BIC under the UTM's Skill Development Programmes. This 'hands-on' training programme is conducted between 3 to 6 months where the students are exposed to the real working environment. Besides providing the machinery and technical tools, BIC also provides supporting services such as technology outsourcing services and promotional and marketing services.

Training / Workshop

The university has hosted a number of training and workshops under the staff development programme. There are two types of training, academic staff and administration staff. Academics' training are more on teaching and conducting research whereby administration staff are more on administration work. Staffs are

required to attend a certain number of hours for training programmes in the university. There are also a number of government training programmes that is compulsory for civil servants managed by the HCD.

Promotion

UTM has recently introduced a new criterion in its promotional exercises. The standard criterion for promotion is based on the key performance set at the beginning of the year. Academics should complete the 5 P's, Research, Writing, Publishing, Social work and Teaching and learning. Under the new promotional exercises, major points will be given for those who manage to publish academic journals in prestige journals, filing for patent and number of citations.

There is also an award ceremony at faculty level. This award ceremony also contributes points in the performance appraisal exercise at the university level. The ceremony is another way for the faculty to recognize staffs' contribution in academic works as well as in research activities.

Role Model

There is also evidence that peer pressure and role models in the university influence academic staff to carry out research activities and publications. The role model poised a greater influence especially amongst the junior lecturers. Some of the respondents believe that the role model is important because they can learn and get new knowledge from them. For example, Respondent 1 claimed that, "*We don't know who is doing any commercialisation. They should let everybody knows that someone is doing a commercialisation so that it is easier for us to follow suit. Take the person as our mentor. Then this person can give talk, shares experiences*". Respondent 10 also stated that "*If there is a spinoff company make known to the other researcher so that we can follow them or at least get some advice on setting a business ventures*". For Respondent 3, the main reason some of them did not disclose their activities is because of the "silo culture". He said, "*when you are in big organization, you confine to your area, become a silo, this is my thing...nobody should know, it is a secret*".

In terms of research and publications, the majority of the academic staff agreed that the vice-chancellor of UTM is their idol (Box 7.5). The VC is very active in research

and publications and is a man of his word. As Respondent 9 said, "*Our VC is very busy but still he got postgraduate students. If he can do it why can't we. If you want to make an excuse, you will come up with 1000 excuses. If you think you want to do it, you will find 1000 ways to do it*".

Universiti Malaysia Pahang

The training and competency department of UMP is responsible for providing training and skill development courses for the university's staff. This department is under the purview of the Registrar's Office. There is a requirement for the university's staff to attend certain amounts of credit hours in training and skill development courses especially amongst the academic staff. Academic staffs are required to attend courses that are related to teaching and research activities. However, a course that is related to research and commercialisation activities is not available in the university.

Box 7.5: UTM Vice Chancellor

'A Good Teacher Educates, A Great Teacher Inspires…'

Professor Zaini Ujang, 44, is the fifth and the youngest vice-chancellor ever appointed in UTM took the office in October 2008. Prior to his appointment, he had been the deputy of the vice-chancellor (research and innovation) since March 2007. He has exhibited excellent leadership skills and this is displayed by the number of senior management positions he held which included the Director of Institute of Environmental & Water Resource Management (IPASA) and the Dean of faculty of Chemical and Natural Resources Engineering.

Professor Zaini is well known in Malaysia as a professional environmental engineer, academic leader, innovator and environmentalist. In 2009, he was one of the individuals to receive the most prestigious Merdeka Award. This was the first award ever received by an academic for his Outstanding Scholastic Achievement. Further the New Straits Times daily recognized him as a 'Malaysian Water Icon' in 2004 and BERNAMA, the Malaysian national news agency, introduced him as an 'environmental ideologue'. This was in recognition of his outstanding contribution to research, teaching and advocacy in environmental related issues.

Besides being a member of several professional bodies, Professor Zaini can be considered as the 'man behind the scene' on several occasions especially related to national initiatives on education in the late 1990s.During this period, he was appointed as the Special Officer to the Minister of Education. He has also been recognized internationally, for example, when he was appointed as the Senior Advisor to the Prince Khalid bin Sultan Chair on Water Research, King Saud University, Saudi Arabia in January 2009. He has also been appointed as a consultant to water-related issues with Taibah University and is the head of a research group to study the ground water in the holy city of Medina, Saudi Arabia.

Professor Zaini is very passionate with writing and publication. He has published more than 200 technical papers, 22 books and more than 1000 articles besides writing a weekly column in the Malay dailies (Utusan Malaysia, 1988-1998 and Berita Harian, 2004-now). In addition to writing, he is also active in technology transfer activities. Currently he has registered more than 20 intellectual property rights jointly

owned by his co-workers and former students. He has commercialised six research products, eight patents, eleven copyrights and one industrial pattern.

Since taking over the office, he has implemented a number of initiatives and programmes to stimulate the creativity, innovative and dynamic culture amongst the university staffs. He is implementing and formulating a number of strategies towards positioning UTM as a Malaysia's premier university in engineering and technology and most importantly as a Research University.

Based on the researcher's experience, Professor Zaini is a person who is true with his words. As a UTM vice-chancellor, he has inspired the staff not only to be excel in teaching activities but also to contributes in driving UTM to become an academic research and innovation hub.

Under his administration, the university has undergone a major restructuring exercise. Among the restructuring is the establishment of two new faculties; Faculty of Bioscience & Bioengineering and Faculty of Biomedical & Health Sciences. A centre of Islamic Studies and Social Development was upgraded into the Faculty of Islamic Civilization. A number of departments and units were also undergoing a restructuring exercise. This new units are more focus and efficient.

Besides restructuring the organizations, he also introduced a number of new incentives and rewarding systems in the university. Academic will be financially rewarded if they successfully published an article. The amount of money to be received will be based on impact factor. Submission for patent will also receive RM1000. Promotional exercises will be strictly based on individual performance with a major marks comes from research and publication activities.

One of the major restructuring exercises in the university is the implementation of Research Alliance. The idea behind this formation is to conduct a world-class leading-edge research with a combination of experts from different background. Tapping the university intellectual capital and exploit it to the fullness was in line with the vice-chancellor's vision in bringing UTM academic yardstick to the highest level, locally and internationally.

Making sure the UTM staff is abreast with the university progress; Professor Zaini uploaded his monthly talk in UTM vice chancellor website. He believes that by uploading his talk in the university website, every university staff will be able to access especially those who are out of the station. Besides his monthly talk, he uploaded his personal CV, his speeches and keynotes talk. His website has over one million hit.

Under his administration, Professor Zaini identified five main strategies that UTM has to address to become the first 'Research Innovative University' in Malaysia. The strategies are:

1. **University ranking**: Improving the university current ranking
2. **Students**: Strategy in acquiring and producing excellent student through a number of initiatives and programmes.
3. **Branding**: University Branding – UTM.
4. **Publication**: Producing high-impact journal article and citation.
5. **Financial**: Strategies in reducing the operational cost and generating income.

In terms of operational, one of the interesting branding activities is the cutting short of university's meeting. As it has been practice before, some of the meetings took more than two hours and some of them may take a whole day! He believes that this is not efficient in terms of time management. Academic should allocate at least 70% of their time doing academic work i.e. research. Therefore he suggested that every meeting should be limit to two hours maximum.

He also wanted UTM website to be in the first position when someone 'Google' it, just like any other well-known universities in the world (MIT, Harvard University, University of Oxford and University of Cambridge). This can be achieved by creating a huge number of internet traffics to the UTM website. Furthermore, he wanted that every UTM staff to use UTM email address when communicating with each other. This will create the number of flows. To some extent, he did mentioned that if any UTM staffs send him an email without using the university email address, he would not reply.

Every dean and head of unit in the university is supplied with Blackberry Smartphone. He will send any information or idea and expect to get a reply and action as soon as possible. He said that '…there will be no reason for you to say you are not informed or act late. Technically you can access your email almost anywhere…'

7.6 Discussion

The case studies identified some interesting findings related to academic commercialisation activity in the three case universities. It can be argued that the university culture is shaped based on the university objectives, policy and strategy. The three case studies presented in the above clearly showed that the university plays an important role in shaping and moulding the academic commercialisation in the university. For example in UTM, university policy is much favourable towards research and publications compared to commercialisation (from the perspective of reward and incentives). UTeM strongly encourages hands-on teaching and applied research in its academic curriculum based on the vocational university models. In

UMP the university is focusing on developing their teaching capabilities by encouraging academics to further their studies. The university also fosters knowledge transfer program amongst the academic staff. This program will eventually foster smart partnership program with the industry. It can also be argued that the university culture is strongly influenced by the university's top management. As in the case of UTM, the vice chancellor has a strong influence in fostering research culture amongst the university staff.

In terms of infrastructure or supporting units, all universities provide supporting units for research and commercialisation to take place. As it should have been expected, UTM provides a complete infrastructure for commercialisation to take place compared to the other two universities. UMP is the least amongst the universities by having a small unit to handle research and commercialisation in the university. However, even though UMP has the smallest unit (the unit has six staff members) compared to the other two. There is evidence that commercialisation activities have been successfully completed (meaning the product has been sold). This shows that facilities are not the main requirements for commercialisation to take place.

Interview evidence revealed that even though all of the universities provide facilities that encourage research and commercialisation to take place, commercialisation activities are still not popular amongst academics. They believe that as academics, their main responsibilities are teaching and conducting research. They perceived that commercialisation is associated with high-risk investments and are time consuming. Whereas, conducting a research is a risk free activity. As far as funding is concerned, they are not accountable to any government body if the research activity goes bad. Therefore, it can be argued that there is a complacent culture existing amongst the academics in Malaysian public universities.

Even though each university provides supporting units for research and commercialisation, the case studies reveal that there is an issue in terms of its implementation. There is a general view that the TTO lacks expertise in terms of work force and inadequate protection policies. As in the case of UTM, the TTO lacks to create awareness of the importance of IP protection and commercialisation of academic research output. A number of respondents asserted that the unit is certainly

lacking in terms of expertise and skills and qualified personnel. Deficiencies in the competency and skills amongst its personnel cause a number of patents to go unexploited. This is because they are unable to identify which patent should be given priority in seeking patent protection and commercialisation. In UTeM, the case study revealed that there is a grievance from academic respondents on the same issues. The lack of proper policies and incompetency of TTO staff are the major issues that are discussed. There seems to be a general view that on one hand, the TTO is trying to encourage research and commercialisation but on the other hand, limits the activity. It is clearly that there is an internal issue regarding the implementation system. In terms of business skills, UMP admitted that the unit has the same issues. For example, the unit lacks the expertise in doing a thorough market survey and business plans for commercialisation activities. They believe that without a proper market survey conducted, there is a minimal chance for the product to survive in the market. For that, the unit has to rely on private consultants. This creates another issue on the level of commitment by the private consultants and the project timeframe. It is also revealed that all of the units in each university are headed by engineers with limited business experience and knowledge. It can be argued that the lack of business skills contribute to the low numbers of commercialisation activities in the three case universities.

The case study also revealed the importance of faculty and university support and the influence of management in encouraging and facilitating research and commercialisation. There is evidence of power distance existing in all three case universities. The university top management shapes the goals of the university. As in the case of UTM, the university focuses more on publication and IP application instead of IP exploitation. This is reflected on the university's reward system, promotion and funding facilities of which there is little effect on commercialisation. In UTeM, the top management emphasises the hands-on approach by having a strong collaboration with the industry.

Another important finding is that many respondents reported that the faculty's top management has a strong influence in commercialisation activities. There is evidence from the case studies that the dean and the head of department play important roles to

facilitate commercialisation activities. This would suggest the role of top management should be encouraged to enhance research and commercialisation in the faculty.

The case studies also found an interesting finding about the types of commercialisation activities conducted in the university. The normal process of commercialisation activities is when the researchers are able to produce a research output and apply for patent protection. This is a classic example of the types of commercialisation activities conducted in UTM. For the other two universities, the type of commercialisation is somewhat different. The type of commercialisation is more like learning by doing approach. It can be argued that the type of commercialisation is influenced by the types of university or the university focus. UTM, for example, focuses on research activities whereby UTeM and UMP focus on vocational types of curriculum. In UTM, research activities are given a priority compared to teaching and learning. Research is conducted with a view of knowledge creation and publications and not for commercialisation. On contrary, the other two universities were established based on the principle of 'vocational university'. The university 'model' indirectly encourages academics to conduct applied research rather than fundamental research as in the case of UTM. This gives an opportunity for academics to get directly involved in solving industrial problems and eventually forming a strong link with the industry. It can be argued that research is conducted with the objective of knowledge transfer or solving industrial problems not for publication. Furthermore, the strong links with the industry gives a better chance for academic to commercialise their research output. The notion of the 'ivory tower' does not apply to the university. With this model and directive from the university, academics are forced to be proactive in searching for industrial collaboration for their teaching purposes as well as for their research activities.

7.7 Conclusion

The three case studies presented in the above showed some interesting findings. On the whole, each university acknowledged the importance of commercialisation in the university. This is shown with the establishment of technology transfer offices in each of the universities. The technology transfer offices were given the responsibility to

forge collaborations with the industry. Furthermore, they are required by the university to assist academic in exploitation of research output.

Even though all of the universities have to comply with the ministry agenda, it seems to appear that each university shapes their own aims and objectives. From the case studies, each university pursues different agendas. This shows that the government takes a moderate stand in terms of controlling and monitoring the public universities.

There is also evidence showing that the university and faculty play a major role in motivating research and commercialisation activities. From the three case studies, academics tend to follow directives from their immediate superiors i.e. the dean and the vice-chancellor. This shows that the management team plays an important role if the university decides to take research and commercialisation activities more seriously.

To conclude, this chapter has identified that the institutional initiatives such as recognition, incentives and policy do affect research and commercialisation in the university. The direct intervention of top management can be the main source of motivation for academics to venture into entrepreneurial activities in the university.

Chapter 8 will discuss government's initiatives towards commercialisation activities in the Malaysian universities.

Chapter 8

Government Perspectives

8.1 Introduction

There is a growing interest on the role of government in fostering research and commercialisation activity in the country. Many governments have taken substantial measures in developing their country's national innovation system. A government initiative through the implementation of policy, infrastructure and incentives are few measures taken to enhance country's technology capabilities.

This chapter discusses the views of academic respondent on government initiatives (top level) in the light of Malaysian technological development, particularly initiative to promote and facilitate commercialisation activity in the university. The government has implemented a number of initiatives at the governmental level as well as at the university level. This initiative is particularly important to answer the first research question on the status and current trend of commercialisation activity in Malaysian universities.

This chapter will be structured as follows: Section 8.2 will present the development of Malaysian policies from its independence until the country's aim to achieve a fully developed country status in 2020. This will be followed by Section 8.3 on Malaysia initiatives and support toward research and commercialisation. The last section (section 8.4) will conclude the chapter.

8.2 Government Policy in Malaysia

The effects of globalization have resulted in Malaysia undergoing a number of economic transformations since its independence in 1957. The economic transformation on several fronts has made Malaysia as one of the fastest growing economies in Asia. Malaysia has moved from being a commodity-based economy in the early 1960s to a manufacturing focused economy in the middle of 1980s and has now recently progressed into a technology driven economy with greater reliance on

knowledge for value creation. The privatization scheme in the middle of 1980s resulted in the private sector to dominating the Malaysian economy. Malaysia also shifted from a highly regulated system to a more liberal and deregulated system.

Within the manufacturing sector, Malaysia has undergone a major change from labour-intensive production to more capital intensive activities (Figure 8.1). Production of goods with higher valued added is now preferred to production of assembly products. The production process has also changed from simple processes to more integrated and technology-driven processes. More recently, the government's strategy is leaning towards product-driven growth by stressing the importance of utilizing local resources and technology to facilitate Malaysia's progress towards the next level of development.

Figure 8.1 shows the development of Malaysians' Government policies since its independence in 1957. The most important policy is the implementation of New Economic Policy and the Malaysian five-year plan. It was introduced in 1970 after a racial riot in 1969, which stemmed from economic imbalance between the native Malays and the non-Malays (Chinese). The New Economic Policy is revised every five years (the Malaysia Five year Plan) to monitor and control outcomes.

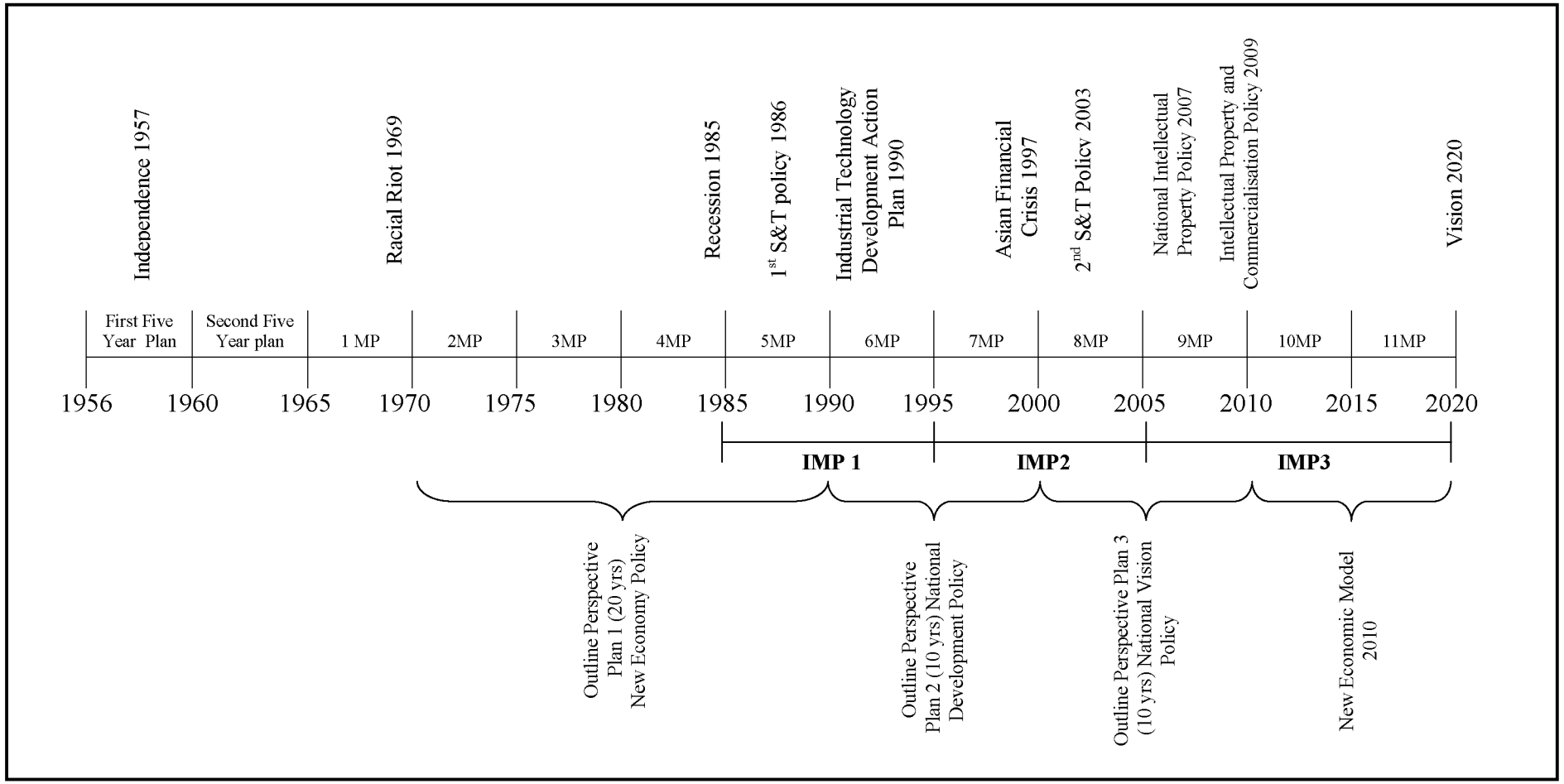
In 1985, Malaysia was hit by the first economic recession, resulting in an increase in the unemployment rate. At the same time, the country experienced a large burden of external debt occasioned by failure in promoting the heavy industrialization program. It was then the country implemented privatization and the introduction of the first Science and Technology Policy (STP1) in 1986. Technology Development was the initiative of the fourth Malaysian Prime Minister aimed at developing the country's technological capabilities.

In 1997 Malaysia was hit by a wave of financial crises. What Malaysia learned from the crisis is that there are two industries that were not affected by the recession; these are the power and food industry. The government then decided to focus on developing local technological capabilities focusing on Information and Communications Technology (ICT) and biotechnology industry. Malaysia has an abundance of flora and fauna in the country which presents an advantage for Malaysia

to focus on life-sciences and biotechnology industries. In order to give a boost to these two high-tech industries, the government introduced the second Science and Technology Policy (STP2) in 2003. This policy was introduced in order to overcome a number of weaknesses identified by the government in the area of Technology Development.

One of the weaknesses identified in Malaysia's technological development related to insufficient Intellectual Property (IP) protection. In order to create awareness of the importance of IP protection, the government implemented the National Intellectual Property Policy (NIPP) in 2007. This policy provided a platform for the creation of an innovative environment and gives confidence to potential inventors that their innovations will be protected. Then, in order to further strengthen Malaysia's technological development, the government introduced the Intellectual Property and Commercialisation Policy (IPCP) in 2009. This policy provided guidelines and protection towards research and commercialisation activities funded by the government. The purpose of this policy was to encourage public universities and Government Research Institutes to participate in advancing technology development in the nation.

Figure 8.1: Malaysia's Government Policy at a glance



Source: Compilation by author

8.3 Government's Initiatives and Support

This Section presents findings that are related to initatives and support made by the Malaysian Government towards stimulating research and commercialisation among the Malaysian universities. This case analysis has identified five types of initiatives implemented by the Government. Figure 8.2 shows the initiatives and the phases of R&D in Malaysian public universities. Each initiative will be discussed in the following section.

Figure 8.2: Government Initiatives

	R&D Phases			
Types of Initiatives	Fundamental Research	Applied Research	Pre-commercialisation	Commercialisation
Ministry	MOHE	MOSTI	MOSTI	MTDC
Types of Grants	FRGS	E-Science	Techno-Fund	CRDF
Policy	STP I & II	STP II & NIPP	IPCP	-
Award	Allocated	Allocated	-	-
Infrastructure	University / Research Centres	University / Research Centres	Technology Park	Technology Park / MSC

Sources: Compilation by author

8.3.1 Ministries and Government Agencies

There are six government ministries directly involved in Science and Technology (S&T) development in Malaysia. These ministries are considered important players in of Malaysia's National Innovation System. The government also set up a number of government agencies that help to assist and facilitate the development of local technology capabilities. Table 8.1 shows the various ministries and agencies that are directly involved with the development of S&T in Malaysia.

Government agencies such as MIGHT, MTDC, ACE Market[18] and MAVCAP are some of the government agencies that have a common purpose to foster technological development in the local industries. They are responsible for implementing government initiatives and strategy. MIGHT is responsible for promoting and coordinating partnerships between the government and the high technological-driven industries. The ACE Market was set up to give a chance for newly established high-technology companies to have access to capital market. The MAVCAP is a government company set up using venture capital that serves to provide financing and management assistance in new high risk ventures. Their main role is to support ICT based companies to a higher level besides playing a role as a catalyst in venture capital industry. The MTDC is another venture capital company that serves the same purpose as MAVCAP and it is responsible for the government-backed commercialisation fund, the CRDF.

Table 8.1: Ministries and Agencies Involve in S&T Development

Ministry	Agency
Ministry of Higher Education (MOHE)	Malaysian Technology Development Corporation (MTDC)
Ministry of Science, Technology and Innovation (MOSTI)	Malaysian Industry-government Group for High Technology (MIGHT)
Ministry of International Trade and Industry (MITI)	ACE Market
Ministry of Human Resource (MOHR)	Malaysian Venture Capital Management (MAVCAP)
Ministry of Domestic Trade and Consumer Affairs (MDTCA)	

Source: Compiled by the author

Respondents expressed their views on the extent of government assistance and support besides the financial assistance provided. Ten of the respondents claimed that the government provided sufficient support in terms of organizing programs, monitoring and establishing links between

[18] ACE Market was previously known as MESDAQ (Malaysian Exchange of Securities Dealing and Automated Quotation) was launched in 1996 as part of the government initiative to give a chance for newly high-technology based companies to tap the capital market. The listing procedures are much easier with better certainty and efficiency for trading. The regulatory framework is much transparent and has better disclosure.

the industry and universities in order to enhance the entrepreneurial skills and business knowledge of academia. Respondent 15 claimed,

> "*The government of Malaysia is very supportive through the Department of Higher Education where they have a unit which is called industrial unit. This industrial unit is actually monitoring closely about the research that coming out from this research and so on*"

The same respondent continued to say:

> "*The government is more than encouraging. They monitor us every now and then. In fact we have to submit a report…to show them that we are doing it. They seriously monitor us…. No joke. Sometimes they organize a seminar, help us to link with European Union-Malaysia Chamber of Commerce and Industry…thing like that*" (Respondent 15)

Some of the respondents stated that the Government agencies i.e. Multimedia Development Corporation (MDeC) and Malaysian Technology development Corporation (MTDC) were also actively involved in providing business management assistance to the academic researchers in carrying out commercialisation. Respondent 3, for example, believes that the support given by the Government was a valuable thing for him because it increased his knowledge in business. He stated:

> "*MDeC pre-seed funding provided a lot of assistance such as short courses, financial courses, marketing courses and strategic planning which is very important… because I never attended any such courses, which strengthen my business model and strategy, how to approach customer*", (Respondent 3).

Expressing similar views, Respondent 8 believes that he will continue to deal with MTDC in the future as he was of the opinion that the agency was keen to assist him as stated below:

> "*I'll stick to MTDC. In the future I will ask funding from MTDC because I believe MTDC is more reliable. Inno-fund and techno-fund have so many procedures and there isn't any staff to help us with the business. Unlike MTDC they have specific group of staff to guide us*", (Respondent 8).

Respondent 14 also confirmed that the governments *do* support research and commercialisation through funding and other kinds of support but their main problem was inadequate numbers of personnel to do the monitoring. Unlike the MTDC, they have a specific unit that is responsible for assisting the researcher.

Furthermore the officers in charge lack the necessary skills required to assist academia to conduct the required research and commercialisation. Conversely MTDC provides sufficient assistance in terms of monitoring and management assistance. From respondents' general views, MTDC is very active in assisting academic to form business entities because they are considered as a private firm responsible for the management of government grants.

8.3.2 Research and Commercialisation Grants

The availability of research and commercialisation grants is important for S&T development in a country. In Malaysia, the first research grants were introduced in 1986 to encourage research activity in public universities and Government Research Institutes. The Intensification of Research in Priority Areas (IRPA) is managed by MOSTI focusing on key strategic areas that have the potential to enhance the national socio-economic environment. At that time, IRPA were the only available research funds provided by the government. The budget allocated for IRPA also increased significantly from RM413 million (GBP 82 million) in 1986 to RM883 (GBP178 million) in 2001.

In the Ninth Malaysia Plan, the IRPA was replaced with the Science Fund and Techno Fund. The main objective of Science Fund is to support fundamental and applied research projects. It also seeks to generate knowledge as well as enhance the local researchers' skills and expertise.

This fund also supports the development of new products or processes that have the potential for further development.

The Techno Fund is an extension of the Science Fund. Any research funded by the Science Fund, which shows promise of possessing commercial value, can be nominated for more funding through the Techno Fund Scheme. The aims of Techno Fund is to provide funding assistance for further development of the research output to attain level of commercialisation. This pre-commercialisation fund is meant for commercially viable prototypes, pilot plants, clinical trials and up scaling. The fund is not for commercialisation purposes. Another characteristic of Techno Fund is that it is earmarked for priority areas of funding which have the potential to create new businesses and economic wealth for the country.

The Fundamental Research Grants Scheme (FRGS) is another research grant initiated by the MOHE under the Ninth Malaysia Plan. It was first introduced in 2006 with a budget of RM200 million (GBP40 million). The main objective of this Research Grants Scheme is to provide funds for fundamental research projects in universities. There are six strategic areas that are considered to be fundamental in Malaysia; pure science, applied science, social science and literature, technology and engineering, natural science and national heritage, and medical sciences.

The Commercialisation of Research and Development Fund (CRDF) is another government grant for commercialisation activity in the country. It was managed by MTDC for full-scale commercialisation projects. The CRDF is a matching grant where the entrepreneur and MTDC pool the same amount of funds for the project (see Box 8.1).

Box 8.1: Malaysian Technology Development Corporation (MTDC)

MTDC was established in 1992 following the recommendation from APITD to the government in order to strengthen the role of S&T and technology development in the country. MTDC is a quasi autonomous non-government body responsible on promotion and commercialisation of local research and investment in new venture. Eventually, over the years, MTDC has becoming one of the active venture capitalist in the country. MTDC provides a number of grants to assist the formation of newly technology-based business amongst the local people as well as foreigners. To date, MTDC has already invested more than RM500 million in both local and foreign companies. With good reputation and outstanding achievement, in 2004 the government has allocated another fund worth of RM1 billion for

non-ICT projects and appointed MTDC to solely manage the fund. As of February 2011, out of this a total of RM294 million investments have been approved for 21 high technology companies.

Besides financial assistance, the institution also provides advisory and management assistance towards the grant recipients. One particular initiative was the establishment of incubator facilities. The incubator facility is a joint initiative between MTDC with local university and government research institution. Currently they are four incubator facilities under the MTDC management:

- UKM-MTDC
- UPM-MTDC
- UTM-MTDC
- FRIM-MTDC

One particular initiative under the technology development program is the establishment of special purpose grants that help HEIs and GRIs researchers to exploit their research output. The Commercialisation of Research and Development Fund (CRDF) is a matching grant to support commercialisation activities of locally developed technology undertaken by local companies. The grant was introduced in 1997 following the recommendation from APITD to the government in order to spearhead local technological development in the country.

In terms of the process, each application will go through a rigorous 'due diligence' conducted by MTDC. The due diligence will go through three main phases; screening, evaluation and approval. This process usually takes an average of twelve weeks. This is then followed by investment phase where the fund will be deployed. The last stage of the process is the monitoring and exit stage. All application will be submitted to a panel of evaluators elected by MTDC.

The CRDF has different types of categories that suit the different scales of business. This classification makes it easy for MTDC to identify the level of progress of each business and the level of assistance that these company's needs. For example, CRDF 1 is meant for spin off company formation and the target market is amongst the academic in HEIs and GRIs. The maximum amount of grant is RM500 000. The CRDF 2, on the other hand, was set up to support commercialisation of research output from HEIs and GRIs by start-up company. All types of grant require collaboration between university and the industry.

The main rational of its establishment was to encourage academic or researcher to involve in entrepreneurial activity. The grant was also meant to develop and to foster collaboration between the university and the industry. The grant requires academic and industry to form a joint venture in order to be eligible in applying for the fund. The academic will provide expertise in technological aspect of the business whereby the industry will provide business related aspect such as marketing, management and etc. With such requirement imposed, it can be said that CRDF was actually established based on two main purposes; 1) to encourage entrepreneurial activity amongst the academic through the formation of university spin off companies and 2) to foster university-industry links.

In terms of funding, there is substantial assistance from the government to develop R&D capabilities in the country. Each grant has a specific target, managed by a specific ministry or agency and overall provides funding at each stage of R&D phases.

The case study also revealed that there is an issue with the slow pace at which the government funding is processed and implemented. A few respondents claimed that there is too much bureaucracy involved in grant management. One of the respondent asserted that

> "*Government is another issue, they are very slow. The process is really slow. Another thing is that the government did not have a centralised unit or division that monitors and manages the grants. Under MOHE we have one division, under MOSTI we also have another division, MTDC is another division. It should be that this thing is group and monitored by one division. Once you submit the application, they will decide which grants you should get. This is much easier and probably faster. Current practice each department will do the screening than if it is not suitable, they will advise to get different types of grant by another unit or agency*", (Respondent 18).

Respondent 5, 7 and 9 claimed that the government grants are very difficult to obtain due to high competition within the research community. For example Respondent 5 claimed that he had a very bad experience and getting a techno-fund is extremely difficult. His proposal for a Dental Implants research project was rejected and the cost was slashed by more than half. Respondents 7 and 9 commented on government grants (Techno-Fund) being too competitive, inflexible (i.e. confined to specific area) and there was also evidence of conflict of interest with committee members on the Techno Fund awarding board tending off potential competitors in their respective fields of research. The following comments represent the views.

> "*So far the techno-fund ...there is a problem. The problem is the allocation is limited. Project is based on their priority. If you want it fast... do a research that is inline with their priority. For example now they are going for Bio-diesel, so if you apply for Bio-diesel, you'll get the fund. We don't do that. Another thing is that*

even a professor also sometimes difficult to get the fund. Very competitive, it is not easy", (Respondent 7).

"*Tech- NO-Fund. To me I laugh at it because it is Technology No Fund. Because some of the good technology was not chosen. I got an experience with that. I have submitted a proposal but was turned down, because we heard that some of the committee member feels that that person is their competitor. Something like that. So I was quite frustrated that is why I do my own commercialisation*", (Respondent 9).

It is anticipated that even though grants for research and commercialisation are available, the interview evidence showed that they are highly competitive. This is because government grants are the only available grants in universities to facilitate research and commercialisation activities. Universities lack funding assistance from the industry.

Commenting on the type of assistance and support from MTDC, there are two contrasting views from the respondent. Respondent 14 asserted that

"*So far it is already a year, I don't find any problem of them not helping us. They always help us. Even the company also said they have no issues with MTDC. The problem that we had is from ourselves. The company CEO always receives advice from them even sometimes their officer will visit office and discuss if they have any problem with the business.*", (Respondent 14).

Respondent 14 was involved in the development of product for termite control and had collaborated with one local company. He used waste product to produce the termite control treatment and has successfully penetrated the local market. Currently the company has made sales of more than RM 5 million over the past two years. On top of that the company currently employs two of the university graduates to work with them.

In contrast, Respondent 6 had a different experience with MTDC. He accepted that the government is very serious in encouraging commercialisation through different mechanism such as policy development and funding. However, when it comes to implementation he is of the opinion that there is a big flaw namely bureaucracy. According to him,

> "*The government has a very clear policy committed itself to funds commercialisation from research. Funds are there. But the flaws that are in between are the bureaucracy. Bureaucracy in the management of the claims, bureaucracy in the payments, and bureaucracy in evaluating the claims there is a lot of bureaucratic issues*", (Respondent 6).

Respondent 6 received about RM2 million from MTDC under the CRDF scheme. However the respondent has since turned to commercial banks for further funding. His business, developing corrosion inhibitor for PETRONAS, is now making an average of RM10 million to RM15 million sales a year. The business has currently operated for more than 6 years.

He also commented on the lack of commitment on the part of MTDC's officers toward his business. He believes that the officer in charge lacks the passion and necessary skills to assist him in doing business. He said,

> "*This people are working people. They are not entrepreneurial in their mind. They don't have a heart or give a damn about the emotional feeling that you have. You are emotional to your project. They don't care. They work from 9 to 5 and that's it. Your emotional issue....they don't care. I got my key performance index to meet. If your claim is not right, I'll reject. There is no compassion*", (Respondent 6).

8.3.3 Policy

Realizing the importance of Science and Technology (S&T) in technology and economic development, the government has implemented a number of policies that helps to govern the Science and Technology related activities.

The development of Science and Technology policy can be traced back in the early 1970s when the first Ministry was setup to oversee S&T issues in the country. However in the early years of its establishment, the Ministry was considered as a low profile Ministry with limited portfolio. Then in 1975, an advisory unit was established with an idea to provide advice to the ministry on S&T development. Apparently, the committee did not have the capacity in coordinating different ministries to support research activity.

Technology Development in the country received greater attention when the fourth Prime Minister took office in 1981. The reformation of the Science and Technology Policy and structure was implemented and it became more established for better co-ordination of technological development. During the tabling of Fifth Malaysian Plan in 1986, the first National Science and Policy (STP1) was introduced. Under the STP1, the Government has identified five structural weaknesses in Malaysian technology development. One of the weaknesses identified is the lack of action plan in implementing technology policy. It was then in 1990, the government implemented the Action Plan for Industrial Technology Development (APITD) for better coordination in Science and Technology Development. It also gave recommendations to strengthen the role of Science and Technology by establishing some support agencies in technological development. This has resulted in the government introducing new policy and strategy for technological development in the country.

The second Science and Technology Policy (STP2) came into effect in 2002, after the government revised the STP1. It can also be argued that the introduction of STP2 is partly due to the country's second financial crisis. During the crisis the government come to comprehension about the importance of knowledge–based economy for survival. The STP2 addresses seven key priority areas in order to support the transformation of the Malaysian economy from an input-driven growth to high value added and knowledge-based economy. Table 8.2 provides comparisons of the strategies under the three policies.

The National Intellectual Property Policy (NIPP) is another policy initiative implemented by the government to protect IP activity in the country. The NIPP acts as a guideline for all entities in the countries that engage in IP related activities. These include government agencies, research

institutions, HEIs and private sectors. The NIPP is administered by the Ministry of Domestic Trade, Co-operatives and Consumerism (MDTCC). The policy initiative was launched in 2007, marking the government's commitment in addressing IP as an engine for wealth creation and for economic growth. It was designed to create a strong IP landscape to encourage inventive activities amongst the local as well as the foreign investor and making Malaysia an IP hub in the region. The main rationale was to develop a principle guideline (law and regulation) for IP related activities.

Table 8.2: Comparison of the Strategies between the Policies

STP1 (1986)	APITD (1990)	STP2 (2002)
National Development	Government need to provide leadership to better co-ordinate to support institutional and infrastructure for technological development	Strengthening R&D capacity and capability
Integrate science policy with other policies		Promoting commercialisation of research output
Upgrading national scientific capabilities	Enhancing the diffusion of market-driven technology efficiently in the country	Developing human resource in S&T fields
Self reliance		Promoting the culture for science, innovation and techno-entrepreneurship
Encouraging R&D activity	Indentify and focusing on specific technology	
Developing human capital	Strengthening the institutions and mechanisms for continual development in the country	Strengthening the institutional structure, monitoring mechanisms and the implementation of S&T policy
Encourage private sector participation		
Facilitate transfer of technology	Fostering the awareness of the importance of R&D and providing a conducive environment in fostering technological development	Ensuring the widespread and the use of high valued technology leading to market driven R&D
Identify centre of excellence		
Formulating plan of action		Specializing in key emerging technologies

Source: compiled by the author

Another policy initiative implemented by the government specifically governing commercialisation activity is the Intellectual Property Commercialisation Policy (IPCP). IPCP were introduced in 2009 under the purview of MOSTI. The main objective of the policy was to provide guidelines on IP and commercialisation activity that is funded by the government. As it was highlighted in the STP2, one of the strategies was to promote the culture of innovation and techno-entrepreneurship in the country. Thus it is imperative that the government provide

conducive environment within which innovations can be protected and exploited to benefit all parties. The main objectives of IPCP are:

1. To establish a common framework to regulate the ownership and management of IP
2. To promote and facilitate the protection of intellectual property in line with the National Intellectual Property Policy
3. To promote and facilitate the exploitation and commercialisation of Intellectual Property generated from projects funded by the Government of Malaysia

The IPCP was designed to protect the ownership of IP and commercialisation activities generated from the Government fund. Until then there was no policy available to protect government funded IP exploitation activities.

One interesting feature of IPCP is about the ownership of intellectual property. The policy stated that any research activity conducted using government grants shall have the ownership of the IP vested in the recipient. This is similar to the implementation of Bayh-Dole Act in the US, giving exclusive rights and control over the invention to the inventor.

The policy also laid out the wealth sharing guidelines amongst those who participate in the research project. The wealth sharing guidelines explain how financial gains generated from the commercialisation activity should be distributed. The main intention was to have a fair rewarding system in order to encourage innovation activities in the country.

The government also recognized the creative idea and innovative research by introducing incentives schemes for researchers and inventors under the IPCP. The incentives were part of the government initiative to encourage innovative culture in the country especially amongst the academic and government researchers.

8.3.4 Government Incentives

The Malaysian Government recognizes contribution in S&T development by introducing special awards towards excellent achievement in R&D activity in the country. The first award introduced by the Government was the National Science Award. It was introduced in 1985 as recognition towards the development of S&T and local R&D activity. Currently there are eight awards introduced by the government as a source of motivation for R&D development in the nation (See Table 8.3). Award recipients receive a certificate of appreciation and cash reward.

Table 8.3: Awards

National Science Award	National Inventor Award
National Young Scientist Award	National Technologist Award
Science and Technology Journalism Award	NCSRD Awards for Mathematics Education
NCSRD Award for Institute of Research and Development	NCSRD Award for the Advancement of Public Understanding in S&T

Sources: www.mastic.com.my

Besides the award, the government has introduced a number of fiscal incentives for commercialisation of academic research. The fiscal incentives, such as pioneer status with 100% tax exemptions for 10 years and personal tax deduction for individual researchers creates conducive environment for researchers and companies to get actively involved in R&D activities.

In order to further encourage the innovation culture, under the IPCP, the government has created a new incentive scheme to aim at showing appreciation and recognition of creative ideas and innovative research amongst the local researchers. This incentive scheme is as follows:

- Disclosure of invention : RM500
- Filing patent : RM5 000
- Granting of Patent : RM10 000

The government incentives show the seriousness action of the government in developing R&D capabilities amongst the local researchers. It also clearly indicates the intervention of government at all levels of S&T development including the people at the bottom of the chain i.e.

the researcher. Getting a direct acknowledgement from the government is considering a major motivation factor to actively engage in R&D activity.

8.3.5 Infrastructure

The Technology Park is one of the evidence that the government has provided basic infrastructure to encourage and facilitate high-tech industries in Malaysia. Within the park, tenants enjoy a number of state-of-the-art facilities and incentives in terms of rent subsidies, tax exemption etc. Currently Malaysia has more than four technology parks which focus on developing high-tech industries.

Besides the technology park, another major initiative is the establishment of the Multimedia Super Corridor (MSC). The main rational behind the establishment of MSC was to support the development of high-tech industries, to disseminate hi-tech information and facilitating technology transfer to local industries (www.mscmalaysia.my). The MSC is located in Cyberjaya, adjacent to the Federal Administrative Centre of Malaysia (Putrajaya). The location of MSC near the Malaysian Government Administrative Centre shows the important role in fostering technological development in the country. Companies operating in MSC enjoy a number of incentives such tax incentives, government grants and freedom of ownership among others.

The National Incubator Network (NIN) is another proof of government determination to provide infrastructure that can nurture R&D and commercialisation activities. The NIN plays a major role in capturing, clustering and nurturing successful techno-entrepreneurs in the nation. The Multimedia Development Corporation (MDeC) is responsible for monitoring the progress of the incubation network and is fully responsible for facilitating the initiatives to attain the government's vision. Currently there are 19 incubation centres, of which 12 centres have achieved MSC status.

8.4 Discussions and Findings

The discussion of the case studies in Section 8.3 showed some important findings in commercialisation of academic research in Malaysian universities. These findings sought to answer the research question on the nature of commercialisation in Malaysia. It is anticipated that this chapter will provide an understanding of the government initiatives in facilitating R&D and commercialisation activity in the country.

As depicted in Figure 8.2, the interview evidence revealed that R&D phases in Universities can be separated into four distinct phases (fundamental, applied, pre-commercialisation and commercialisation phase). At each phase of R&D, the government has allocated specific funding mechanism and infrastructure with an adequate policy to govern the activity. There are also specific Ministry responsible at different phases of R&D and each Ministry offers specific grants. The government provides support in terms of research and commercialisation infrastructure such as the Technology Park and the Incubator facilities. Overall there is evidence that the Government provides a lot of support for research and commercialisation activity in Universities.

Figure 8.2 shows that government assistance is skewed more in favour of research activities than for commercialisation. It is interesting to note that the Ministries (MOHE and MOSTI) are monitoring the earlier phase of R&D whereas a government agency is responsible for commercialisation activity. This shows that the government gives more priority to research activity than commercialisation activity.

The case study also revealed that there are more than one Ministry involved in R&D phases as shown in Figure 8.2. It can be argued that that this greatly slowed down decision making as the R&D phase needs to go through each individual Ministry and the agency until finally arriving at the commercialisation phase. One can also argued that the monitoring is much efficient within the ministry but the coordination between the other Ministries on R&D activity might is effective.

Another interesting finding is the type of fund provided by the Ministries. Each ministry provides their own research grant which varies based on the type of research to be conducted i.e. fundamental or applied research by the researchers. However since each grant is offered specific Ministries and agencies, there seems to be a lack of consistency between each ministry in terms of application or continuation of the research grants. Applications have to be submitted separately to each ministry. Furthermore in terms of monitoring, no department monitors or follows up the recipient/researcher's research activity. This allows a researcher to complete a research and move on to another Ministry with a 'new' application and new record. It therefore becoming difficult to keep track with recipients making it simple for researchers to be in receipt of multiple awards.

It is interesting to note that the government has formulated adequate policies to govern and to encourage research and commercialisation activities. The STP I & II and NIPP provide a favourable environment in terms of encouragement, coordination and protection for IP produced in universities and GRIs. The formulation IPCP was to provide protection on IP and commercialisation activity funded by the government (up to Techno-Fund). However there is lack of government policy that governs commercialisation activities between university and industry.

Furthermore, in regards to policy, there were a few respondents expressing their grievance. They believed that the government should not always change its policies especially relating to research and commercialisation. This created an obstacle when it came to applying for grants as most government grants had priority areas that the government intended to focus on. If the research conducted in the university is not in line with the government priority area, the chances to secure the grants were slim.

8.5 Conclusion

This chapter has presented the analysis and discussed the findings on the government's initiatives in facilitating commercialisation activities in the university. The discussion in this

chapter, which was drawn from the case study, is focused on government policy, infrastructure, ministries and government agencies, grants and government incentives.

With regards to policy, the government has implemented a number of policies that have been formulated to protect and encourage R&D and commercialisation activity conducted in the university. Most of the policies focused on research and development (the earlier phases in diagram 2 Figure 8.2). Policies on commercialisation activities were rather limited or new. This finding clearly shows that even though the government stresses on innovation and exploitation of IP in Malaysia, proper policy to govern the activity is still lacking.

In terms of monitoring, two ministries are directly involved with R&D activity at the university level. The ministries are also responsible for managing grants up to the pre-commercialisation phase. As for commercialisation activity, this phase is solely managed by MTDC. Furthermore MTDC has been given the responsibility of managing CRDF for commercialisation activities conducted in the University. The segregation of authority shows evidence that the government is focusing more on research activity rather than commercialisation activity in the country.

In conclusion, it can be implied that the Government has taken a moderate stand on commercialisation activities in the universities. Even though the government has implemented a number of policies and initiatives, but the implementation has been left solely at the discretion of the University Management Team. Academic believes that Government policies are not encouraging enough to promote commercialisation activities in the university.

Chapter 9

Conclusions

9.1 Introduction

This chapter summarises and concludes the thesis. Section 9.2 reviews the research question put forward in this study and the objective of the study. Section 9.3 offers the findings of this study in relation to the research question followed by limitations in this study in Section 9.4. The next two sections 9.5 and 9.6, respectively, present the contribution of the study and recommendation of further research in the issues of commercialisation amongst the universities in Malaysia. The last section 9.7 provides a conclusion to the chapter.

9.2 Research Question and Objectives

This study seeks to understand commercialisation activities in Malaysian universities. The tri-lateral concept used in this study is to explain the role of the government, the university and academia in facilitating and maintaining commercialisation activities in Malaysia. The main objectives are to provide systematic description on the nature of commercialisation activity in Malaysia and to explore the factors that motivate academics to commercialise. At the start of the thesis two-research questions were put forward to guide the study. These were

1. What is the nature of commercialisation of academic research activity in Malaysia?
2. What factors motivate academics to venture into commercialisation?

The first objective of the study is to explore the Malaysian government initiative in promoting commercialisation of academic research output in Malaysian Universities. As it has been noted, government action plays an important role in fostering commercialisation and forms an important part in national innovation system. This study seeks to explore the initiatives and measures adopted by the government to facilitate commercialisation in the Universities. Identifying government initiatives can provide a better understanding of the current scenario in

commercialisation. This also gives an insight into the type of intervention used by the government in promoting commercialisation in the country.

The second objective of the study is to examine the university's initiatives and programs in assisting academics to commercialise their research output. Identifying relevant assistance is crucial to this study because it points out the underlying issues that hinder the commercialisation process. The second objective shed some light on the management practices in the Universities and the reaction of academic towards commercialisation activity in the Universities.

The third objective of this study gave insight into academic perceptions towards research and commercialisation. This objective sought to understand the reason behind the transition from being an academic towards becoming an entrepreneur. This disclosed some interesting findings as to what motivates academia to do commercialisation, and the conditions in which they will attempt to exploit their intellectual property. The study also identified factors that impede or discourage academics from getting involved in commercialisation in the context of developing economies.

The three objectives put forward in this study provide an overall view on commercialisation of academic research output in Malaysian Universities. The government, the University and the academia form a tri-lateral concept that explains the role of each actor and highlighting underlying issues regarding commercialisation activity in Malaysian Universities. The next section will present summarized findings from Chapter Five to Chapter Eight. Summarised findings are presented based on the objectives of the study.

9.3 Summary of Key Findings

One of the key findings based on the analysis is the types of policies taken out by the government. There is substantial evidence that the government exercises persuasive forms of policies rather than directive forms of policy. The implementation of a reward and incentives system is an example of the government trying to influence performance. The form of policy has a significant impact on the level of commercialisation activity. Since commercialisation is akin

to voluntary work, the activity attracts a less favourable attitude from the academic staff. This has resulted in low levels of commercialisation activity in the Universities. At the macro level, the unattractiveness of doing commercialisation resulted in slow technological development progress in the country.

The study also found out that the government policies and incentives are biased towards research activity rather than commercialisation. Research conducted in Malaysian universities received greater attention than commercialisation. This further explains why the commercialisation activity in Malaysia is not popular. Based on the Figure 8.2 in Chapter Eight, the study shows that government interest leans more towards research activity. This is evidenced by the fact that there are two ministries responsible for developing research capability in Malaysia but only one semi-quasi government agency is responsible in assisting commercialisation of academic research in the university. As far as the funding assistance for commercialisation is concerned, the study has revealed that the supporting mechanism is limited. The government provides only one supporting mechanism which is the Commercialisation of Research and Development Fund. Academic commercialisation seems to rest on this particular initiative. This will eventually create a high demand for funding amongst academics. This can also mean that commercialisation is not a priority on the government agenda compared to research activity.

Evidence also showed that the Malaysian government *does* acknowledge the importance of research and commercialisation activity as another means of contributing to the country's economic future. Substantial assistance has been provided to facilitate technology transfer and commercialisation activity in Malaysian universities. However, the intervention of government in commercialisation activity is considered minimal as shown in financing assistance and the number of government agencies that are responsible for managing commercialisation activity in Universities. Even though commercialisation received minimal attention from the government, credit should be given to them on the limited initiatives.

From the institutional perspective, the evidence shows that almost all Universities recognized the importance of commercialisation activities. The provision of structures and systems to assist commercialisation shows there is an initiative by the university to support the commercialisation

process. Amongst the most important initiatives is the setting up of a Technology Transfer Office (TTO) in each university. TTO plays an important role to disseminate research output to the market and to provide necessary assistance to academic staff in regard to commercialisation activity. However, there seems to be a general view that the TTO is passive, lacks necessary skills and qualified personnel who can assist academic staff in doing commercialisation. This supported previous findings (Colyvas et al., 2002; Lockett et al,. 2002; Markman et al., 2005a; Markman et al., 2005b; Chapel et al., 2005). It is noted that the majority of the officers in charge of TTO are academic with engineering background. They have none or limited experience in doing business as well as management skills. Most importantly this study identified that the officer in charge lacks the necessary skills to channel the external funding to academia. This limited management skills and funding assistance contributes to the low level of IP exploitation in the Universities. In addition to the issues raised above, the university certainly lacks appropriate policy and guidelines in relation to commercialisation activity.

This study also found that the type of academic commercialisation activity is determined by the type of university. Two of the sample universities are Vocational University and one of them are Research University. Even though Vocational University focuses on teaching and spend less time in research activities, the university is actually engaging in what is effectively considered as commercialisation. It may not be the classical model of commercialisation, like in the research university, but it involves knowledge transfer. From the study, the majority of academic commercialisation activity in vocational university started when academic staff involved directly with industry, solving industrial problems. At first the research collaboration was purely for research and academic purposes but since the university encourage hands-on approach, this collaboration is eventually turned into a joint venture and manages to produce a product which has a commercial value. It is also believed that this forms of joint venture has a better survival rate because trust between both parties has developed prior of starting the business venture. Research University, on the other hand, focuses more on research activity. Research is conducted with a purview to produce intellectual property (IP). The IP produced will go through a number of stages before it is ready to be commercialised. This is an example of the classical model of commercialisation. It is, therefore, the focus of the university has a significant influence on the type of academic commercialisation in the university. To the very best of our

knowledge, none of the current literature highlights the importance of university focus in moulding the type of academic commercialisation activity in the university.

This study also revealed that academic commercialisation is not just about monetization of IP i.e. the classical model of academic commercialisation. Indeed, academic commercialisation is more than that. This study has revealed that knowledge transfer and consultation is another types of academic commercialisation activity and should be given a fair consideration in defining academic commercialisation in the literature. To the best of our knowledge current literature did not discuss in depth the potential of these two types of academic commercialisation. The bulk of academic literature focused more on the formation of spinoff companies and licensing activity. This study shows that knowledge transfer and consultation is much popular amongst academic staff in the three universities. This is because the academic commercialisation landscape in the university is still not fully developed. The lack of proper policies and support for example, made the classical model of commercialisation is less favourable. There is a general sense that monetization of IP involves high cost and associated with high risk whereby consultation and knowledge transfer is much easier to venture. Furthermore, the study also showed that academic staffs found it difficult to persuade industry to involve in University R&D, especially when it involves with product development.

The study also found that government grants for commercialisation of academic research are limited and very selective. The CRDF, for example, is the only available fund to support a full-scale commercialisation activity on research conducted by University academic staff. Hence, the demand for the fund is very high given the fact that there are more than twenty public universities in Malaysia. Given the high demand the fund is very competitive and selective. The high demand, the strict selection process and the secondary task (in doing commercialisation) creates an environment which does not favour commercialisation. This significantly contributes to the low levels of commercialisation activities in Malaysia. Another point of interest is that the main reason behind the high demand of CRDF is the fact that it is a risk-free funding option. This means that academic staff is not liable for anything if the venture, between the academic member of the staff and MTDC, is not successful. Consequently, academia tends to invest minimum effort in the business ventures, as no responsibility is pinned on them. As such it can

be likened to "flipping the coin", with the result that "heads you win, tail you won't lose". View from another perspective, risk-free financing indicates that the government is not result oriented. The government simply provides the financing mechanism and cares less about the outcome. In other words risk-free financing is more like a "give-away funding" that demands no return or responsibility of failure from academia. Yet a key principle of investment requires that the risk should be commensurate to the return. Therefore, the higher the risk the greater the profits expected from the venture.

The government grants are also very selective in the sense that government grants are awarded based on priority areas. Empirical evidence has revealed that research in priority areas received favourable consideration from the government. This favouritism act has its consequences. Such prioritization leads to lopsided research. Academic involved in research in priority areas sand a better chance of being awarded a grant compared to those whose research was not considered to fall within the priority areas. This will eventually discourage academics from pursuing research and commercialisation activity in their areas of specialisation. In addition to that there is evidence that government grants are associated with a high level of bureaucracy. Each Ministry offers different types of grants and each grant has different characteristic and requirements that suit a specific Ministry's objectives. Academics will often find it difficult to match their research interests with the characteristics and requirements of available grants. Furthermore, finding the suitable grant is difficult because there is a lack of coordination between the ministries. Certainly, this study has found that there is a gap in determining the right grants from the appropriate ministry.

This study has also found that one of the reasons commercialisation is not popular amongst academics is because of the negative attitude and perceptions of academic staff towards commercialisation. A majority of the academic staff believed that commercialisation is not important because there is no specific requirement for them to engage in commercialisation activities. Furthermore academic believes that doing commercialisation is associated with high risks and is time consuming. Subsequently commercialisation is viewed as a burden by academia with no real financial incentive. They consider that the salary they draw from being academic staff in the university is more than enough and therefore they see no reason to get

involved in high risk ventures that could lead to a hectic and challenging life. Moreover, working in a public University as a civil servant, provides a sense of job security and the academics are content with that. This directly contributes to the low levels of academic staff taking on the challenge of becoming techno-entrepreneurs.

From the interview evidence, this study has identified eight reasons why academic were keen to venture into entrepreneurial activity. The empirical evidence showed that the main reason or the main motivational factors for academia getting involved in commercialisation is often the promise of financial reward. The academic staff expressed the fact that academia should be allowed to find a way of turning knowledge into financial return or gain without which commercialisation would end up being just another community service. This contradicts current literature (Nilsson and Friden, 2006; Shapero, 1984; Blair, 1998; O'Shea et al., 2005) which suggested that monetary reward is a secondary objective of commercialisation. This suggested that government policy and initiatives did not have a strong motivational influence on the commercialisation process. Academics are motivated based on personal or individual factors. This shows that there is a gap between the government and the academics in terms of motivation to do commercialisation.

Findings also showed that the concept of 'academic revolution' has limited influence on the Universities in the three universities. There is evidence that the traditional role of the university i.e. teaching and learning is firmly entrenched in the university's systems. The idea of the 'entrepreneurial university' is still at infancy stages and requires more to be done in terms of its development. Even though the universities provide basic infrastructure and guidelines, the universities in this study take a moderate stand on the development of the entrepreneurial university.

9.4 Limitations of the Study

This study has a number of limitations. First, is in relation to the number of case studies. Originally, the research design was planned to include all technical Universities in Malaysia. However, due to cost and time constrains, the researcher had to limit the number of case studies

to just three. Furthermore, some universities denied the researcher access to information regarding research and commercialisation activity in the university.

Second, this study is heavily depended on the secondary data on government initiatives and strategy because the researcher was unable to secure an interview with key government informants. Third, time and financial constraints limit the number of respondents and could limit the generalisation of findings to a larger population.

Another limitation is the method used in data collection. Since this study used qualitative approach and heavily depended on interviews, the skills of interviewing can influence the outcome of the interviews.

9.5 Contributions to Knowledge

The findings from this study did not solve the world's problem nor save the world. It only contributes to the knowledge pool on academic commercialisation literature especially in the context of developing economies. The contributions from this study are only a drop in the ocean but nonetheless it is important for knowledge expansion and understanding in the area of technology management.

This study showed that the type of academic commercialisation i.e. spinoff formation, licensing, consultation and knowledge transfer is strongly influence by the type of university i.e. Vocational University and Research University. The evidence showed that academic staffs working in Vocational University is more likely to forms collaboration with the industry than in Research University. Furthermore in Vocational University research conducted is based on knowledge sharing and hands-on experience. These types of program can eventually be developed further into business venture. On the other hand, academic staffs in Research University tend to conduct research with the intention to produce IP and publication and not for IP exploitation. Academic commercialisation in Research University was a secondary objective since this activity received less persuasion and encouragement from university. Moreover in Research University commercialisation carries a minor point unlike publication and patent

submission received better point and prospect for promotion. This finding is an extension to the current literature on academic commercialisation. It has been agreed that university plays an important role in IP exploitation through the provision of policies, human resource and infrastructure but the current study shows that even though the university provides all the necessity in making commercialisation activity works, the type and focus of the University is considered to be another important factor in making academic commercialisation works. The example in UTM showed that commercialisation is still very low even though the University has provided necessary assistance. This is because UTM focuses much of her effort on research activity.

The current study shows that academic commercialisation is more than the formation of Spinoff Company and licensing. The bulk of academic commercialisation literature mainly discusses the issue regarding the formation of Spinoff Company and issue in licensing. However current research points out that spinoff formation and licensing received less favouritism than the formation of Spinoff Company and licensing. Instead, empirical evidence shows that consultation and knowledge transfer is much more popular amongst academic in the three universities. This findings contribute to the current literature in the sense that academic commercialisation in developing countries are more keen to venture in this type of commercialisation activity rather than the formation of spinoff company and licensing. These two types of commercialisation are popular due to the less exposure to risk compared with the previous activity.

Another contribution from this study is the important role of the university towards facilitating commercialisation activity. This study has identified, from the three universities, the university's role in developing research and commercialisation capabilities in the university. The implementation of policy, recognition system and infrastructure, affect the research and commercialisation activity amongst the academics. Government policy has less influence in the research and commercialisation activity in the university (Powers, 2003; Dietz and Bozeman, 2005).

9.6 Recommendations for Future Research

The suggestion for further research is drawn from the findings and discussion in the current study. The areas for further studies are presented below under the relevant research theme.

The current study can be developed through an expansion of the research sample in the current universities. By including other universities, government research institutes and private research institutions, a comparative study on the framework, procedures and personnel involved in the commercialisation would give interesting findings on the impact of commercialisation activity in the country. This expansion of the research sample can contribute to literature in the context of developing economies.

Secondly the existing findings can be used to form the base for the expansion of the research objective in two main areas. Firstly, the issue of the management of the technology transfer office can be investigated more in-depth. Secondly, further analysis can be developed through strategy and organizational characteristics of technology transfer offices in universities in Malaysia. This requires detailed and multiple interviews with representatives from each technology transfer office to enable the development of issues raised within the current study.

Lastly, suggested further research can be developed is in the area of financing mechanism i.e. CRDF. The evaluation of CRDF would provide interesting findings as to what extent financing assistance helps academic to commercialise. The study will cover the main rationale of its establishment and provide its current status in assisting the commercialisation activity.

9.7 Conclusion

This study has examined the commercialisation activity in Malaysian technical-based universities. It has provided a reasonable understanding on the current trend of commercialisation and initiatives by the government and university. This study also presented findings on factors that motivate and influence academics to venture in entrepreneurial activity in the context of Malaysia. It is hoped that this study will provide insight into the nature of

commercialisation activities in the country for policy makers and the university to promote academic commercialisation in Malaysian Universities.

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APPENDIX 1

Interview Questions for Academic Staffs

1. Would you describe briefly the commercialisation activity in your institution/department?
2. In your own word please define commercialisation?
3. How would you describe the university's and faculty's attitude in general towards commercialisation?
4. Have you been involved directly and indirectly with any commercialisation activity?
5. What are the factors that facilitate and impede commercialisation activity?
6. How would you describe the university's attitude in general towards working with the industry?
7. How would you describe industry's attitudes in general towards working with the university?
8. What kind of support and guidance you received from the Technology Transfer Office? Did you receive significant input?
9. Have you received significant assistance from any other sources?
10. What about the funding? Are you satisfied with the funding arrangements?
11. What are your expectation from the government and university in encouraging commercialisation activities of academic research?
12. Do you have any other comments and questions?

APPENDIX 2

Interview Questions for University Administrators

1. Would you describe briefly the commercialisation activities in your institution/department? What major developmental stages can be distinguished?

2. What are the nature of commercialisation of academic research in your institution/department (e.g. joint research, contract research from industry, consultancy, spinoff formation and others)?

3. What had motivated your institution/department to forge collaboration with industry? Why is it so important for your institution to promote industrial links?

4. In your opinion, what are the factors that facilitate and impede (within the institution and the external environment) the influenced of commercialisation of academic research?

5. How would you describe academics' attitudes towards working with industry?

6. How would you describe the willingness of industry to have collaboration with the university?

7. What are the common problems in commercialising academic results with the industry?

8. What are the problems commonly associated with research commercialisation?

9. What do you expect from the government in promoting commercialisation of academic research?

10. Do you have any other comments or questions?

APPENDIX 3

Biographical Detail

This appendix presents the details of the respondents participate in this study. A total of 29 respondents from three universities participate in the current study. Out of this 23 respondents are academic staff and the respondents are from different background and discipline. Six of the respondents are university administrator and they are being selected from different level in the university management team.

Respondent 1

Respondent 1 is appointed as a research officer in Department of Food Technology in 1996. She was then been transferred to the Department of Bioprocess Engineering when later on she continued her PhD degree in one of the English University in Chemical Engineering. Upon returning to Malaysia, she is actively involved in food technology research and was elected to head a research group named FOBERG.
She found her interest in commercializing her research when she was heavily involved in research exhibition. The research exhibition gives her the opportunity to meet with the industry which eventually gives her an insight of market demand. Furthermore there is also evidence peer pressure plays an important factor in encouraging her to commit herself in business world. She wanted to follow a number of senior lecturers who are aggressively engaged in commercialization activity in the university. She is in the middle of 40s.

Respondent 2

He was in the middle of 50s. He joins the university as an assistant lecturer in 1976. He then further up his doctoral degree in one of the English University. His research background is in communication specializing in wireless. His main contribution in research concerned wireless bridging using a flat antenna. He received a couple of IRPA grants to develop a complete solution for flat antenna using lower frequency. He manages to sell his product to a number of Malaysian universities, used in the incubator centre.
He commented that commercialization activities in university received less support because based on his experience; he received very minimal assistance from the university in commercializing his product. He believes the university is lacking an expert in this field. According to him the university lacks the human capital in handling university commercialization activities. For him, he felt very lucky because at the time his finishing his study, the demand for cellular phone and that he is actively involve as a technical consultant in a few communication company in Malaysia. Working as a consultant enables him to establish business networking with the industry and eventually inspires him to produce marketable product.

Respondent 3

He was 38 and held a degree in electrical engineering from American university. Currently he is on sabbatical leave, reading for his PhD in one of the Malaysian university. He is attached to

Department of Microelectronics and Computer Engineering. Before joining the university, respondent 3 used to work as a researcher in Malaysian Institute of Microelectronic Systems (MIMOS). After completing his master degree, he is actively involved in research and consultation works. During his free time, he works as a freelance programmer and product developer. He has submitted an application for CRDF grant and was shortlisted as one of the recipient.

Respondent 4

He is in the middle of 50s. He is a professor in Mechanical Engineering and a Dean of Research Management Centre. He received his education from English Universities. He held a degree in mechanical engineering, a master in thermo and fluids mechanics and a PhD in condensation technology. His research interest is on air conditioning system; focusing on compressor. He has been working as a technical consultant for a number of private firms and has decided to engage in commercialization activity. He has received the CRDF grants but his project is postponing due to financial constraint faced by his collaborator. The collaborator finds some difficulties in getting extra funding to match the grant. From his side (technical perspective), his work and progress is on track.

Respondent 5

This respondent was 35. He holds a degree in Mechanical Engineering and a PhD in Biomedical Engineering, specializing in biomechanics and biomaterials for medical applications. He is the Deputy Dean for Research and Graduate Studies. He has secured a number of research grants for medical application research and has been working as a consultant in local hospital. He also involved in commercialization of orthopedic implant and dental implant, collaboration with a local firm. He spoke mainly on the problems associated with the commercialization activity, in which according to him there are two main problems for his projects; funding and support. For the orthopedic implant, he believes the main reason his product cannot get 'through' is because of political intervention. The company has already approach the ministry but they have been turn down due to favoritism. For another project, he finds it difficult to continue as the amount of grant received from the government is not sufficient to conduct further testing for the product. He is now looking for another source of funding for the project.

Respondent 6

By profession, respondent 6 is a qualified engineer. Before joining the university, he works with PETRONAS in a dredging department. When he joined the university, he was appointed as the director of technology transfer office. His main responsibility is to assist academic to commercialize their research output. He received his education in American university. He was in the late 40s. He gives comment on the commercialization activity in the university which he believed the main problem behind the low number in commercialization is the lacks of qualified personnel within the university besides bureaucratic issues.

Respondent 7

Respondent 7 was in the early 50s and a professor in biochemical. His research interest focuses on biotechnology specifically on nutrition and herbs. He received his education from English university in the area of chemical and biochemical. Currently he is the deputy director of chemical engineering pilot plant (CEPP). He is very active in research activity especially in biotechnology research and was appointed by the university to head a collaboration research with Korean university on herbal study. Besides research he also did consultation works on business development and product development. He is well known in the industry as product developer. However, according to him, the main reason of him doing commercialization is not about making money, rather it is about creating an opportunity and responsibility.

Respondent 8

Respondent 8 is an associate professor in faculty of electrical engineering. He was in middle of 40s. He is a graduate from English university. He obtained his PhD in high voltage and pulsed power engineering and currently a deputy dean in the Institute of High Voltage. His main research interest is in ozone technology. Using his knowledge in ozone technology, respondent 8 has successfully commercialized his product in the market. He collaborates with individual entrepreneur and act as a technical consultant to the firm. However, one interesting observation about respondent 8 is that he is very energetic to turn his research product into financial gain but did not have any interest in becoming a businessman. He choose to be a 'silent partner' in any ventures.

Respondent 9

Respondent 9 received his professorship at the age of 38. He is one of the youngest professors in the university. He obtained his PhD from English university in chemical and process. He is active in research and commercialization. His research interest focuses on membrane technology. He is one of the recipients of CRDF for commercializing his research output producing membrane for water treatment with local firm.

Respondent 10

This lady scientist was 48, with an education background in polymer chemistry. Her research concerned on packaging and molding technology. The finding has helped her to further develop several varieties usage such as biodegradable product. She spoke mostly about problem associated with commercialization of her research output. She believed the university is not serious in assisting commercialization activity within the university. Based on her experience, her commercialization process is not completed. She has secured one local firms to become the collaborator and have submitted application for CRDF. Once the grant is approved she handed over the case to the technology transfer office to follow up the procedure. Sadly, according to her, she was left in the dark. She does not know what the status of the particular project is since the technology transfer office took over her case. She was hoping the technology transfer office be more aggressive and responsive towards her case.

Respondent 11

The interviewee was in her early 50s and held a first degree and a PhD in chemical engineering from an American university. She was the deputy dean of research and postgraduate study at her university. She is interested in commercializing her research output but she faces some financial constraint. She has two projects that are ready to be in the market. However, due to some financial constraint, she has to keep aside for a while. The third project has been turn down when she apply for the CRDF. The fund provider believes that her project needs more works before it can be accepted in the market.

Respondent 12

The respondent was the dean of his faculty. Previously he was one of the management team of university technology transfer office. He was in the middle of 40s. His education background is in statistic and obtained his PhD from European university in technology management. He discusses mostly about the reason why the university commercialization activity is still poor. One of the key problems is the academic attitude towards research and commercialization. The majority of the academic believes that research activity received better pointer than engaging themselves in entrepreneurial activity. Besides he believe that the university need to have a good structure and system in order to make commercialization activity works.

Respondent 13

This young scientist was in the late 20s. He obtained his PhD degree from Japanese university in robotic. He is very active in publication and has received numerous awards for his outstanding research and publication activity. Commented on commercialization, he states that senior lecturer should be doing it and not for junior lecturer like him. Junior lecturer should spend more time on research activity and publication rather than venturing in entrepreneurial activity. He is strongly believed that publication is more important than commercialization because it carries high point in terms of promotion exercise. Moreover publication is another mean for academic to be well known in the academia world.

Respondent 14

Respondent 14 was in the middle of 30s. He holds a diploma degree in food technology and started working as a research officer in R&D department of a food factory. For 5 years he works there and manages to produce 150 formulas for the cultured milk drink. He then continued his degree in chemical engineering. Once he completed his study, he continued to work as a research officer for two years. He then continued his master degree and was appointed as a lecturer. Speaking about commercialization, this young scientist has successfully commercialized 3 research output. Two of his product is related to water treatment and the other one is for pest control. One interesting facts about his product is that he started his research without any research fund or any special facilities. He claimed that he used anything that is available within the faculty to complete his research. For him, the attitude and initiative is the most important factor if one chooses to excel.

Respondent 15

The interviewee is in the early 50s. He holds a degree in mechanical engineering and a master in business administration. He graduated from American university. He is working with the university technology transfer office as the deputy director. He went to argue that in commercialization, the researchers' needs to conduct a proper market survey in order to make sure the product is acceptable in the market. What is happening right now is that a researcher conducted a research without prior understanding of market demand. He believed it should be a market demand and not product demand. This explained the low number of commercialization in the university.

Respondent 16

This interviewee is a senior lecturer with a background in mechanical engineering. He was in the early 50s. He is from English university. He is one of the recipients of CRDF for commercializing his research product. He spoke mainly about wealth creation through commercialization activities. He believed commercialization is another means of promoting university amongst the public. It also reflects the research culture of the university. High numbers of commercialization means high numbers of research and high numbers of patent filed.

Respondent 17

He is the dean of technology transfer office for his university. He was in the early 50s. He has a background in electrical engineering. He has been working as an academic for more than 30 years. He spoke on why commercialization did not get much attention from the academic is because it is quite difficult to get industry to involve in research project. He said the majority of the industries are reluctant to collaborate with the university. Industry is more interested in making profit rather than investing in research and product development.

Respondent 18

The respondent was in the late 40s. He graduated from Malaysian university with a background in mechanical engineering. He is one of the recipients of government grant to produce prototype of energy saving equipment for building. He is also involved in consultation on mechanical engineering design.

Respondent 19

This interviewee was 36. He is the officer in charge of commercialization in university's technology transfer office. He has a degree in technology management. Previously he works as a deputy director in advertising firm. He spoke mainly about the importance of exposure in order to encourage commercialization. He believed that academic are very enthusiastic in venturing in entrepreneurial activity. However, due to lack of exposure in business knowledge, many academic fails in this area. He claimed the main reason contribute to this situation is because of the majority of them are fresh graduates with limited experience working with the industry.

Respondent 20

This young scientist is very energetic and ambitious in doing commercialization. He was in the early 30s. He has a degree in Mechatronic and MSc in Electrical Engineering from Malaysian university. He spoke mainly about his fundamental belief on doing a research that can help other people to solve their problem. Base on his previous experience working as a researcher in electrical manufacturing firm, he will only carry out a research project if and only he can identify the potential customer first. He will not conduct a research just for fun or for promotion purposes. He believed by identifying the potential customer, he can tailor his research towards the customer preferences and also it will cut down the research time as he has already known what the customer wants.

Respondent 21 and 22

Both respondent 21and 22 was in the early 30s. Respondent 21 has a master degree from Australian university in multimedia whereby respondent 22 obtained her PhD in computer science from English university. Both of them are from the Faculty of Information and Communications Technology. The research team manages to produce software for dyslexia patient, to help the patient in improving their reading skills. The project was initiated when they are involves with industrial attachment in the dyslexia treatment centre. In the beginning, the research project was just to assist the patient in improving their reading disorder. A simple software was developed to helps the patient. Later on they come to realize that the software has commercial values.

Respondent 23

The respondent is in the late 30s. He is from the Faculty of Mechanical Engineering. He holds a PhD degree in vehicle dynamics control from local university. When talked about doing commercialization, he admitted that he don't have any experience of doing it. Currently he is focusing on his research. However he did mention about the difficulties in securing government research grants. Even the university, for that matter, is very strict and very selective in giving research funds to the academic staffs. He is also actively involved with consultation works with the industry.

Respondent 24

Respondent 24 is in the late 20s. He holds a degree in electrical engineering from one of the Malaysian university. He then received his master degree from Australian university. Currently he is involved in wireless communication research in one of the centre of excellence in the university. During the interview, he did mention about his ambition to commercialize his research output. However at the moment his research is still at initial stage, further research and development is needed before it can be commercialized. He also commented on the difficulties to secure a research grant for his research project.

Respondent 25

The respondents just completed his master degree from Australian university. He holds a degree in Mechatronic and Electrical Engineering. The respondent is in the early 20s. He is very active and jovial. His main research interest is on antenna for communication. He is very active in publication. He won a few universities' award for publication. However he has no intention of venturing academic commercialization activity. He strongly believes that as an academic the main task is teaching and researching, not commercialization. He states that doing commercialization requires huge amount of time and very risky. \

Respondent 26

This young scientist is very active in doing research. He is in the late 20s. Right after he finished his first degree, he works as a research officer in one of the local university. He holds a degree in Computer Systems and Communication. His research interest is in the area of wireless communication and antenna. Currently he holds a number of research project funded by the university. In terms of commercialization, he works as a consultant for two major communication companies in Malaysia. He is in charge of 3G cellular system network.

Respondent 27

Respondent 27 is a research officer in Chemical Engineering Centre of Excellence. He is in the middle of 30s. His main interest is in the study of bird's nest. He is very active in research and publication and he has won a number of awards locally and internationally. Commenting on research and commercialization activity, he believes a good network and relationship is important to be established prior of the business venture. He has successfully commercialized his research output. He was also appointed as a consultant in few firms. For him creating an opportunity is important in making sure his customer continues to seek his expertise. This is done by continuing organizing a short course to his potential customer. As he mentioned it before, a good relationship with the industry is really important. For that the bulk of his research funding been funded by the industry. According to him the government and university research fund are very competitive.

Respondent 28

Respondent 28 is an academic who holds administrative position in the university. He is in the late 40s and holds a degree in civil engineering. He is in charge of university spin off company. Prior of joining the university, he works as a project manager in one of the GLC.

Respondent 29

Respondent 29 is the officer in charge in university technology transfer office. He holds a degree in management technology. He has been working in the unit for more than 4 years. Based on his experience managing research and commercialization activity in the university, he commented that university is still needs a lot of improvement in terms of policies and incentives. According to him, one of the main reasons the numbers of commercialization activity in the university is still low is because of academic staff attitude. He believes academic staffs are very passive when it comes to commercialization. To some extent academic staffs are not aware of university initiative such as the existence of technology transfer office.